KNIGHT'S
AMERICAN
MECHANICAL
DICTIONARY

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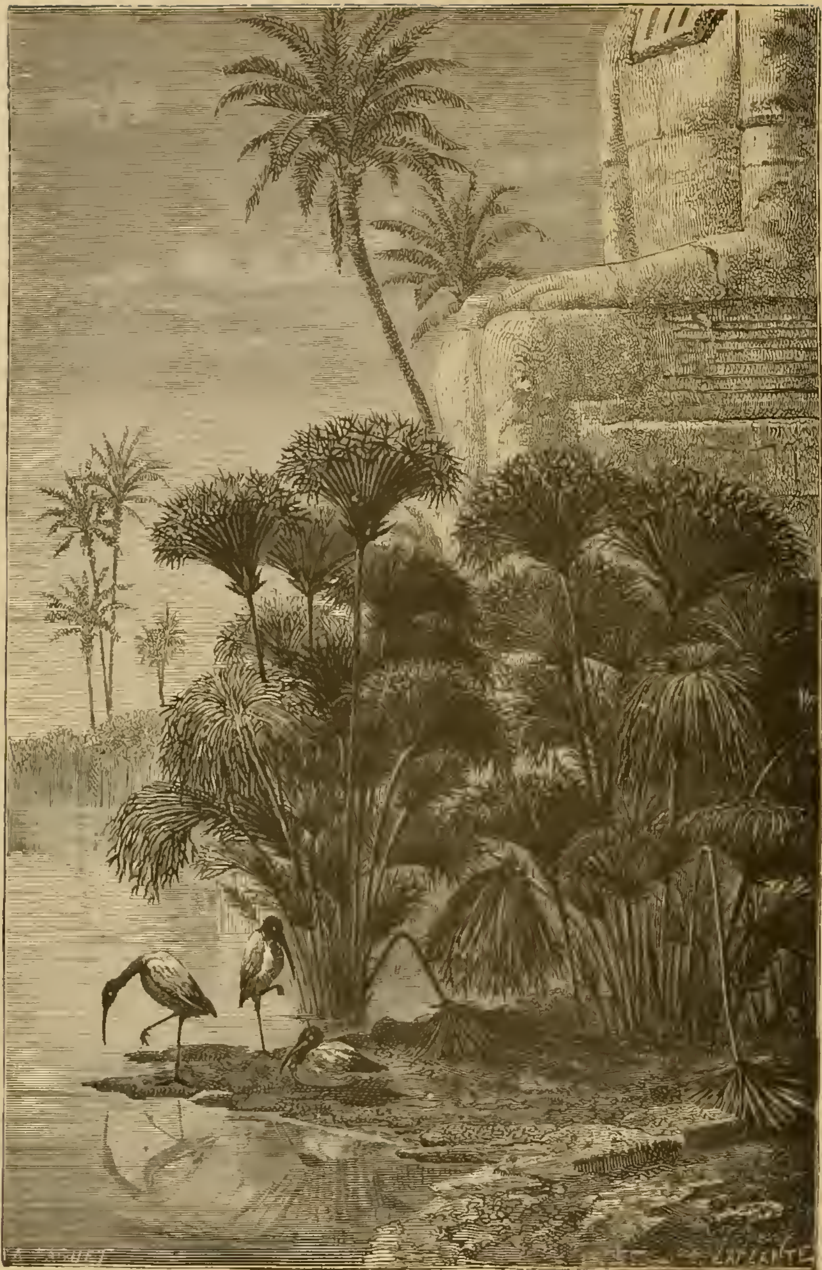


THE PAPYRUS-PLANT OF THE NILE.

PLATE XXXVI.

See page 1604

KNIGHT'S
AMERICAN
MECHANICAL DICTIONARY.

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES,
AND ENGINEERING; HISTORY OF INVENTIONS;
GENERAL TECHNOLOGICAL VOCABULARY;

AND

DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.

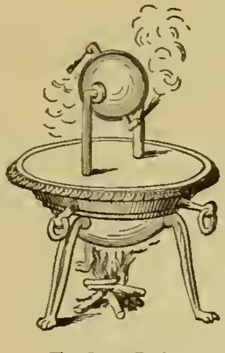
By EDWARD H. KNIGHT,

CIVIL AND MECHANICAL ENGINEER, ETC.

Illustrated
WITH UPWARDS OF SEVEN THOUSAND ENGRAVINGS.

VOLUME II. — GAS–REA.

"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light." — LUCRETIUS, Book V.



First Steam Engine.

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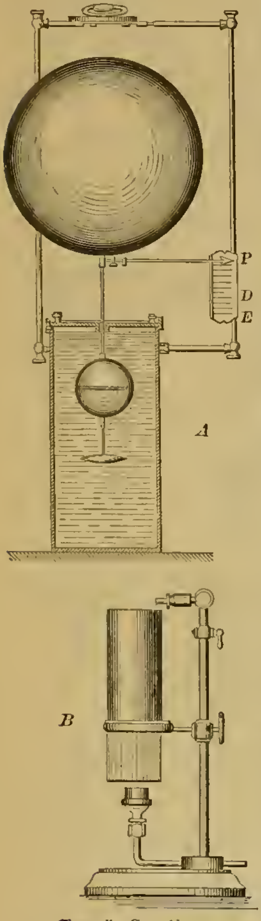
supply from certain localities for repair or other purposes. These are hydraulic water-traps, in fact, consisting of inverted cups shutting down over the top of the pipe, which is turned up for that purpose beneath a small dome; or other mechanical devices are used, such as spring or slide valves, which are essentially similar to some described under VALVES. An essential part of the distributing apparatus is the meter; these are *wet* or *dry*, and are described under GAS-METER.

Gas-a-larm′. A device invented by M. Chuard, and described in the forty-fourth volume of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, 1845.

Fig 2162.



Chuard's Gas-Alarm.

It is called by him a "gasoscope" (*A*), and was intended to indicate the presence of carbureted hydrogen in mines and dwellings. It is constructed like a very delicate areometor, with a light metallic stem, surmounted by a thin glass globe filled with atmospheric air. The lower ball, which gives it buoyancy, and the suspended weight, which maintains its vertical position, are submerged in a vessel of distilled water. The weight is graduated, so that the normal condition of the air causes the finger to indicate zero on the scale; *P*, pure. When the surrounding air becomes mixed with hydrogen, the relative weight of the glass globe will be changed, its contained air being heavier than the air and gas by which it is surrounded. It will then sink, and the pointer will indicate upon the graduated scale a dangerous degree of suffusion of the air; *D*, danger. When nearing the point *E*, explosion, a stud on the stem trips a trigger or comes in contact with a magnet, by which a lever is moved and a hammer caused to sound upon an alarm-bell.

Several other devices founded upon endosmotic action have been proposed. A bladder of air is placed in a position exposed to the action of escaping hydrogen, and by the absorption of gas its form or specific weight becomes changed, the change being made the means of mechanically actuating a device which sounds the alarm.

Another gas-alarm for mines or rooms consists of a galvanic battery with a bell and a glass tube filled with chloride of palladium. This metallic salt is extremely sensitive to the presence of carbonic-oxide gas. A small quantity of the gas will at once throw down some of the metal from the solution, and this precipitate collecting in the bottom of the tube, at once establishes a connection in the current of electricity, and the violent ringing of a bell will warn the sleeper of his danger.

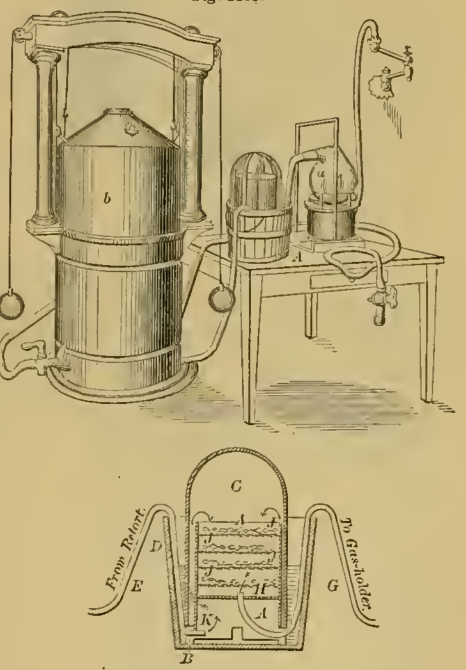
Van der Weyde's burglar-alarm *B* is so arranged that the opening of a door or window to which it is connected will turn a gas-cock and emit gas into a cylinder, where it is exploded by contact with a small, constant burner above.

It has an upper metallic cylinder and a lower apron of wire gauze, into which the gas enters as the lower gas-cock is turned by the opening of the door. As the gas reaches the upper end of the tube and is ignited at the burner, it produces a shrill sound which may be heard by the inmates of the house. The apparatus may be placed within the room which is being surreptitiously entered, or at any other point, connected by wire with the door of said room, and conveniently situated to alarm the person in charge.

Gas′a-lier. A stem or dependent tube having a group of branches tipped with gas-burners.

Gas-ap′pa-ra′tus. The apparatus for making nitrous-oxide gas is shown in Fig. 2163. It consists of a retort *a*, purifier *A*, and gas-holder *b*. The purifier *A* is a copper cylinder, divided into two chambers by a gas-tight horizontal disk *H*. The cylinder is pierced just below the disk by a number of small holes. *B* is a wooden stand; *C*, a glass vase covering the cylinder; *K*, a short pipe, to which the conducting tube is attached, curving under the vase, and passing into the lower chamber and connecting with the retort by a rubber tube *E*. A similar pipe communicates with the upper chamber, and is connected with the gas-holder by tube *G*. The cylinder is loosely fitted with four wire-cloth disks *J*, placed equidistant, on which is spread lime.

Fig. 2163.



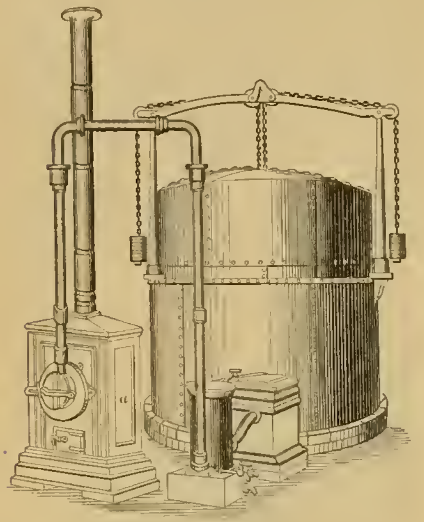
Nitrous-Oxide Gas-Apparatus.

The whole apparatus sits in a vessel *D*, which should be about half full of water.

The gas passes from the retort by tube *E* into the lower chamber, is partly washed by the water, passes out at the small holes into the inside of the vase, up into the top of the cylinder, down through the lime into the pipe *A*, and to the gas-holder by tube *G*, as indicated by the arrows.

Fig. 2164 shows a portable apparatus for making the usual carbureted hydrogen for manufactories or country mansions, having a furnace and retort *a*, a condenser, washer, purifier, and gas-holder, connected by pipes with couplings, so as to be set up on a pavement or floor without special excavation or building. See also Carburetor, and the subjects under the following heads: —

Fig. 2164.



Portable Gas-Apparatus.

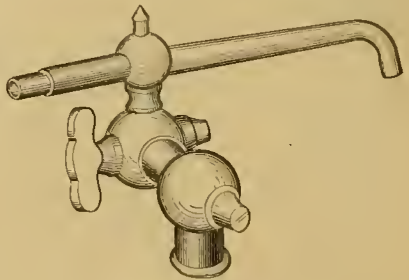
Ammoniacal gas-engine.
Argand-burner.
Bat's-wing burner.
Burner.
Butterfly-burner.
Carbureting-machine. Air and gas
Compensator.
Detonating-tube.
Dry-meter.
Electrophorus.
Eudiometer.
Exhauster.
Fan-tail.
Fish-tail burner.
Gas.
Gas-alarm.
Gasalier.
Gas-apparatus.
Gas-bellows.
Gas blow-pipe.
Gas-bracket.
Gas-burner.
Gas-check.
Gas-compensator.
Gas-condenser.
Gas cooking-stove.
Gas-engine.
Gas-fitters' tongs.
Gas-fitting tool.
Gas-gage.
Gas-generator.
Gas-governor.
Gas-heated furnace.
Gas-heater.
Gas-holder.
Gasing.
Gas-injector.
Gas-lighter.
Gas-lighting by electricity.
Gas-machine.
Gas-making.
Gas-meter.
Gasometer.
Gasophaner.
Gasoscope.
Gas-pipe.
Gas-pipe tongs.
Gas-pressure indicator.
Gas-pressure regulator.
Gas-purifier.
Gas-register.
Gas-regulator.
Gas-retort.
Gas-retort charger.
Gas reverberatory furnace.
Gas-stove.
Gas-torch.
Gas-washer.
Hydraulic main.
Hydraulic valve.
Hydrocarbon burner.
Lid-closer.
Lighter.
Lighting gas by electricity.
Nitrous-oxide apparatus.
Oil-gas.
Oxygen-gas apparatus.
Oxyhydrogen-light.
Petroleum-still.
Photometer.
Quicksilver-valve.
Scrubber.
Seal.
Switch.
Tar-well.
Tell-tale.
Torch.
Vapor-burner.
Water-gas.
Wet-meter.

Gas-bel'lows. A kindling device consisting of a hollow poker attached by a flexible tube with the gas-pipe. The end of the poker is perforated, and is thrust among the coals in the grate or furnace, so that the ignited jet may start the fire.

English patents of 1854 and 1856 describe bellows connected with a gas-reservoir, and also a portable apparatus containing compressed gas, and having a nozzle which may be thrust among the coals.

Gas Blow-pipe. A form of blow-pipe designed to be attached to a gas-pipe, for using gas instead of oil or alcohol. The atmospheric air is driven through the center tube, adding force and giving a cylindrical form to the flame, which issues at an annular opening.

Fig. 2165.



Gas Blow-Pipe.

Gas-brack'et. A branch proceeding from a wall and having on its end a burner or burners.

Gas-burn'er. The jet-piece at which the gas issues.

It consists of a slit or of a number of orifices disposed so as to produce the shape of flame required.

The *fish-tail* flame is made by two oblique orifices at an angle of about 60°, so as to cause the jets to cross each other; the object is divergence, to spread the gas and bring the carbureted hydrogen in contact with the air.

The *cock-spur* burner *a* has three apertures, one central and the others divergent.

The *union* burner *b* has a row of holes so disposed that the jets touch and nearly coalesce, each maintaining in part its distinctiveness.

The *bat's wing* *c* has a slit aperture instead of holes, giving a flat, fan-like flame.

The *beak* has a round, smooth hole $\frac{1}{28}$ of an inch in diameter.

The Boccius light, named after the inventor, consists of two concentric, metallic cylinders, placed on the flame and within the usual lamp-glass, so as to modify the combustion and increase the brilliancy of the light.

The *Argand* burner *d* is a hollow annulus, the upper surface of which is pierced with a circle of small openings having a diameter of from $\frac{1}{32}$ to $\frac{1}{50}$ of an inch. It also has a central aperture to allow access of air to the inside of the flame as well as the outside.

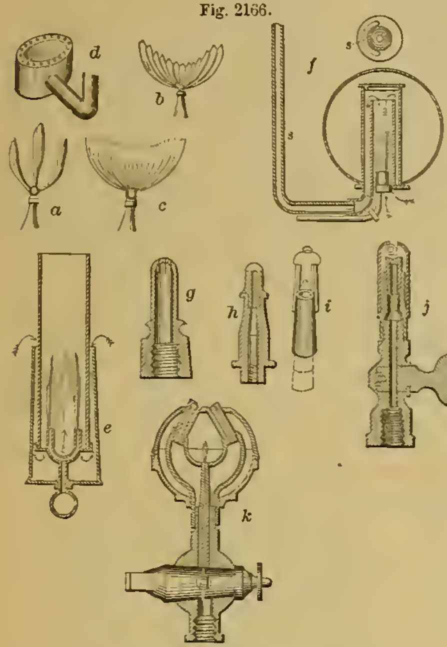
The jets from each hole unite to form a cylindrical flame. The holes are about $\frac{1}{6}$ of an inch asunder, and when there are ten holes in the circle the middle opening will be $\frac{4}{10}$ of an inch in diameter. With twenty-five holes the central orifice will be about 1 inch in diameter.

Burners with ten, fifteen, twenty, or twenty-five holes have central apertures $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{5}$, and $\frac{95}{100}$ of an inch in diameter. The flames of these burners may be raised without smoking to the height of $3\frac{1}{2}$, 3, $2\frac{1}{2}$, and 2 inches respectively. The glass chimneys for the burners mentioned should be $\frac{8}{10}$, $1\frac{2}{10}$, $1\frac{3}{10}$, $1\frac{5}{10}$ of an inch in diameter respectively.

The *Bude* burner has two or three concentric Argand rings.

The *Winfield-Argand* has a metallic button above the annulus to deflect the central current laterally.

Fig. 2166.



Gas-Burners.

A contraction of the chimney above the jet has a similar effect upon the exterior envelope of air.

Leslie's Argand has a series of small tubes arranged in a circle, which eject the gas in a conical form just below the contraction of the chimney.

Frankland's burner *e* is an Argand with two chimneys, the outer one standing on a plate so as to be closed at bottom, and the air passing between the two for the supply of the flame.

Faraday's ventilating burner *f* removes the products of combustion, and prevents their mingling with the air of the apartment. It is shown in vertical and horizontal section, the arrows indicating the course of the air, and *s* being the exit-pipe for the effete air and gases.

g is a three-slit burner.

h is a soapstone-tipped burner.

In *i*, the elongated ring upon the burner has on its sides two arms supporting fine platinum wires bent over at the top, between which is a spongy platinum with wires at the bottom to ignite the gas issuing from the jet of the burner.

j is also a platinum coil-lighter, the resistance of the metal causing it to become red-hot when a current of galvanic electricity is passed through it.

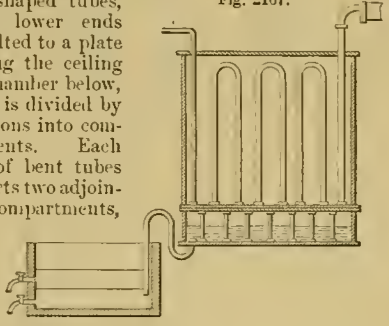
In *k*, a small axial tube supplies the jet in the bulbous cap around the main burners; the jet remains lighted while the main pipe is closed, and is closed when the main pipe is lighted. The same spigot acts to make these changes of connection, having side ramifications which conduct to the axial tube in the former case, and a divisional piece which closes the said tube in the latter case.

Gas-check. A ring or plate at the rear of the charge chamber in some kinds of breech-loading ordnance, such as Broadwell's, Krupp's, Armstrong's, etc. It is designed to close the rear aperture completely, and prevent escape of gas rearward. See GAS-RING.

Gas-con-dens'er. The gas from the retorts is passed through the condenser to rid it of the tar. It comes hot from the retort, and is passed through the convoluted pipes, which are surrounded by water, precipitating the tar. It is the second in the series of apparatus in gas-making, — *retort, condenser, washer, purifier.* From the latter it passes to the gas-holder and the distributing mains. The condenser gathers about eight or ten gallons of tar from the gas produced from 2,000 pounds of coal. The tar is used, in connection with paper and gravel, for roofing; and combined with sawdust, gravel, and various other matters, in making pavement. It is distilled to obtain different grades of hydrocarbon liquids used for illumination and in the arts.

The form of the condenser is a tank having a submerged series of siphon-shaped tubes, whose lower ends are bolted to a plate forming the ceiling of a chamber below, which is divided by partitions into compartments. Each rank of bent tubes connects two adjoining compartments, so that the gas is compelled to pass through each set, by which it is brought to the temperature of the air, the tar and ammoniacal liquor being condensed and collected in the lower chamber, whence they are drawn off into a cistern.

Fig. 2167.



Gas-Condenser.

Where 100,000 cubic feet of gas are produced every twenty-four hours, the condenser should have a surface of from 800 to 900 square feet.

Gas-en'gine. An engine in which the motion of the piston is caused by the combustion or sudden production or expansion of gas in a closed cylinder.

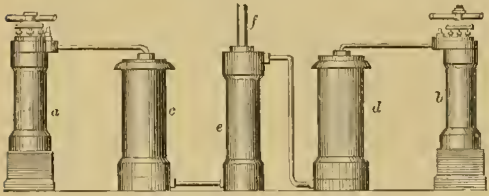
The first gas-engines were gunpowder-engines, the gas generated by the explosion being the means of expelling the air, the condensation of the gases producing a partial vacuum in the chamber. See Brown's English patent, vacuum engine, 1824.

D'Hautefeuille, in 1678, seems to have been the first to use this power ; Huyghens applied it in a cylinder so that the atmospheric pressure might force a piston downward when the vacuum was thus formed beneath it. Papin substituted a bell-valve over the air-eduction port, for the collapsible leathern tubes of Huyghens.

In 1791 Barber took an English patent for a gas-engine in which a stream of carbureted hydrogen gas was introduced at one induction port and a quantity of atmospheric air at another, the resulting combustion giving an explosive force against the piston. Street, in 1794, proposed to use the expansive power of heated gas instead of its explosive power. Lebon's French patent of 1799 described the distillation of carbureted hydrogen from coal, and its introduction into the cylinder beneath the piston and simultaneously at another channel a proper proportion of atmospheric air. The mixed gases were then exploded by the electric spark (see also Pinkus's English patent, 1840), their dilatation furnishing the desired motive-power. The engine was self-regulating and operated two pumps, one of them designed to introduce the supply of gas, and the other that of air.

Brunel's gas-engine (1825) consisted of five distinct cylindrical vessels ; the two exterior vessels *a* and *b* contain the carbonic acid, reduced to the liquid form, and are called the *receivers ;* from these it passes into two other vessels *c* and *d*, called *expansion vessels.* These latter have communication with the central vessel or working cylinder *e*, the piston of which is operated by the alternate expansion and contraction of the gas, giving motion to machinery through the medium of the piston-rod *f*.

Fig. 2168.



Brunel's Gas-Engine.

Heat and cold are alternately applied to the contents of the receivers by means of steam, water, etc., circulating through pipes which pass through the *receivers.* The air in the *expansion*-chambers presses upon a body of oil in the chamber, and through it transmits the pressure to the piston. It being much easier to make an oil-tight than a gas-tight joint, the direct access of gas to the piston is thus obviated.

If water at 120° be passed through one cylinder, the gaseous contents will have an expansive pressure of 90 atmospheres, and cold water be passed through the other receiver, the latter will exert a force of from 40 to 50 atmospheres. The difference in the pressures, say 45 atmospheres to the square inch, will be the power on the piston (at the start).

Davy and Faraday, about 1823, succeeded in reducing several gases to a liquid state by means of great pressure and very low temperature. Upon releasing the pressure, the gases were found to again expand to their original volume. This discovery again turned attention to gas-engines. It was ascertained — a result which was of course expected — that in the condensation a considerable amount of caloric was rendered sensible, and that in re-expanding the same amount of caloric was rendered latent.

Cooper, 1835 (English patent, No. 6875), describes an engine in which one part oxygen and two parts hydrogen are ignited to produce a vacuum alternately on each side of a piston.

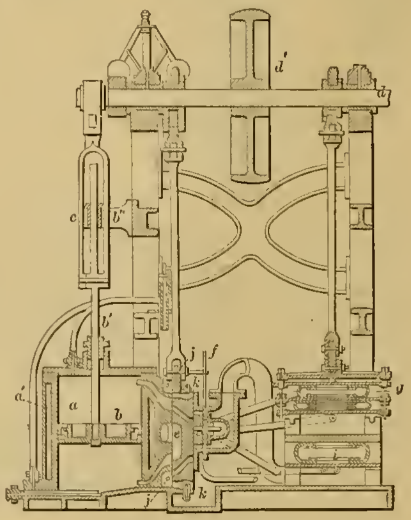
In Sir James C. Anderson's (English patent, No. 11,273), two cylinders open at the ends are placed end to end. A web of gun-cotton is fed to cylinders alternately and ignited by electric spark.

Johnson's British patent of 1841 proposed to introduce pure hydrogen gas and oxygen instead of atmospheric air, in order that the water, the resultant of the explosion, might render the vacuum practically perfect.

Otto and Langen's gas-engine is an upright hollow column, having a heavy piston, whose rod is a rack acting upon a cog-wheel on the fly-wheel shaft ; as the piston ascends, the cog-wheel slips loosely on the shaft. The mixed gases, coal-gas and air, are exploded by communication with the gas-jet, which is kept constantly burning. As the gases rapidly condense after the explosion, the atmospheric pressure, aided by the weight of the piston, is made effective upon the shaft of the wheel by the engagement of the rack-teeth with those of the spur-wheel. See Dr. Barnard's "Report of the French Exposition," pp. 60 – 63. The same excellent report gives an account and illustration of the Lenoir gas-engine, of which three hundred were, in 1862, in use in France. The essential portions are a horizontal cylinder with a piston which communicates motion by a crank to a shaft which carries a heavy fly-wheel. The great weight of this wheel is for a double purpose : to absorb the force suddenly developed by the explosion, and so moderate the speed at this period ; and, secondly, to carry the machine over the one half of its period in which the driving-power is absent. Like the Otto and Langen engine, a water-jacket around the cylinder prevented the latter from becoming overheated. The explosion was made by electric spark. See AIR-ENGINE.

In Hugon's gas-engine, a small quantity of water is introduced into the cylinder along with every charge of gas. By its evaporation the water absorbs some heat, and in becoming steam it prevents the abrupt fall of pressure which follows the explosion

Fig. 2169.



Hugon's Gas-Engine.

when the gases are used entirely dry. The mode of firing is by permanent lights placed on the outside of the cylinder, jets being inflamed at these and taken to the charges at the respective ends of the cylinder. As the explosion exhausts the oxygen of the cylinder, the jet is extinguished. The gases are admitted by a slide-valve, and the lighted jet by a supplementary slide.

The cylinder is shown at *a*, the small space *a′* being the interval between it and the jacket, which is filled with cold water.

b is the piston with its rod *b′*, guided by the support *b″*.

c is the connecting-rod, which is forked below, and attached above to the crank.

d is the arbor moved by the crank, and carrying the pulley *d′*, by which the motive-power is applied. The same arbor carries the fly-wheel at the extremity.

e is the slide carrying the portable gas jets *k k*, and serving also to open the escape passage to the exhaust gases.

f is the induction slide, admitting the explosive mixture to the cylinder.

g is the compressor by which the inflammable gas is introduced into the chamber where the mixture is formed.

i is the reservoir of inflammable gas.

j j are the fixed jets, and *k k* the movable.

In Hugon's English patent 653 of 1863, the explosive force of the gas acts upon a column of water which transfers the force to the piston.

See also Lenoir's patent, March 19, 1861; Dick's, 1867; Million, 1867.

The ammoniacal engine has been termed a gas-engine, but this latter name is more fairly applicable to those engines in which the force is obtained by the inflammation of the charge, rather than to those in which the motor is an elastic vapor under pressure.

Frot's ammonia-engine resembles the steam-engine so closely that comparative experiments with the vapor of water and of ammonia have been made with it. See Ammoniacal Engine.

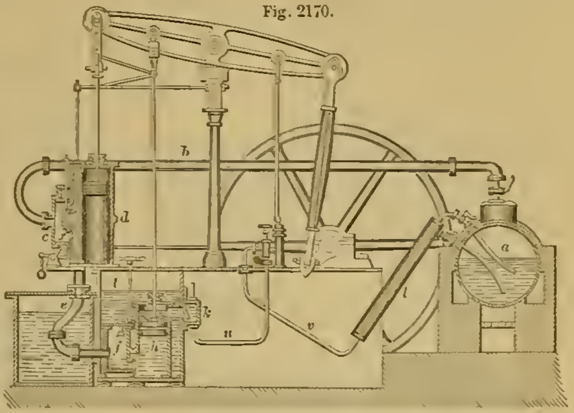
R. Waller (English patent, No. 1019 of 1854) uses condensible and permanent gases; as carbonic acid, ether, air. Vaporizes by steam or hot water.

Arbos (English patent, 3108 of 1862), steam and gas combined.

N. H. Barbour (No. 46,769, March 14, 1865) has a traveling car with reservoir supplied with carbonic acid from condensing stations along the route. See Compressed Air-engines on this principle; Bompas and others, pp. 602–604.

In Delaporte's ammoniacal gas-engine, *a* is the boiler, *d* the cylinder, and *b* the tube communicating between the cylinder and the boiler. *c* is the valve-box, and *x* the slider by means of which the gas is introduced alternately above and below the piston. *e* is the eduction-pipe and *f* the condenser and dissolver. In this machine, the condenser and dissolver are not separate, as in Mr. Frot's. The water of injection is introduced by a pipe and rose-jet at the top of the condenser *f*. The solution passes from *f* into *h*, from which it is withdrawn by the piston *h*, passing through the reservoir *k* and the tubes *u* and *v*, by which it is returned to the boiler. As its return is opposed by the elasticity of the gas in the boiler, it must be forced in, and a small forcing-pump is employed for this purpose. The tube *v* is surrounded by a jacket *l*. The water which has been deprived by heat of its ammonia is withdrawn from the bottom of the boiler by the lower tube, and passes into the jacket *l*, where it imparts a portion of its heat to the solution in the tube *v*, which is on its way to the boiler. It is then discharged by a connection, not shown, and carried through a refrigerator, which is also not shown, after which it is conveyed into the vessel *t*, and is employed for injection into the dissolver *f*. See also Air-engine.

Fig. 2170.



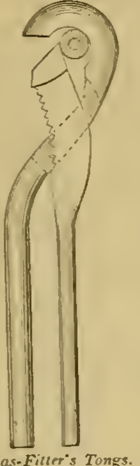
Delaporte's Ammonia-Engine.

Gas-fit′ter's Gage. An arrangement by which the tightness of the joints in a line of pipe is ascertained. The pipes being filled with air by a pump, the pressure-gage in connection therewith remains stationary if the joints are perfect. If the gage fall, ether may be admitted to the interior and the escape detected by a torch.

Gas-fit′ter's Tongs. One for pinching gas-pipe, holding them while screwing joints together, or screwing gas-burners into their sockets.

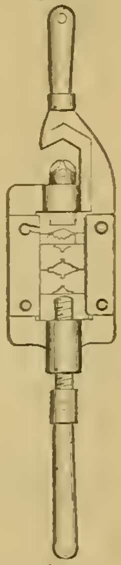
In Fig. 2172, a cutter for cutting off the ends of pipes, a scraper for clearing its surface before forming the screw, dies for cutting the thread, and a cramp for holding the pipe to turn it, are arranged in a frame or stock fitted for the purpose.

Fig. 2171



Gas-Fitter's Tongs.

Fig. 2172.



Gas-Fitter's Tool

Gas-fur′nace. 1. A small furnace, much employed for laboratory purposes, and which is so arranged as to receive the maximum heating powers of the gas without regard to its illuminating purposes. Various forms have been contrived.

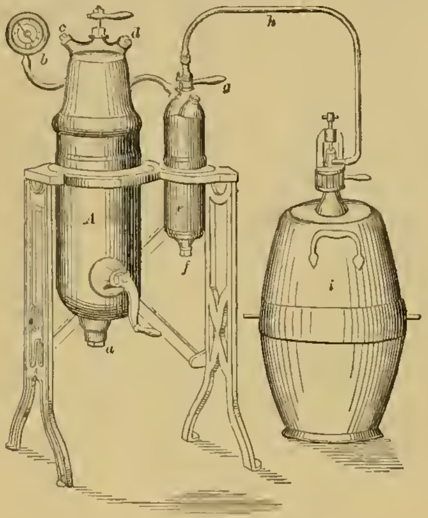
2. A furnace of which the fuel is gas from burners suitably disposed in the chamber for the purpose required. Steam-boilers and metallurgic furnaces are sometimes thus heated. See Siemen's English patent, 1861.

Gas-gage. An instrument for ascertaining the pressure of gas. A bent graduated tube containing water or mercury, open at one end and with the other screwed into the vessel containing the gas. It resembles Lind's anemometer (p. 99), except that the open end is exposed to the gas pressure instead of wind pressure.

Gas-gen′er-a′tor. A chamber in which gas is evolved. The term includes: — 1. The retort in which volatile hydrocarbons are evolved by heat, as in the ordinary gas-apparatus. 2. The machine in which air is saturated with the vapor of liquid hydrocarbon. (See CARBURETOR.) 3. The machines in which carbonic-acid gas is evolved for aërating water or other purposes. Such is that shown in Fig. 2173, in which A is the vessel containing the sulphuric acid in an upper chamber, and the other materials in a lower portion. a is a discharge for spent matter, b is a pressure-gage, c d are openings for charging, e is the purifier, f the discharge for the exhausted materials of purification, g a stopcock in the pipe h leading to the vessel i, which contains the water to be aërated.

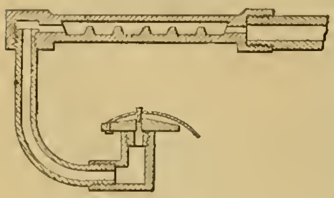
Of an allied character is that for producing the deutoxide of nitrogen for anæsthetic purposes. 4. A device belonging to a vapor-burner in which the liquid hydrocarbon passes from its reservoir into the chamber b between the plates a a, where it is vaporized by heat from the burner f. The vapor of the oil passes by the pipe d to the burner, and the flame is regulated by the thermostatic spring and plug h i.

Fig 2173.



Carbonic-Acid Gas-Generator.

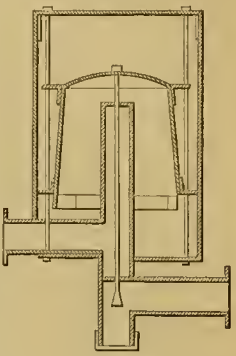
Fig. 2174.



Vapor-Burner.

Gas-gov′ern-or. The gas-governor is a small gas-holder into which the gas enters, and from which it is passed to the mains with a regulated pressure. The velocity of gas in the mains increases in the ratio of the square root of the pressure, so that by adding to this it may either be driven more rapidly or to a greater distance.

Fig. 2175.



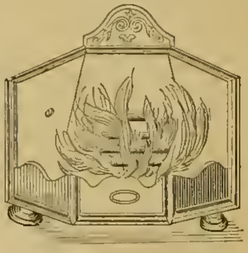
Gas-Governor.

Gas-heat′er. An apparatus contrived for the application of gas to specific purposes of heating.

While every jet of inflamed gas will warm the surrounding air, it becomes necessary, in adapting it specifically for warming purposes, to change the jet from its usual position and in some other respects. In deference to the custom, the gas-heater is sometimes made to assume the forms of grate-bars or logs of wood in the usual fireplace.

Goddard's gas-heater has perforated bars in the form of a basket-grate, and over these is spread a quantity of asbestus, which makes an incandescent mass, resembling a coal fire.

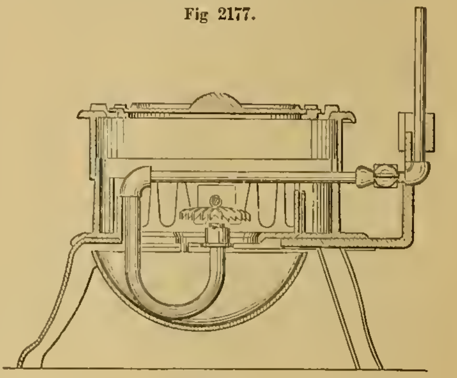
Fig. 2176.



Goddard's Gas-Heater.

In Fig. 2177, the air-regulating dish is formed in the segment of a sphere, and has its concave side upward. The influx of air is regulated by the vertical distance between the edge of the dish and the bottom of the stove. Above the frame is a rotating disk, consisting of a series of inclined sectoral wings, which distribute the heat.

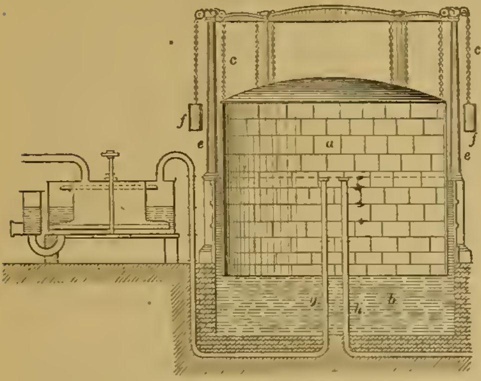
Fig 2177.

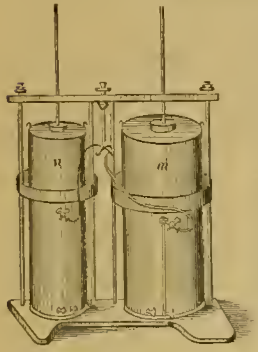


Gas-Stove.

Gas-hold′er. A large, vertical, open-bottomed cylinder a, inverted into a tank b of water, and used for storing the gas from the retorts after purification. Its hight is usually equal to its radius, in accordance with the geometrical law that a cylinder having those proportions has the greatest capacity with a given surface.

Fig. 2178.





Gas-Holders

Gas-holders are now made much larger than they were some years back. A work on this subject, written a few years since, speaks in admiration of the Westminster gas-holders as having a capacity of 250,000 feet. We have far exceeded this.

Gas-holders are made of sheet-iron plates riveted together and daubed with tar inside and out to prevent leakage. They are stayed with rods and braces internally, and are suspended by chains *c* which pass over pulleys on the posts *c* which encircle the holder. Weights *f* on the pulleys partially counterbalance the weight of the holder, the extra weight of the latter being the power which drives the gas through the mains and service-pipes to the burners of the district supplied by it.

Within the frame the holder ascends and descends as it is filled or emptied of gas, the lower edge remaining submerged in the tank to prevent the escape of gas. The gas is introduced and withdrawn through pipes *g h*, whose terminations are above the level of the water in the tank of the gas-holder.

Valves regulate the inlet and outlet apertures, so as to direct the gas into the holder, or to allow it to pass therefrom, as may be required. To prevent the freezing of the water in the tank, the surface of the water is covered with tar in the space between the outside of the holder and the side of the tank.

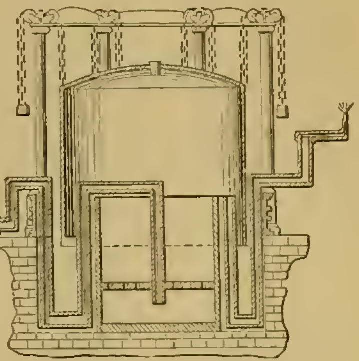
Gas-holders are made of various sizes, from 100,000 to 1,000,000 cubic feet capacity.

For laboratory and exhibitional use a pair of gas-holders is found useful, containing respectively oxygen and hydrogen gas. Their purpose in this connection for the exhibition of the oxy-hydrogen light, or the microscope illuminated by that means, requires that the hydrogen-holder *m* shall have double the capacity of the other one *n*, as the combining proportions of the two gases to form water is oxygen, 1, hydrogen, 2, by bulk. By weight the statement is very different: oxygen, 8, hydrogen, 1; oxygen being sixteen times heavier than hydrogen.

Gas-holders are sometimes made of flexible impervious bags, or sheet-metal cases. These require no particular description.

The weighted gas-holder is the air-forcing device in some forms of carburetors, as in M'Avoy's. In the illustration, the tank *B a* contains the liquid hydrocarbon; the air comes in by pipe *c* to the lower part *a*, where it is distributed through the liquid by perforated plate *b*, and ascends into the holder *A*. It passes off by pipe *d* to the burner.

Fig. 2179.

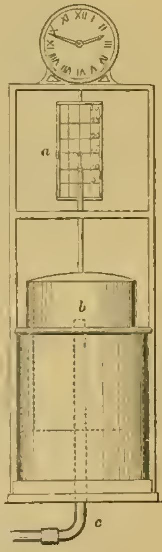


Air-Holder for Carburetor.

Gas-in'di-ca'tor. This instrument is connected to the main pipe, and indicates by the rising and falling of a spring piston, or a weighted gas-holder *b*, the pressure of gas in the pipe *c*.

A register is attached, having a pencil which rises and falls as the pressure varies; and as the pencil rests on a sheet of paper on a drum *a* traveling at a given rate, the diagram gives a faithful report as to pressure and time by the combined movements of the paper and pencil. A *gas-register*.

Fig. 2180.



Gas-Pressure Indicator.

Gas'ket. 1. (*Steam-engine.*) A strip of leather, tow, or textile fabric, to form a packing or calk a joint.

2. (*Nautical.*) A plaited cord by which the sails, when furled, are bound close to the yards or gaffs.

Gas-light'ing Ap'pa-ra'tus. Devices for gas-lighting are matches, spongy platinum, fuse-pipe, electrophorus or voltaic circuit, eliciting a spark, or heated platinum coil. See, in this connection, LIGHTING-DEVICES and GAS-BURNER.

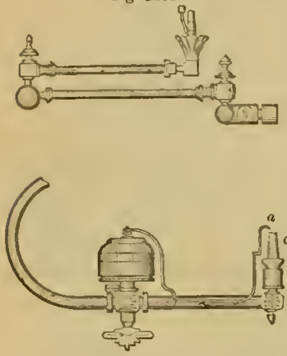
Spongy platinum is heated to redness when exposed to a jet of hydrogen gas, and has frequently been used for this purpose. The effect is more immediate and certain when a stream of pure hydrogen is emitted temporarily, as in Fig. 2181, in which a small cylinder containing spongy platinum is attached to a gas-burner, which throws a stream of gas thereon to ignite the same. A mixture of pure and carbureted hydrogen is first passed through the pipe, and after ignition the flow of the former is stopped.

The *fuse-pipe* is a pipe leading from an accessible position to burners at a distance, and having a row of small openings throughout its length. Gas being turned on issues at these jets, and, a light being applied, runs along the pipe from jet to jet till it reaches the distant burners. It is then turned off.

Gas-lighting by electricity is adopted as a measure of convenience in reaching distant burners, or those in situations difficult to reach. Of the former character may be cited the circles of burners in the dome and rotunda and the cluster in the tholus of the Capitol at Washington ; and of the latter the works at the royal arsenal, Woolwich, England, where all the burners are fixed upon the outside of the windows.

The means adopted are an electric spark produced by friction, as in the *electrophorus*, or a resistance body, such as a platinum coil placed in a voltaic circuit.

Fig. 2181.

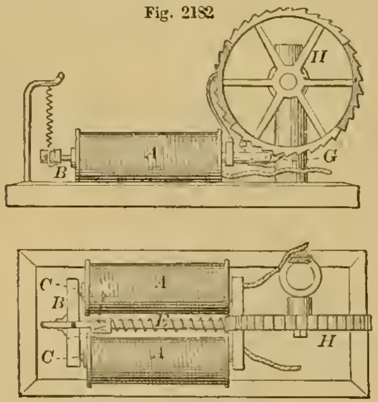


Gas-Lighters.

The electrophorus has assumed many forms : a glass piston in a metallic baton lined with Canton flannel ; a pair of disks with cloth-lined faces, etc. (See ELECTROPHORUS.) Fig. 2181 shows one form in which the device is attached to the stop-cock, so that the act of turning the same to let on gas shall generate a spark at the break of the circuit between the point *a* and the tip of the burner *c*.

The other mode of gas-lighting by electricity is by means of a voltaic circuit. A battery is placed in any convenient place, and is connected by insulated copper wires with the burners. A coil of fine platinum wire, forming a part of the circuit, is placed above and a little on one side of the opening in each burner, and this coil becomes heated by its resistance to the passing current, and so ignites the gas, which has been previously turned on. Or, a break may be made in the circuit immediately above the gas orifice, and the spark leaping across the interval lights the gas. These modes have been adopted in a number of legislative halls, public buildings, manufactories, and stores, on both sides of the Atlantic, and the electric current has been also the means of turning on the gas at the distant points by means of a ratchet-wheel on the axis of the gas-cock, which is turned by the successive pulsations of the armature, the latter being alternately actuated by electric connection and a retracting spring. This device is shown in Fig. 2182. The sliding rod *E* is a stem attached to the armature *B*, and has a click *G* which acts upon the teeth of the ratchet-wheel *H*, whose axis is the spigot of the gas-cock. When the voltaic current is passed through the coils *A*, the armature *B* is attracted, and the ratchet moved one tooth ; the voltaic connection ceasing, the armature is retracted by the spring ready for another impulse.

Fig. 2182.



Gas-Cock Electro-Motor.

On a less extended scale, the burners of a room may be connected with one pole of a battery and a wire hidden in a tassel with the other pole ; when the wire is brought near to the burner, a spark leaps across the interval and lights the gas.

Clock-work has also been employed to turn on and light gas at a set time ; and also to turn off the gas at a prearranged time.

Gas-main. A principal gas-pipe leading from the works, and having branches and distributing pipes.

See also *hydraulic main*, invented by Clegg in 1807, and forming a part of the gas-producing works.

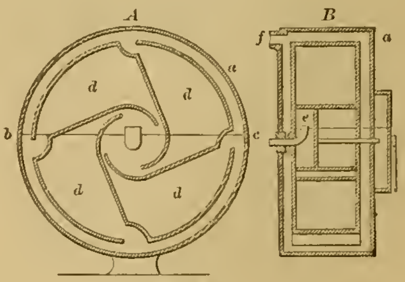
Gas-me′ter. A device for measuring the quantity of volume of passing gas.

Citizen Seguin, of the National Institute of France, described a gas-meter at the sitting of the Institute, October 6, 1797.

The wet-meter was invented by Clegg in 1807, and improved by Crosley in 1815. The dry-meter was invented by Malam in 1820, and improved by Defries in 1838. Many improvements and variations have been added since by various parties.

A (Fig. 2183) is a longitudinal and *B* a transverse section of the wet-meter, which is composed of an outer box *a* partially filled with liquid, as water, alcohol, or glycerine, to the level of the line *b c*, somewhat above its center. Within this is journaled an axis carrying a series of buckets *d d d d*, each capable of containing a definite quantity of gas, which is admitted through the pipe *e* at the central part of the meter, and causes the buckets successively to rise, maintaining a continuous rotation. The gas passes out through a pipe *f* at the upper part of the meter, its quantity being measured by a series of multiplying gear-wheels ; these derive their

Fig. 2183.



Wet-Meter.

motion from the axis on which the buckets are journaled, and register 100s, 1,000s, 10,000s, and 100,000s of feet, the amount being indicated on a series of dials.

Valves are arranged to cut off the supply of gas when the water in the meter rises above or falls below certain limits.

The constant-level meter has an automatic arrangement of float, which, as the water wastes by evaporation, descends and immerses an equal portion of its bulk, which is always equal to the quantity of water which has disappeared.

The principle of the dry-meter may be understood by describing it as a machine having a bellows of known capacity, and alternately filled with gas and emptied, the pulsations being counted by a register. Or it may be described as a cylinder with a reciprocating piston, whose motions are counted, the gas being discharged from the alternate ends of the cylinder as the piston reciprocates. The pressure of gas is the motor, and the changes of direction of motion are effected by induction and eduction valves, much as in a steam-engine.

Sugg's (English) photometric gas-meter is designed for experimental use, to show not only the volume of gas which has been consumed at the end of a given time, but also the rate per hour or per minute that the consumption is proceeding. It has two index-hands, one revolving once in a minute, and moved by clock-work; the other making a complete revolution during the passage through the meter of one twelfth foot of gas. The standard of the London companies is that the gas, when burned at the rate of 5 cubic feet per hour, shall give a light equal to the burning of 14 sperm candles, each consuming 120 grains in the same time.

Gas'o-line. A light grade of petroleum.

Gas-om'e-ter. The term is applied in England to a large vertical cylinder, closed above, and with its lower edge immersed in a water-tank, and used for holding gas. Such a vessel is more appropriately called a GAS-HOLDER (which see). The term *gasometer* probably arose from the fact that the *holder* is of known capacity, and as it rises affords so ready a means of estimating the quantity contained, thus constituting a *meter*. It is usual now to provide a *meter* in gas-works, whose duty it is to measure the gas on its way to the holder.

From gasometer has arisen the term *airometer*, when a vessel of similar construction contains atmospheric air. This is used in one form of blower, in ventilating-machines, in aspirators, machines for carbureting air, and for other purposes. See AIR-HOLDER.

Gas-oph'a-ner. An indicator of the presence of poisonous gases. It is described as a lump of boracic acid, heated to redness in chlorine, and blown into a bulb. Carbonic acid, sulphureted hydrogen, and other deleterious gases, give peculiar reactions on the bulb, and indicate their presence.

Gas'o-scope. An instrument for detecting the presence of carbureted hydrogen in the atmosphere.

It is used, or should be, in coal-mines, to give an alarm when a dangerous and explosive condition of the air supervenes. It may also be applied to detect a leak in the gas-apparatus of a building, or to give an alarm when Aminadab from the rural districts blows out the gas on retiring to bed at the hotel or at the house of his city cousin. See GAS-ALARM.

Gas-pipe. Gas-mains are laid in sections, the small end of one entering the wide socket of the adjacent section. A packing of hemp dipped in tar is driven in to form a joint; over this is a luting of clay, within which is poured hot lead.

Service-pipes are of various metals, wrought-iron tubing being now more common than any other. The sections of distributing-pipe have screw-socket couplings.

The mains are laid with a gradual slope, and at the foot of each incline, or where two descending slopes meet, a reservoir is formed to collect water of condensation. This chamber has an iron cover into which is fixed a pipe, which descends nearly to the bottom of the reservoir. At the summit of the pipe is a screw, which admits the attachment of a pump, by which the liquid in the reservoir is removed.

Gas-pipe Tongs. A wrench for screwing pipes into or out of their coupling. See PIPE-TONGS.

Gas-press'ure Reg'u-la'tor. See GAS-REGULATOR.

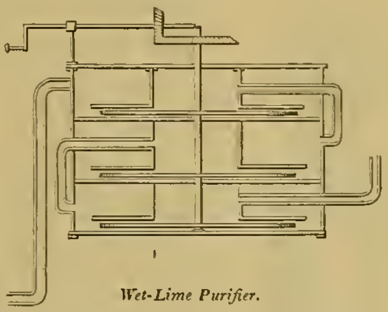
Gas-pu'ri-fi'er. An apparatus in which gas is purified of its sulphur compounds.

The purification of gas by passing it through lime-water is the invention of Mr. Clegg, England, and was introduced in 1807.

The ordinary illuminating gas, after having been evolved in the *retort*, its tar eliminated in the *condenser*, and its ammonia abstracted in the *washer*, is passed through the *purifier*, whose duty is to remove the sulphur and render the gas fit for consumption.

The wet-lime purifier has several chambers containing a certain depth of cream of lime. The gas passes through each chamber in succession, bubbling up through the liquid, the contact being rendered more intimate by arms which rotate in the spaces through which the gas passes in flowing from one chamber to another. The arms also stir up the lime and prevent its settling.

Fig. 2184.



Wet-Lime Purifier.

The cream of lime absorbs the sulphureted hydrogen and carbonic acid, the water absorbs the remaining ammonia.

This process has been generally abandoned on account of the difficulty of disposing of the foul cream of lime known as "blue billy."

In the *dry-lime process* slightly moist hydrate of lime is placed on trays, or iron boxes, through which the gas is made to pass. This process is very effective, and has very generally superseded the wet-lime process. It removes the sulphur compounds and the carbonic acid equally well. When the foul lime is removed, however, it evolves the same odor of sulphide of ammonium which caused the wet-lime process to be abandoned. The suppression of this offensive odor has been effected by washing and special purification. The dry-lime meter has been generally abandoned in Europe, however, as was the wet-lime process previously.

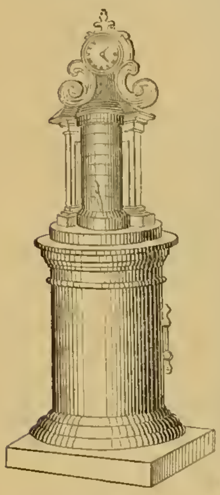
The Laming process, now used in Paris, and generally over the continent of Europe, was introduced in 1849. The hydrated sesquioxide of iron forms a substitute for the lime. It is prepared of a suitable quality by mixing copperas (sulphate of iron) with slacked lime and sawdust, and exposing the mixture to the air to oxidize the protoxide of iron to the sesquioxide. The resulting mixture contains hydrated sesquioxide of iron, sulphate of lime, and sawdust. When an excess of hydrate of lime is employed, the resulting mixture contains this substance also. This material is very effective in removing the sulphur compounds from the gas, and is not offensive when fouled with sulphur. The latter may be distilled to produce sulphuric acid.

The *iron-ore process* of Hill consists in the use of the natural hydrated sesquioxide of iron or bog iron ore, to which is added by the New York Gas-Light Company a quantity of iron borings and turnings moistened by ammoniacal liquor and exposed to the air. To the mixture is added pulverized charcoal. Other ores are used in Germany, where the oxides of iron are used in purification, to the exclusion of all the lime processes.

In some forms of apparatus for the purification of gases which are led through a liquid, a wheel with fans is made to revolve and keep the liquid agitated, while also exposing a large wetted surface to the passing gas.

Gas-reg′is-ter. An instrument by which the pressure of gas is indicated and recorded. The rate of pressure is not uniform, but varies with the season and the hour. An ordinary pressure during the day is $\frac{8}{10}$ of an inch; that is, a pressure which will raise a column of water in a tube to that hight. At night the pressure is increased according to the hour and the season; the quantity burned in winter is double that consumed in summer; more gas is burning at 9 P. M. than at 12 P. M.; and more at the latter than at 3 A. M. The rate being determined according to the judgment of the engineer, a man is placed in attendance, and a register records his doings. This pressure indicator is a cylinder covered with paper and revolved by clockwork. Against it rests the point of a pencil, which is acted on by the pressure of the gas in the mains, and records in a rising and falling line the changes in the pressure, while the vertical graduations of the paper answer to periods of time.

Fig. 2185.



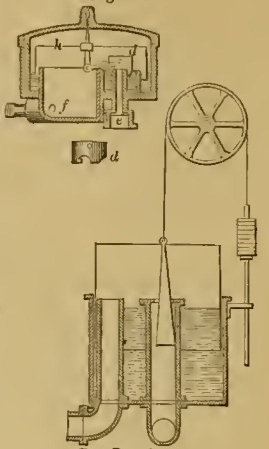
Gas-Register.

Gas-reg′u-la′tor. A device to equalize the flow of gas, notwithstanding varying pressure in the *main* and the variations produced by turning on or shutting off gas to or from burners in the building.

The valve *d* of the regulator is a cup with a notched rim inverted over the end of the inlet pipe *e* and connected by a lever with a larger cup *h*. The edges of cup *h* and valve *d* dip into annular troughs containing mercury.

As the pressure of gas increases, it acts upon the inside of the cup *h*, causing a depression of the notched edge of the valve *d* into the quicksilver. This decreases the opening through which gas can pass to the delivery pipe *f* in such proportion that at the extra pressure and speed an equal quantity will flow.

Fig. 2186.



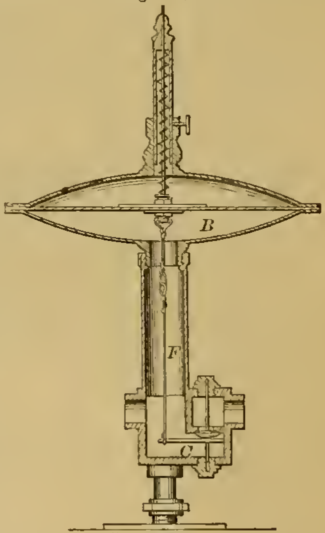
Gas-Regulator.

A decrease of pressure has a contrary effect, increasing the opening. The pressure of gas is beneath both the valve and the cup, but the latter being the larger overcomes the smaller and drives its edge into the quicksilver.

The larger view, Fig. 2186, has also an inverted cylinder which is partially counterpoised by a weight. As the pressure of gas at the inlet increases, the cylinder rises and carries with it the cone, which contracts the area of the gas opening in the plate on the summit of the central inlet-pipe; the pipe on the left is the exit.

Fig. 2187 shows a rubber diaphragm in a chamber wherein the pressure of gas raises the wire *F* and with it the lever *C* on which is the valve. Thus the extent of pressure in *B* determines the position of the valve relatively to its seat, and this graduates the area of opening to the pressure.

Fig. 2187.



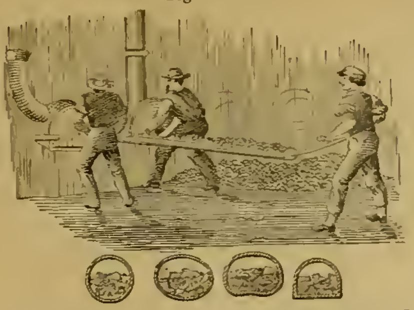
Gas-Regulator.

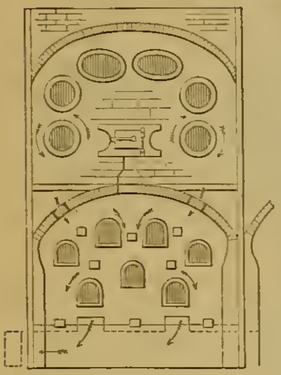
Gas-re-tort′. The chamber in which carbonaceous matter is distilled to produce illuminating gas.

Dr. Clayton distilled illuminating gas from coal in 1688; the "Philosophical Transactions" of 1739 refer to the fact. Dr. Hales in 1726 made a quantitative experiment as to the cubic inches of gas obtained from a given number of grains of coal. Lord Dundonald's patent of 1786 was for ovens or retorts in which coal was distilled. Murdoch in 1792 made lighting buildings by gas a success. See GAS.

Gas-retorts are made of iron or clay, and each in shape is a segment of a cylinder, the flat side forming the floor. These are set in a brick furnace, with their open ends presented outward ready for charging. This is quickly done by a peculiarly shaped scoop, which holds, say, 110 pounds of coal, and is handled by three men, as seen in the illustration. Being introduced longitudinally into the retort, it is upset, and deposits its load on the floor of the retort; a second scoopful makes up the charge, and the mouth of the retort is then closed and luted to prevent the escape of gas.

Fig. 2188.





Gas-Retorts.

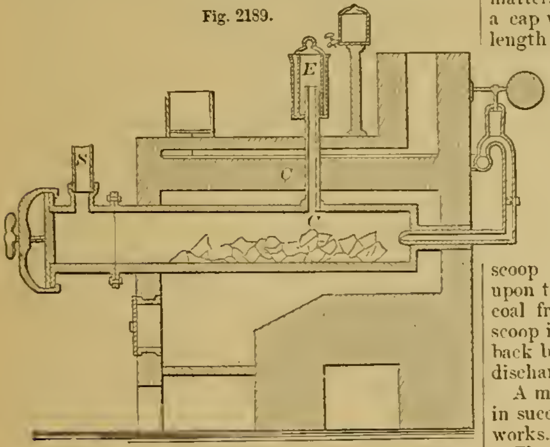
We have Mr. Watson's authority for stating that a retort holds 220 pounds, and that a bench of fifteen retorts is charged in fifteen minutes by three hands. The charge remains five hours in the retort; the coal is expanded to double its bulk and forms coke, but is much lighter, of course.

Some retorts are D-shaped in section, others are oval, and one is noticed having what is called a kidney shape, that is, a general elliptical form is varied by a longitudinal ridge along the bottom.

Croll's gas-furnace, Bow Common, London, England, has an upper series of 6 clay retorts, 18 feet long, constructed to be charged from both ends. The fire has a middle position, and the upper series are heated by the direct radiation from the fire, while the 7 lower retorts of iron, also double, are heated by the caloric current descending from the upper portion of the furnace.

The upper clay retorts are charged every four hours, and the lower iron ones every six hours. The average yield per day is 8,500 cubic feet per retort; 8,500 × 13 = 110,500 feet. Twelve of these furnaces are used at the Central Gas-Works, Bow Common, London, having a capacity for 1,326,000 cubic feet daily. The usual make of gas at these works is 900,000 cubic feet per day.

Fig. 2189.

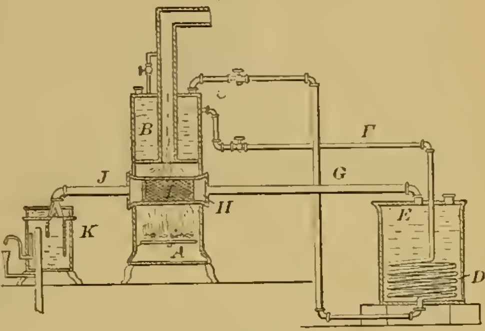


Gas-Retort.

Fig. 2189 shows a retort in which illuminating gas is made from tar introduced from vessel *E* into retort *C*. The tar passes through the water which is contained in the washing vessel above the retort, and which forms an hydraulic stopper to the retort. The steam is generated in pipes over the retort and passes into the latter. The retort is heated to redness and contains coke. A jet of steam is introduced at the rear pipe, and the carbureted hydrogen passes off at *S* to the main.

Fig. 2190 is an arrangement of mechanism for roasting hydrocarbon vapors, or changing them into permanent gases, by exposing them to heat while minutely divided or separated into small streams. The vapors generated in the vaporizer by steam from the boiler pass to the roasting-chamber. The vapor traverses the longitudinal perforations in the charcoal block, and is thus divided into streams to be more effectively acted upon by the heat. It then passes to the condenser.

Fig. 2190.



Gas-Apparatus.

A is the furnace, *B* the boiler, *C* steam-pipe to vaporizer *E*, which contains steam-coil *D*. *G* vapor-pipe to roasting-chamber *H*. *I* charcoal-block, which divides the stream of vapor. *J* pipe leading to condenser *K*.

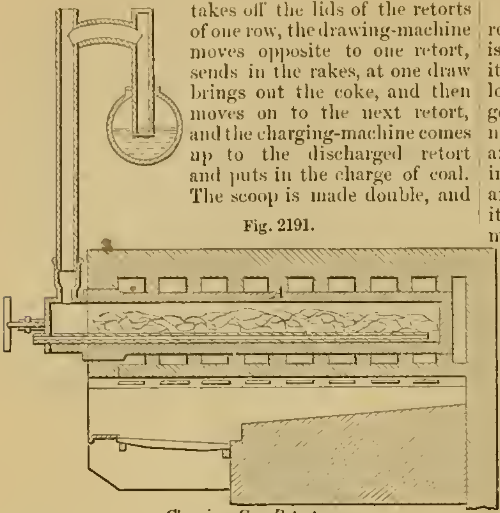
Fig. 2191 is an arrangement for clearing the inner surface of the retort of the scale of carbonaceous matter. The gas-retort is filled with limestone, and a cap with an air-pipe extending nearly the whole length of the retort is luted thereupon. The cap of the ascension-pipe is removed, and a current of air being established through the retort, the "scurfing," or removal of the carbonaceous coat of the inside of the retort takes place simultaneously with the elimination of carbon from the limestone, producing quicklime.

Gas-re-tort' Charg'er. An apparatus for introducing the charge of coal into a retort or removing the coke therefrom. The scoop is sustained on swivel and sliding bearings upon the truck, which runs on a track, and conveys coal from the heap to the bench of retorts. The scoop is run into the retort, and the bottom is drawn back by the rod extending beneath the handle; this discharges the coal.

A machine for this purpose has been for some time in successful operation at the Dublin, Ireland, gas-works.

The method of working is as follows: One man

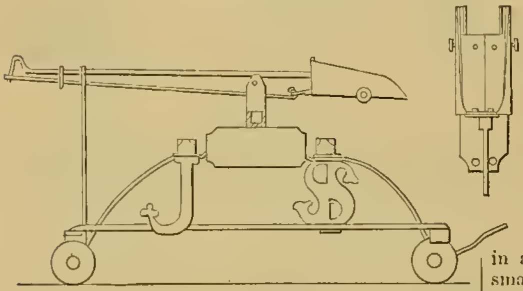
Fig. 2191.



Cleaning Gas-Retort.

takes off the lids of the retorts of one row, the drawing-machine moves opposite to one retort, sends in the rakes, at one draw brings out the coke, and then moves on to the next retort, and the charging-machine comes up to the discharged retort and puts in the charge of coal. The scoop is made double, and forms two small scoops hinged together, and discharging in opposite directions; so that, in turning, the coals are spread well over the surface of the retort, thus utilizing the greatest amount of heating surface in the rein. As the retorts are charged, the man who preceded the drawing-machine and took off the lids now follows the charging-machine, closing the retorts. Two boys drive the machines, one man fills the coal into the hopper, and another attends to the taking off and putting on of the lids or doors. The platforms of the machines are now altered to the level of the row of retorts to be drawn and charged next, and those operations proceed as before. By these arrangements, the retorts are exposed to the action of the atmosphere a much shorter time than in the case of hand labor, as the stokers generally "slack out" ten or a dozen doors at once, and draw them all before charging any, thus leaving the first-drawn retort a long time to the cooling atmosphere, whereas with the machine the retort is charged directly it is emptied, — an advantage that must be appreciated by all gas-engineers. The work of drawing and charging is done with a regularity that cannot be attained by manual labor; the retorts are supplied with the maximum quantity of coal they will take, and the quantity does not depend upon the caprice of a scoop-driver. The coke must be raked out clean and a quantity cannot be left in, as is often the case with manual labor when the eye of the foreman is not on the men.

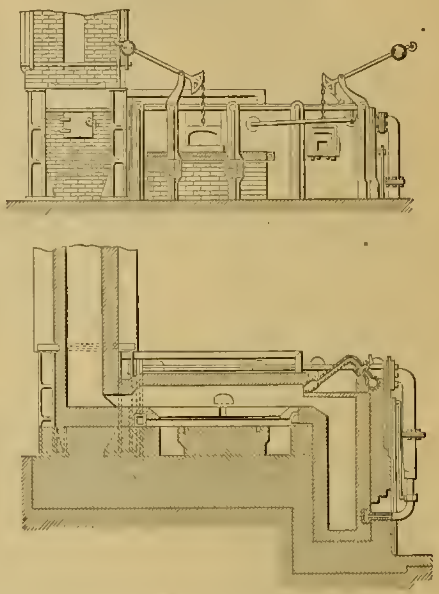
Fig. 2192.



Gas-Retort Charger.

Gas Re-ver′ber-a-to′ry-fur′nace. An iron-refining furnace in which gas from bituminous coal is caused to pass over the molten metal, depriving it of carbon. The upper is a front view, and the lower a longitudinal section of the apparatus. The generator is partially filled with coal which is ignited, a sufficient quantity added to fill the generator, and the opening is bricked up. The metal, broken into pieces of suitable size, is placed upon the hearth, and the inflamed gas is directed downwardly upon it by tuyères. A limited quantity of air is also admitted to the generator by pipes. The metal, when in a state of fusion, is stirred occasionally, and a small quantity of limestone added from time to time. The treatment lasts from two and a half to five hours, according to the quality of iron produced, and the metal is drawn off in a fluid state. The fire is allowed to die out, and the generator cleaned at intervals of about fourteen days.

Fig. 2193.



Gas Reverberatory-Furnace.

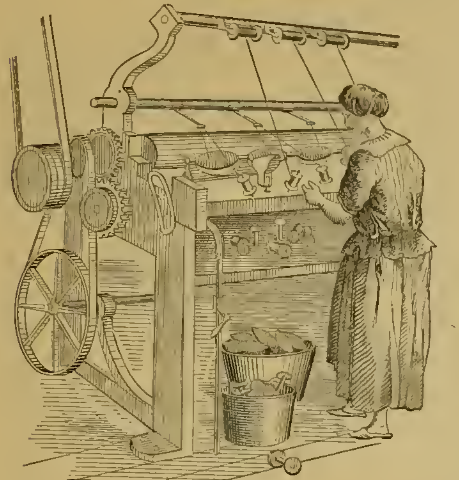
Gas-ring. A thin plate of steel or copper, perforated to the exact size of the caliber of the gun, and used as a face-plate to the breech-block in Sharp's breech-loading rifle and Broadwell's breech-loading ordnance, adopted by the Prussian government. The breech-block is chambered out larger than the hole in the plate, so that the gas from the explosion of a charge in the gun flies back into the chamber and presses the plate or ring forward against the breech of the gun. A *gas-check.*

Gas′sing. (*Cotton-manufacture.*) The process of burning the divergent fibers or *fluff* from yarn. The loose filaments are burned off by passing the yarn quickly through a gas-flame. The yarn is thus prepared for thread, lace, and hosiery. An average yarn loses about one eighteenth in the operation.

The *gassing-frame* has a row of jets about twelve inches apart, and a little hood above each. The yarn is led from one bobbin to a second, which is rotated by being pressed against a rotating roller. The yarn in passing between the spools traverses back and forth through the flame passing over pulleys.

On emerging from the flame the yarn is cleaned by a brush and passes through a notch in a piece of brass, which is arranged to detect any knot or lump in the yarn. A defect of this character depresses the brass, and instantly turns aside the gas-burner, so that the yarn is not burnt during the temporary stoppage; the defect being remedied by the minder, the parts are restored to their normal position and the operation proceeds.

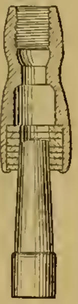
Fig. 2194.



Gassing Yarn.

Gas-sock'et. The metallic socket which slips over the tip of a burner, and connects the elastic gas-tubing therewith.

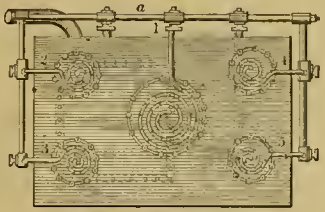
Fig 2195.



Gas-Tube Socket.

Gas-stove. One usually made of iron, and may be partially lined with fire-brick.

Fig. 2196.

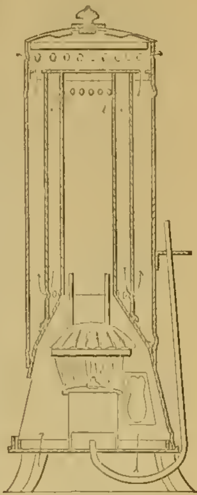


Gas Cooking-Stove.

Branches 1, 2, 3, 4, 5, from the main pipe *a* are carried to the upper part of the stove and to the bottoms of the various interior compartments designed for roasting, baking, etc. These terminate in circularly arranged tubes, provided with minute burners, over which the vessel containing the article to be cooked is supported.

Fig. 2197 is a heating stove in which the gas is turned on to the perforated top of a gas-chamber, and over this a corrugated conical cap is suspended from an upright flue, the product of combustion flowing into and around this cap up the flue, and through holes in the side at top, down another flue as far as the cover of the combustion chamber, and thence through the apertures into and up a third flue to the top of stove. The flues are formed by spaces between three cylinders of different diameter; a plate at the top covering the inner flues has perforations over the outer flue.

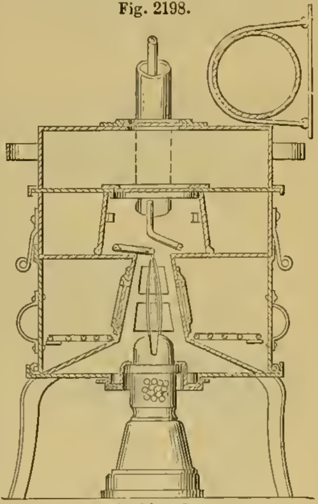
Fig. 2197.



Gas Heating-Stove.

Fig. 2198 is a gas cooking-stove which has a square sheet-iron stove, to be used with a kerosene lamp, or a gas-burner, having on each side an oven for baking, etc., which is surrounded on all sides, except the outside and ends, by a flue, in which the products of combustion circulate. On the top of the stove are holes in which the cooking utensils are placed, and a pan for baking may also be placed thereon. By means of dampers the products of combustion may be prevented from circulating beneath the top, and made to pass directly out of the chimney. On one end of the stove is a boiler in which to generate steam, which is conveyed off by pipes to perform various culinary operations. Pieces of mica are let into the stove in various places to expose the light and also to give a view of the interior of the ovens.

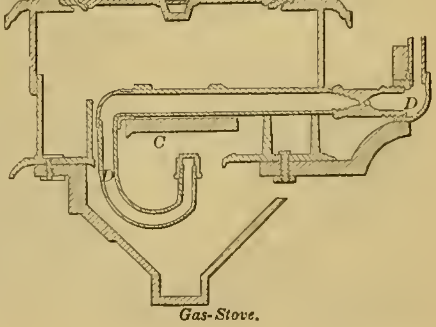
Fig. 2198.



Gas Cooking-Stove.

Fig. 2199 is a gas-stove in which the heat of the burning jet is made to vaporize coal-oil in the pipe *D*. The generating chamber is of a metal less liable to oxidation than cast-iron, and is protected by a movable plate beneath, which is suspended over the surface of the burning hydrocarbon. The heat is concentrated by an annulus *C*, which encloses the combustion chamber. A fire-cup beneath the burner catches the waste oil.

Fig 2199



Gas-Stove.

Gas-torch. A lighter for gas. See LIGHTING-DEVICES; ELECTROPHORUS.

Gas-wash'er. This apparatus receives the gas from the condenser, which removes the tar. The office of the washer is to remove the ammonia, which affects the quality of the gas and is otherwise injurious. Several forms of washers are known. The essential features consist of devices for bringing every particle of the gas into contact with water, for which the ammonia has a great affinity. The effectiveness of a particular machine is in proportion to the intimateness of the contact of the gas and water therein. Dr. Watson, Bishop of Llandaff, announced the fact in 1750, that the inflammability of gas was not affected by contact with water. The *washer* is the third in the series of gas-making apparatus. (See GAS-MAKING.) Mr. Croll, an English gas-engineer, is credited with the invention of the gas-washer now in use.

Eight or ten gallons of ammoniacal liquor are extracted from the gas produced from 2,000 pounds of coal, and it is treated by manufacturing chemists, who extract about fourteen ounces of sulphate of ammonia from one gallon of the liquor.

Gas Weld'ing-fur'nace. (*Metal-working.*) A heating jet, or cluster of jets, to heat pieces of metal locally, in order to bring them to a welding temperature. See GAS BLOW-PIPE.

Gate. 1. A barrier which may be opened to permit passage; as, —

Canal-lock gate.
Farm-gate.
Flood-gate.
Sluice-gate.
Turnpike-gate.
Water-gate.

Some of which are considered under their alphabetical order.

a is a gate with adjustable hinges, operating on rings on the post; the fastening consisting of a movable latch and staple.

b shows a mode of setting up the gate when the outer end sags, by means of the diagonal strut.

c shows another form of setting up the outer end by means of a tie slat.

d is a gate whose top bar is pivoted on the post, the gate being counterweighted by a box of stone on the extended bar.

e is a gate which slides longitudinally, its slats traversing on rollers.

f is also a sliding-gate, which has rollers to keep it level, whether open or shut.

g is a gate which slides half its length and then rotates on a bar at its midlength.

h is a gate of pivoted bars on the principle of the lazy-tongs.

i is a gate having a set of pivoted slats, which assume a vertical position when the counterweighted top slat is allowed to oscillate.

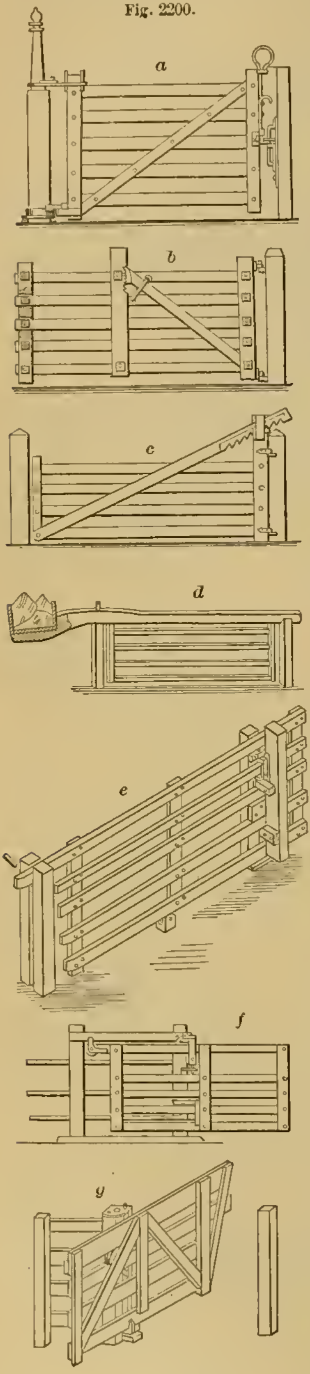
j is a suspended gate, which swings upward broadside in a vertical plane.

k is a gate suspended from pulleys, and counterweighted.

l m are gates operated by equestrians or persons in vehicles by means of ropes.

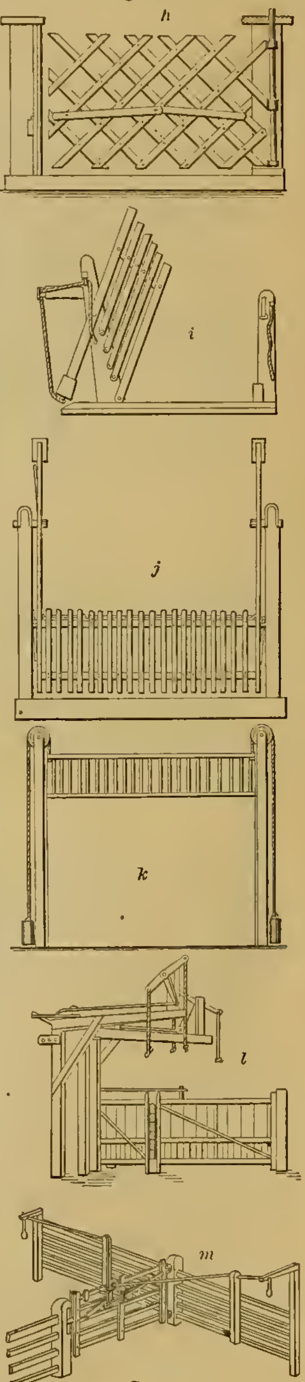
2. (*Locksmithing.*) One of the apertures in the *tumblers* for the passage of the *stub*.

Fig. 2200.



Gates.

Fig. 2201.



Gates.

3. The valve which admits the water to the bucket of the WATER-WHEEL (which see).

4. (*Founding.*) *a.* An *ingate.* The aperture in a mold through which the metal is poured. The *runner* conducts the metal from the *ingate* to the hollow in the mold, where it forms a *casting.* The piece of metal which occupies the *ingate* and *runner* is called a *sprue,* and is knocked off the casting.

b. The sprue or piece of metal cast in the gate. A sullage-piece.

Gate-cham'ber. (*Hydraulic Engineering.*) A recess in the side wall of a canal-lock, which receives the opened gate, so that it shall not project into the lock-chamber.

Gate-chan'nel. (*Founding.*) The *gate, geat,* or *git,* through which molten metal is admitted to the mold. See GATE.

Gate-hook. A gate-hook is that part of a gate-hinge which is driven into the post and sustains the leaf attached to the gate.

Gate-post. One to which a gate is hung or which it shuts against, and which are known respectively as the *swinging* or *hinging* post, and the *shutting* post.

Gate-saw. A mill-saw which is strained in a *gate* or *sash* to prevent *buckling.*

Gate-shut'ter. (*Founding.*) A spade or paddle which closes the channel against the molten metal when the mold or bed is full, and turns it in another direction to other molds or beds.

Gath'er. 1. (*Vehicle.*) The inclination forward of an axle journal, or spindle, usually one tenth of its diameter.

The amount of gather depends upon the amount of taper. A perfectly cylindrical spindle requires none.

The inclination downward is also dependent upon the taper, and is called the *swing.* The latter renders the *dishing* of the wheel necessary, in order that each spoke as it comes to the bottom position may be vertical. See SWING; DISH.

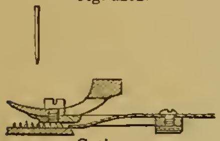
If a taper spindle be made without any *gather,* the tendency of the wheel is to slip outward against the linchpin or nut. If the *gather* is in excess, the *boxing* of the *hub* rubs hard against the *butting-ring* of the axle.

2. (*Bookbinding.*) To collect and place in consecutive order the printed sheets of a book. The pile of sheets is *folded, gathered, collated, stitched,* and *bound.*

3. (*Needlework.*) To draw into plaits or folds by means of a thread or cord.

Gath'er-er. (*Sewing-machine.*) A device which brings the cloth together in folds or plaits, so as to be sewn in crimps. It may consist of a tongue whose end pushes against and puckers up the material in advance of the action of the needle. In the example, Fig. 2202, the device is attached to the presser foot. The upper and lower pieces of cloth are separated by a metallic tongue, so that the feed-bar acts first upon the lower piece and gathers the same. The two pieces of cloth are then forwarded together beneath the presser.

Fig. 2202.



Gatherer.

There are numerous varieties. See Gregory's "Sewing-Machine Attachments," Washington, 1872. The ruffler acts upon the same principle.

Gath'er-ing. 1. (*Bookbinding.*) The selection and arranging of a set of sheets according to signatures, to form a book. See GATHER.

2. (*Carpentry.*) An assemblage of beams supporting a scuttle.

Gath'er-ing-board. (*Bookbinding.*) A horseshoe-shaped table on which signatures are laid to be gathered or assembled to form a book. A more convenient way is to arrange the signatures on a long straight table, the first half on one side and the latter half on the other, so that the gatherers may follow each other consecutively, "knocking up" and depositing the complete book on an adjoining table.

Gath'er-ing-hoop. One used by coopers to draw in the ends of the staves so as to allow the hoop to be slipped thereon.

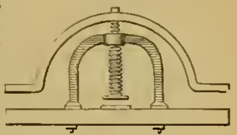
Gat'ling-gun. A machine-gun which has a cluster of barrels and a charging breech at which the cartridges are automatically loaded into the barrels and fired in succession. See BATTERY-GUN.

Gau-din'o-type. (*Photography.*) A process named from its French discoverer, Gaudin.

Gauf'fer-ing-press. A press in which pieces of fabric cut to the shapes of leaves, petals, etc., are pressed between dies to confer the ridges, indentations, creases, and other irregular features of the natural object.

The ancient Egyptians gauffered their linen by pressing it between fluted boards.

Fig. 2203.



Gauffering-Press.

Gauf'fer-ing-tool. A tool for giving the roundness, fluting, crimping, or other peculiar form to leaves, petals, calyxes, etc., for the construction of artificial flowers and sprays.

The hand tools are spherical, conical, pyramidal, hooking, or cylindrical, and attached to handles, the working faces being heated to deliver the impression or indentation.

Other tools are stamps with counterpart convex and intaglio faces, between which is stamped the piece of fabric which has been previously cut to a shape.

The material is cambric, jaconet, and fine muslin, crape, gauze, taffeta, satin, and velvet, according to the natural appearance of the flower represented.

Various other materials are necessary, — silk thread, wire, wax, beads, floss-silk, chenille, gum-water, starch, gold-leaf, kid, colors, nap of cloth, etc.

Gauge. A measuring device. See GAGE.

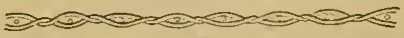
Gaunt'let. An armed glove, anciently of mail or leather, with metallic shells or scales.

Gaun'tree; Gawn'tree. A trestle for casks.

Gauze. (*Fabric.*) A light, transparent silk or cotton goods. Said to be named from Gaza, in Palestine, from whence it was introduced.

In gauze-weaving, between every two casts of the shuttle, the warp-threads are turned or twisted after receiving the woof from right to left, and the reverse, alternately, between each throw of the shuttle, so that the weft threads, represented by black dots in the figure are separated from each other, and a light, transparent texture produced.

Fig. 2204



Gauze-Weaving.

Gauze Wire-cloth. A textile fabric, either plain or twilled, made of brass, iron, or copper wire, of various degrees of fineness. Used for sieves, safety-lamps, respirators, etc. Brass-wire gauze was shown in the French department of the London

Exhibition of 1851, having 67,600 meshes to the square inch = 260 parallel threads in a linear inch.

Gav'el. 1. Originally, a small parcel of grain in the straw. Now, enough of the grain to be bound into a sheaf; the grain is raked from the harvester platform in *gavels.* Binding makes it a *sheaf.* A stook, or collection of sheaves placed on end, leaning together and mutually supporting, is a *shock.*

2. A mason's setting maul.

3. A presiding officer's mallet.

Gav'e-lock. An iron crow-bar.

Gay'di-ang. A vessel of Anam resembling a junk. It carries two or three masts with triangular sails.

Gaze-a-Blu-toir'. (*Fabric.*) A thin silk gauze, made in France, for bolting cloths.

Gaz-o-gene'. A portable fountain or soda-water apparatus. See Fig. 45, p. 18.

Ga-zon'. (*Fortification.*) A piece of sod used as a revetment or lining for parapets and earthen banks.

Gear. A general term which may mean: —

1. Arms ("ready all his *gere,*" Chaucer), *accouterments* ("armours and al other *gere, Ywaine and Gawin,*" Ritson), *clothing, dress, trappings, harness, chafing*-gear.

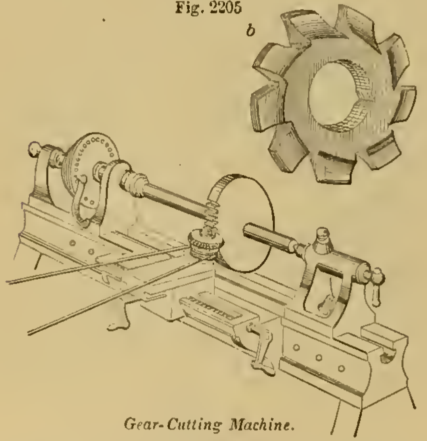
2. Furniture, rigging, tackle (*jeers*), apparatus, the appurtenances of an implement: e. g., *expansion*-gear, *valve*-gear, *pump*-gear, *plow*-gear; the working parts of a locomotive; the rigging of a spar or sail; the running parts of a wheeled vehicle, as the *fore-gears, hind-gears,* referring to the *fore*-axle and its wheels, the *hind*-axle and its wheels. To the former is attached the tongue and fore hounds, to the latter the hind hounds. Each carries its bolster.

3. A cog-wheel. See GEARING.

Gear-cut'ting Ma-chine'. One for making cog-wheels by cutting out the interdental material. Invented by Henry Maudslay.

In one form of this machine, the disk to be cut is fixed on a spindle or mandrel, to whose end is attached a graduated dividing-wheel. This wheel has a number of circles, each having its own series of graduations, at which are holes with which the stop-pin engages to hold the blank while the circular cutter on the slide-rest does its work. This cutter has a shape coinciding with that of the interdental space of the wheel required, as shown in the enlarged view *b*. The mandrel of the cutter-wheel is rotated by a band, and the cutter is fed by a hand-crank and feed-screw, so as to traverse past the face of the wheel under treatment.

Fig. 2205



Gear-Cutting Machine.

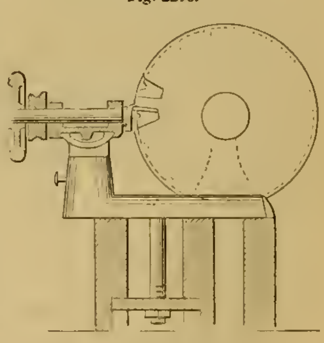
The face of the dividing-wheel, as has been stated, has various circles of graduations, which afford the means of giving a great choice of number of cogs to the wheel on the spindle.

Circles graduated as below are divisible by the numbers attached, and divide a wheel for the corresponding numbers of teeth: —

	GRADUATIONS.										
	192	200	208	216	220	224	252	256	272	304	360
Number of teeth.	192	200	208	216	220	224	252	256	272	304	360
	96	100	104	108	110	112	126	128	136	152	180
	64	50	52	54	55	56	84	64	68	76	120
	48	40	26	36	44	32	63	32	34	38	90
	32	25	13	27	22	28	42	16	17	19	72
	24	20		18	11	16	36	8			60
	16	10		12	10	14	28				45
	12	5		9	5	8	21				40
	8			6		7	18				36
	6						14				30
							12				24
							9				20
							7				18
							6				15
											12
											10
											9
											8
											6

Fig. 2206 shows a machine for cutting wooden gear, or patterns of cog-wheels for casting. Arranged on a lathe-bench is a sliding cutter-carriage, having a revolving cutter of the shape of the side of the tooth, so that as it revolves it cuts the space between two teeth; a graduated dividing-plate governs the spaces between the teeth.

Fig. 2206.



Gear-Cutting Machine.

Gear'ing. Wheels with cogs to transmit power.

The term is also applied to other mechanical devices by which motion is transmitted; as, *change-gear, chain-gear, back-gear, overhead-gear;* or by which parts are operated, as *valve-gear, hoisting-gear, expansion-gear.* Also to other devices involving an assemblage of parts, as *running-gear* of a wagon.

Archimedes was acquainted with toothed wheelwork before the Christian era.

Thomas Young does not doubt that Ebn-Junis, at the end of the tenth century, had applied the pendulum to the measurement of time, but ascribes the first combination of the pendulum with wheel-work to Santorio, in 1612.

The hydraulic clock of Ctesibus, under Ptolemy Euergetes II., which gave the civil hours throughout the year at Alexandria, was, according to the description of Vitruvius, a real astronomical clock; a very complicated hydraulic machine, working by means of toothed wheels. It is not improbable that the clock presented by Haroun al Raschid to Charlemagne, and which marked the hours by the sound of small balls falling, and also by the appearance of miniature horsemen through doors, was analogous in principle.

See under the following heads: —

Addendum.
Angular gear.
Annular gear.
Back-gear.
Bevel-gear.
Cam-gear.
Chain-gear.
Change-gear.
Cog-wheel.
Cone-gear.
Conical gear.
Contrate-wheel.
Crown-wheel.
Differential gearing.
Division-plate.
Double-gear.
Double gear-wheel.
Eccentric gear.
Elliptical gear.
Epicyclic gear.
Equatorial box.
Face.
Face-wheel.
Flank.
Friction-gear.
Gear-cutter.
Gear-cutting machine.
Gearing-chain.
Geometrical radius.
Hooke's gearing.
Hunting-cog.
Interdental.
Intermittent gear.
Internal gear.
Irregular wheel.
Lantern-wheel.
Mangle-rack.
Mangle-wheel.
Match-gear.
Mesh; mash.
Miter.
Multiple.
Multiplying-gearing.
Mutilated gear.
Nest.
Odontograph.
Overhead-gear.
Pinion.
Pin-wheel.
Pitch.
Pitch-circle.
Pitch-wheel.
Pivot-gearing.
Planet-wheel.
Prime.
Rack.
Rag-wheel.
Ratchet.
Real-radius.
Screw-gear.
Scroll-gear.
Sector-gear.
Segment-gear.
Segment-rack.
Skew-gear.
Skew bevel-gear.
Slosh-gear.
Snail-gear.
Speed-cones.
Speed-multiplier.
Spiral gear.
Sprocket-gear.
Spur-wheel.
Star-wheel.
Stepped-gear.
Sunk-motions.
Train.
Trundle.
Variable gear.
V-gear.
Waved gear.
Wiper.
Worm-gear.
Worm-wheel.

Gear′ing-chain. An endless chain transmitting motion from one toothed wheel to another.

Gears. A name applied to harness, as the clothing (Anglo-Saxon, *geara*, clothing) of a horse. The word is usual in the West, and different kinds of harness are indicated by the names *single-gear*, *double-gear*, *lead-gear*, *hip-strap gear*, *Yankee-gear*, etc.

Gear-wheel. Any cog-wheel, whether crown, spur, internal-cogged, bevel, or lantern, is a gear-wheel. The essential feature is the possession of cogs, which act upon the cogs of another wheel in the train or series to impart or transmit motion. See GEARING.

Geat. (*Founding.*) The channel or spout through which molten metal descends into the mold. See GATE.

Geis′ler-tube. A sealed tube filled with rarefied gas, through which an electric spark is transmitted by means of platinum connections inserted at each extremity. On the passage of the spark, waves and bands of light make their appearance, which range in color and intensity according to the character of the gas with which the tube is filled. This apparatus is used with the induction-coil.

Gel′a-tine. An animal substance which assumes several forms, according to the material from which it is made and the mode of manufacture.

Common gelatine is made from clippings of hides, horns, hoofs; and some is yielded by the feet, bones, tendons, and ligaments of animals.

In a jelly form it is called *size*.

The coarser qualities, dried in flakes, are *glue*.

When made from the membrane of fishes it is *isinglass*, the best of which is made in Russia from the air-bladders and sounds of sturgeon.

Gel′a-tine-pro′cess. The action which is at the bottom of nearly all the permanent photographic-printing processes is that of light on gelatine in presence of a bichromate. Dissolve gelatine in hot water, and add to the solution some bichromate of potash, and dry it; the compound is sensitive to light in a way different from ordinary photographic paper. Exposure to light changes the color to a chestnut-brown, but, what is more important, it is no longer soluble in hot water. If a portion of the dried gelatine and bichromate be shielded from light, that portion will dissolve as readily as before, but the portion which has been acted on by light forms a tough, tawny substance which is unaffected by the hot water. The discovery of this action was made in various steps, the first change of color being announced by Mr. Mungo Ponton as early as 1839. This remarkable property was finally laid hold of by experimentalists, and two groups of processes have been founded upon it. In the first group, this action is brought into play in the production of every proof. That is to say, every picture is produced by the action of light on bichromated gelatine. In the second group, one picture is produced by the action of light on bichromated gelatine; and this picture is made by various devices to serve as a printing matrix, from which any number of impressions may be struck off by mechanical means.

In the first group is included what is ordinarily called CARBON-PRINTING (which see). See also AUTOTYPE.

In the second group, the gelatine picture is used as a matrix for producing a printing-base, or is itself used as a printing-base, which is then in either case printed from by mechanical means. The first successful attempts in this direction resulted in the process which is known as photolithography. A print is produced by the action of light on paper coated with sensitized gelatine in the way first indicated. It is found that lithographic ink will adhere to those parts where light has acted. The gelatine print is accordingly inked with a lithographic transfer-ink, and the print thus produced is transferred to the surface of stone or zinc. But a lithographic stone does not do more than discriminate between black and white; it will not recognize half-tones. The process is therefore only suitable for the production of work either in dots or lines. For this purpose it was used by Mr. Osborne in Australia, in Southampton, England, and now very extensively in this country. See PHOTOLITHOGRAPHY.

Poitevin's process, 1855, belongs to this group, and is typical of its kind. He coated the stone with bichromated albumen, and put it through the actinic processes *in situ*, then inked up on the stone.

Another process in the second group is PHOTOGALVANOGRAPHY (which see). See also PHOTOGLYPHIC ENGRAVING; PHOTOZINCOGRAPH.

A third process is the *Woodbury*, in which a gelatine picture, having been obtained by light, is placed in contact with a sheet of soft metal, and submitted to heavy hydraulic pressure. Bearing in mind that the gelatine picture is a picture in relief and depression, the metallic counterpart obtained by pressure will be in reversed relief and depression. A mold will have been obtained, which it will only be necessary to fill with a solution of gelatine to obtain a duplicate, so to speak, of the gelatine picture from which the metallic mold was struck. The resulting picture will be one in relief and depression; but if, as in the case of carbon-printing, coloring matter is mixed with the solution of gelatine used to fill the metallic molds, it will also be in light and shade. A little solution of gelatine in hot water, containing suitable coloring matter, is poured into the metallic mold, a piece of paper is placed on the top, and a level lid pressed down on it, so as to squeeze out superfluous gelatine. In a few minutes the lid is opened and the paper removed, bringing with it the adhering gelatine, which, with the coloring matter, forms the picture. See Woodbury Process; Nature-printing; Heliotype; Albertype, — so named from Herr Albert of Munich.

Gem. A precious stone, as a diamond, ruby, sapphire, emerald, topaz, opal, etc. Some of those in the following list are only semi-precious, and are not strictly gems. In a mechanical point of view, they have about equal interest. Some common and softer minerals are introduced for the sake of comparison.

Table of Hardness of Gems, etc.

Agate	12	Onyx	12
Amethyst	11	Opal	10
Calcareous spar	6	Quartz	10
Chalk	3	Ruby	16 – 17
Crysolite	10	Ruby spinelle	13
Carnelian	11	Sapphire	16 – 17
Crystal	11	Sardonyx	12
Diamond	18 – 20	Schorl	10
Emerald	12	Topaz	11 – 15
Fluor-spar	7	Tourmaline	10
Gypsum	5	Zeolite	8
Jasper	9 – 11		

Gem, Ar′ti-fi′cial. Factitious stones are made of very pure, fusible, highly transparent, and dense glass, usually called *paste* or *strass*. The composition is silica, potassa, and oxide of lead, with some other ingredients at times, and metallic oxides for coloring. (See Glass-coloring.) The beauty depends upon the clearness and the exact imitation of the natural gem, and also upon the care and skill in the cutting.

Gem-cut′ting. The surfaces of gems are cut into facets to increase their brilliancy. The greater the natural brilliancy the fewer facets are required to obtain a given brilliancy.

As a general rule, the back that is inclosed in the setting has double the depth of the face. The back is cut into facets or squares that exactly correspond in place with the position of the principal facets on the front of the stone; and the angles which the squares at the back make with the axis of the stone are required to be such that all the light reflected from their surfaces may fall within the central, flat surface, on the part of the stone called the *table*.

The parts of a cut gem are as follows: —

Front; the face or exposed portion.

Back; the rear portion.

Table; the central plane in the face.

Girdle; the extreme margin of a stone by which it is retained in the setting.

Top; the beveled portion between the *table* and the girdle.

Facet; a small face.

Cullet; a small central plane on the back.

See Brilliant.

Gem-cutting was not so well understood among the ancients as it is now, neither are the Oriental cutters equal to those of Amsterdam. The *Koh-i-noor* was recut after coming into the possession of the British queen. (See Diamond.) We read, however, of gem-cutting in Pliny and elsewhere.

"People bore into these red hyancinths (rubies) by means of the diamond." — Al Khâzinî, 12th century.

The principal modes of cutting may be classed under three heads: —

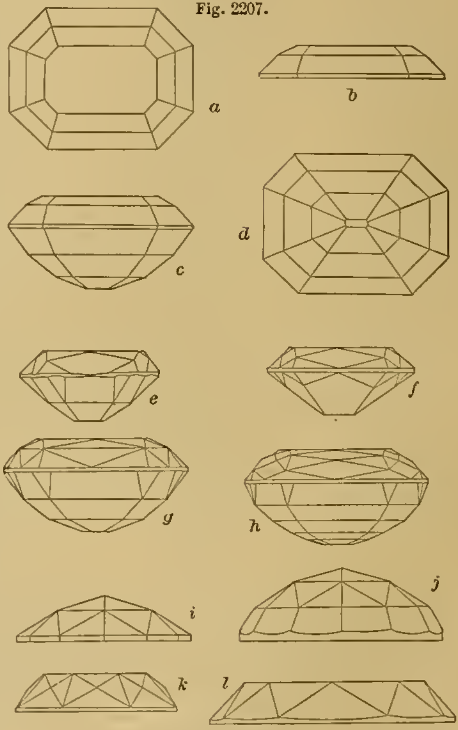
The *trap*, *brilliant*, and *rose cut*.

The *trap* (*a b*) *cut* consists of parallel planes nearly rectangularly arranged around the contour of the stone.

c d represents a thicker stone, trapped in two hights on the front and three on the back.

The *brilliant cut* consists of lozenge-shaped facets alternating with triangles, and is used for the fronts of most transparent stones that are sufficiently thick to allow of being cut into facets on both the front and the back.

Fig. 2207.



Gem-Cutting.

There are several varieties of brilliant cuts, known as —

Half-brilliant *e*.

Full-brilliant *f*.

Split or trap brilliant *g*.

Double-brilliant or Lisbon cut *h*.

The *rose cut* (*i j*) consists of triangular facets arranged upon and around a central hexagon. This cut is employed upon such stones as are thin and large on the surface, as the rose cut is only applied on the surface and the back is left flat. The rose cut is considered to give the greatest luster that can be obtained from cutting the front only, as the surface is entirely covered with facets.

k is the X-cut; *l*, dental cut. Many other minor varieties might be cited.

Gem'el-hinge. (*Locksmithing.*) (Lat., *gemellus*, twin.) A hinge consisting of an eye or loop and a hook.

Gem'el-win'dow. (*Architecture.*) A window with two bays.

Gem-en-grav'ing. The art of engraving on gems. It is performed by small revolving wheels or points charged with diamond dust, emery, etc., according to the hardness of the gem. See Seal-engraving.

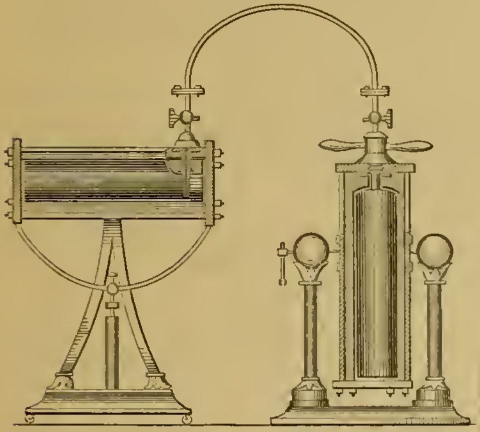
Gen'der. (*Music.*) A Javanese musical instrument introduced into England by Sir Stamford Raffles. It consists of a row of parallel metallic plates, supported horizontally by two strings passed through the respective nodal lines of the plates. The modern dulcimer with glass plates supported on tapes gives an idea of the method. Underneath each plate is an upright bamboo containing a column of air of such a length as to reciprocate the sound of the plate above. The resonance of the unisonant columns of air augments the sounds of the vibrating metallic plates.

Gen'er-at'ing-sur'face. The heating surface of a boiler, that on which heat is applied to generate steam.

Gen'er-a'tor. 1. (*Steam.*) A vessel in which steam is generated from water, for use in a steam-engine, a heating apparatus, etc. The term was first applied to the Perkins steam-boiler, in which water in small quantity was heated to great temperature. It is now specifically applied to a class of instantaneous generators. The name is now rapidly coming into use for all apparatus for generating steam, being held to be more correct than the usual term. See Steam-boiler.

2. (*Aërated Waters.*) An apparatus for generating carbonic-acid gas for charging soda-fountains, or bottles with aërated water. One form is shown in the figure. The generator (shown on the right) is a lead-lined copper cylinder, supported on an axis, and containing the ingredients, which may be water, carbonate of lime, and sulphuric acid, which are commingled by the swaying or reversal of the chamber on its axis. The gas evolved passes to the receiver, where it is absorbed by the water, assisted by the swaying of the receiver on its axis. See Aërator, pp. 18–20.

Fig. 2208.



Generator.

3. A retort in which volatile hydrocarbons are distilled from solid or liquid matters. See Gas-making; Gas-generator.

Ge'o-met'ric-al Lathe. An instrument belonging to the bank-note engraver. Like the Cycloidal-engine (which see), it is used for making complicated patterns of interlacing lines to form an additional guard against counterfeiting. It is adapted for more delicate and minute work than the cycloidal engine, and is the means by which the stars, rosettes, and ornamental tablets, escutcheons and borders, are produced around the denominating figures, etc., of bank-notes.

A graver whose normal motion is in a curve is made by the motion of the plate to form a waved line with any character of convolutions; this is crossed by one of somewhat varying character, and this by a third, and so on, forming an interlacing but regular pattern. If the plate move in a direct line, this pattern will have a general straight direction, but if the plate be moved in a circle, a circular pattern of interlacing lines will be the result. By cams and other devices the general trend of the figure may be made to fill a circle, ellipse, shield, or tablet of any form. Fair examples of the work may be seen on the face and back of the greenbacks of the United States, and it will be seen that the spaces and escutcheons consist of a series of concentric designs.

Machines of this character are very costly, and possessed by but few establishments; the Treasury of the United States and the American Bank-Note Company for instances. The difficulty of counterfeiting is much increased by the use of this mode of ornamentation.

Ge'o-met'ric-al Pen. An instrument for drawing geometric curves, in which the movements of a pen or pencil attached to a revolving arm of adjustable length are varied by changing the toothed wheels which give motion to the arm. — Webster.

Ge'o-met'ric-al Ra'dius. (*Gearing.*) The radius of the pitch circle of a cog-wheel. The *real* radius is that touching the crests of the teeth.

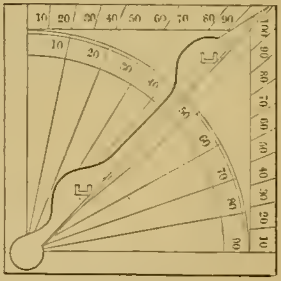
Ge'o-met'ric-al Stairs. A stone stairs where the steps are secured into the wall at one end only, the other forming a continued string with an open newel.

Ge'o-met'ric Chuck. A chuck having a radial slider to which the work is attached, the said slider oscillating in a plane at right angles to the axis of motion, so as to produce curved lines in various patterns, as regulated by special devices. See Geometric Lathe; Rose Engine-lathe.

Ge'o-met'ric Square. An instrument for measuring distances and hights, and useful for its portability as well as for the facility, by the common rule of three, of solving most of the problems arising from its use. It is made of brass or wood, 12 or 18 inches square, and the quadrant is graduated in each direction. The two sides opposite to the axial point of the alidade are graduated to 100 equal parts, with major divisions of ten of said parts. The 100 point finishes at the angle obliquely opposite the center from which the arc is struck. One side represents the horizon, and the alidade with two sights is equal in length to the diagonal of the square. The alidade has divisions equal to those on the sides of the square.

In measuring vertical hights, the distance is

Fig. 2209.



Geometric Square.

measured from the station to the base, and by moving the alidade the angle subtended by the object is observed.

Ge-o-ram′a. A concave globe on the inside of which the countries, oceans, etc., of the earth are represented to the spectators, who stand on a framework inside.

The globe of Gottorp was 11 feet in diameter; that of Dr. Long was 18 feet in diameter. Mr. Wyld's, 1851-61, was 60 feet 4 inches in diameter. The concavity of each of these represented the terrestrial surface.

Wyld's globe was lighted by openings during the day and by gas at night. See GLOBE.

Ge′o-stat′ic Arch. (*Architecture.*) A linear arch of a figure suited to sustain a pressure similar to that of the earth, which consists, in a given vertical plane, of a pair of conjugate pressures, one vertical and proportional to the depth below a given plane, horizontal or sloping; and the other parallel to the horizontal or sloping plane, and bearing to the vertical pressure a certain constant ratio depending on the nature of the material, etc. — RANKINE.

Ge-o-ther-mom′e-ter. An instrument for measuring the earth's heat at different depths, as in mines and wells. The temperature rises about 1° Fah. for every 70 or 80 feet of descent.

Ger′man-bit. A wood-boring tool adapted to be used in a brace. It has a long elliptical pod and a screw-point. See BIT.

Ger′man-chest. (*Metallurgy.*) (*Caisse a tombeau*, coffin.) An apparatus resembling a *trunk* in some respects. It is a long box into which the *slimes* are carried gradually by a stream of water. The heavier portions settle near the head of the box, and the lighter towards the lower end, where the water escapes at holes from which the pegs are withdrawn; a lower peg being replaced and the discharge-opening being made a little higher up as the box gradually fills.

Ger′man-sil′ver. A white alloy for table ware, consisting of nickel, copper, and zinc in various proportions: —

	Nickel.	Zinc.	Copper.	Cadmium.	Iron.	Tin.	Lead.	Antimony.
Brande	1	1	2					
Brande	8	3.5	8					
Parisian	20	5.5	70	4.5				
Packfong (Chinese) .	31.6	25.4	40		2.6			
Parke's (Eng. patent, 1844)	45.5	21	91		45.5			
Cutler's (Eng. patent, 1838)	5	5	16		3			
Toucas's (Eng. patent, 1856)	4	1	5			1	1	1

Another authority gives: —

	Nickel.	Zinc.	Copper.
Common albata . .	3.5	16	20
Best albata . .	5.5	9	20

Another: —

	Nickel.	Zinc.	Copper.	
German silver (finest quality)	1	2	1	
German silver (for rolling) .	25	60	20	
German silver (for casting)	20	60	20	Lead. 20
German silver (original formula)	32	40	25	Iron. 3

It is said to have been originally obtained from a metallic ore found at Henneburg, whose analysis is nearly the same as the last formula given above.

Ger′man-steel. A metal made of charcoal-iron obtained from bog-iron or the sparry carbonate.

Ger′man-tu-ta′nia. An alloy of copper, 1; tin, 48; antimony, 4.

Ger′man White-cop′per. An alloy of copper, 88; nickel, 8.75; with traces of silex, aluminium, antimony, and arsenic.

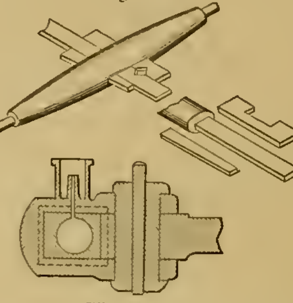
Get-in. (*Printing.*) An order to condense matter so that it shall not extend beyond the end of a line. *Run in.*

Gi′ant-pow′der. A form of *dynamite*, consisting of infusorial earth saturated with nitro-glycerine. The silicious earth consists of diamtoms and frustules, and the result is a brown powder, something like fine sawdust.

Gib. A piece of metal or wood whose duty it is to hold another in place, as in the case of a sled-tongue in its roller, or a strap-head on a connecting-rod. See KEY.

It is usually tightened by a key or cotter, as in the annexed illustration, which shows a very common mode of securing the tongue in the roller of a sled. The notched *gib* is placed in the mortise of the *roller*, the *heel of the tongue* inserted, and a wedge-shaped *cotter* is driven in to tighten them all in place. Pins prevent the endwise withdrawal of the *tongue* or *cotter*.

Fig 2210.



Gib and Cotter.

Gib. 1. *Gib and key.* The fixed wedge and the driving wedge for tightening the strap which holds the brasses at the end of a connecting-rod in steam machinery. See lower illustration in Fig. 2210.

2. The projecting arm of a crane. *Gibbet, jib.*

Gib′bet. The post and arm of a crane, reaching over for the suspension of the load therefrom.

Gif′fard In-ject′or. A steam-jet which acts upon a body of water by which it is condensed, and to which it communicates its velocity, driving it through the feed-water pipe into the boiler. See INJECTOR.

Gig. 1. (*Vehicle.*) A light, two-wheeled vehicle, drawn by one horse.

2. (*Fabric.*) A rotary cylinder covered with wire teeth for *teaseling* cloth.

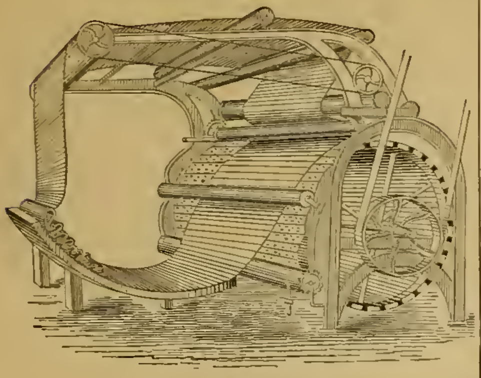
3. (*Nautical.*) A clinker-built boat, from 20 to 28 feet long, and rowed with 4, 6, or 8 alternate oars. It is reserved for the commanding officer. Usually nearly the size of the cutter, but of longer and slenderer build.

4. A fish-spear.

Gig′ging-ma-chine′. A machine for dressing woolen cloth by subjecting it to the action of teasels, whose fine hooks draw the loose fibers to the surface. A *napping-machine.*

The teasel is a kind of thistle (*Dipsacus fullonum*) cultivated for the purpose. The awns or bracts of the prickly head are furnished at the ends with little hooks, which are sufficiently strong to overcome slight impediments in drawing the loose ends of the filaments of wool to the surface. If the hooks of the teasel become engaged with knots which they cannot disentangle, they break, and it is this property which renders them so peculiarly suitable for this purpose. Artificial teasels, such as wire cards, have hitherto failed to answer the purpose as fully,

Fig. 2211.



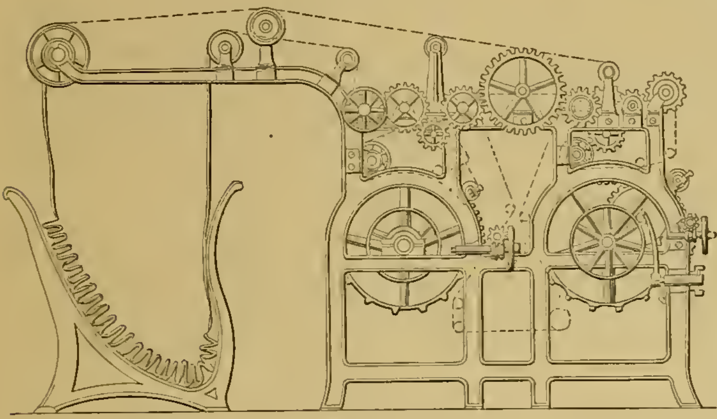
Gigging-Machine.

on account of their unyielding nature when they become engaged with a knot.

From 2,000 to 3,000 teasel-heads are arranged in frames attached to a hollow drum or cylinder, and the cloth, guided by rollers, is drawn in a direction contrary to that of the cylinder, the latter revolving somewhat rapidly and the cloth passing more slowly.

In the illustration, the ends of the cloth are sewed together so as to make it a continuous band which passes round again and again. See TEASELING-MACHINE.

Fig. 2212.



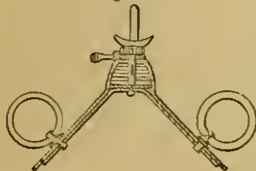
Gigging-Mach ne.

In Fig. 2212 the cloth is teaseled in opposite directions on the same side without removal from the machine, and may be presented twice to each teaseling cylinder. It does not pass under the cylinders so as to catch the falling dirt, etc., and its napped surface is uppermost for inspection at all times.

Gig-ma-chine′. See GIGGING-MACHINE.

Gig-mill. A machine in which woolen cloth is napped or teaseled. A *gigging-machine.*

Fig. 2213.

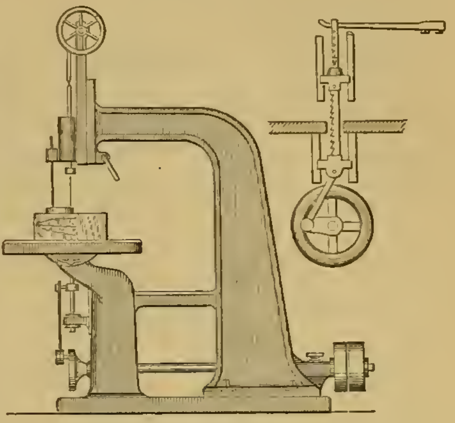


Gig-Saddle.

Gig-sad′dle. (*Saddlery.*) A small saddle used with carriage-harness, and carrying the *terrets* for the *driving-reins* and the *check-hook* for the *bearing-rein.*

Gig-saw. A thin saw to which a rapid vertical reciprocation is imparted, and which is adapted for sawing scrolls, frets, etc. The motion is imparted by the crank and pitman, and the spring above *gigs back* the saw, keeping it strained on its upward stroke.

Fig. 2214.



Gig-Saws.

Scroll-saws are usually gig-saws or band-saws. In Fig. 2215, the saw-guides and operating mechanism have rotary adjustment around the point where the saw passes through the table so as to saw to a bevel. The motion of the hand-crank operates the worm *E*, which moves the segment *D* in the curved guides *C b.* The saw *H* is strained between the ends of levers *I I*, which are pivoted to the segment *D.* Thus the angle of the saw is capable of adjustment in a range of 90°; that is, 45° on each side of the perpendicular, while the other adjustments are the circular and vertical of the table beneath.

Gig-tree. The frame of a gig or harness saddle.

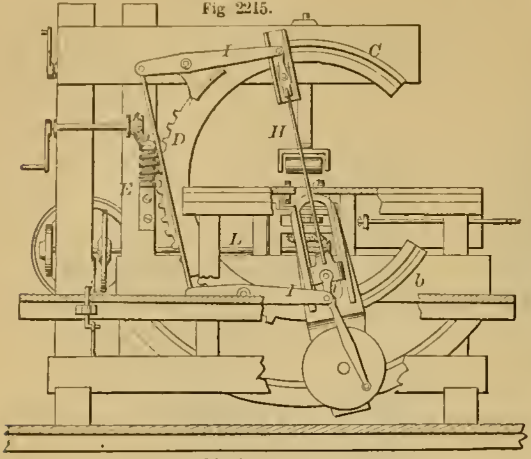
Gild′ing. The process of overlaying with gold. Substances overlaid with fine gold-leaf are found in connection with the earliest Egyptian monuments, even as early as Osirtasen, 1706 B. C. In the time of Thothmes III., the era of the exodus, they had various modes of applying; in leaf, inlaying, or by beating it into other metals. Specimens may be seen in Dr. Abbott's collection, New York. We read that the wood of the ark was overlaid with gold, 1490 B. C.

It was lavishly practiced in ancient Rome; parts of the Capitol were thus ornamented, a single ounce only making 450 leaves, each four inches square.

Gilding is performed: —

1. By laying on gold-leaf.

Fig 2215.



Gig-Saw.

2. By applying gold in amalgam, the mercury being subsequently evaporated.

3. By electro-plating.

4. By a sheet of metal soldered to the cheaper foundation metal.

5. By enameling.

A German plan cited in the "Philosophical Transactions for 1698" is described: —

Steep linen rags in a solution of gold, burn them; with a piece of cloth saturated in salt-water rub the ashes upon the silver. It is not durable.

The modes and purposes are various: —

Burnished gilding is destemper gilding polished by burnisher, and is used especially in picture-frames.

Chemical gilding is produced by galvanic action in the bath, or by affinity. See ELECTRO-PLATING; WASH-GILDING.

Cold gilding consists in rubbing the annealed metal with gilding-powder by means of a piece of cork dipped in salt-water. Polish with steel-burnisher.

Destemper gilding is applied to wood, plaster, or marble. Coat with size, followed by successive coats of finely powdered whiting, and face by rubbing with sand-paper between each coat. Coat with gold size, lay on the leaf, and polish with an agate or dog's tooth.

Electro-gilding. See ELECTRO-PLATING.

Friction gilding. See above, — *cold gilding.*

German gilding; a name for ELECTRO-PLATING (which see).

Immersion gilding; dipping the metallic article into a solution of pyrophosphate of soda in which terchloride of gold has been dissolved.

Or in a boiling-hot gilding-liquor of nitro-muriate of gold, water, and bicarbonate of potassa. (Elkington's patent.)

Or in a solution of gallic acid in water, ether, or alcohol, to which a solution of gold has been previously added. (Tabbot's patent.)

Japanners' gilding. Cover the surface with oil-size thinned with spirits of turpentine, and dab in gold in powder with a puff of wash-leather.

Leaf gilding; coat the paper or vellum with gum-water or glaire, lay on the leaf-gold and polish with an agate.

Mechanical gilding; any process in which the gold is made to adhere by glue, in contradistinction to chemical processes.

Mercurial gilding, by amalgam. See WASH-GILDING.

Oil gilding; coat with size; then repeatedly with calcined white lead or massicot ground in linseed-oil and turpentine; shave smooth the dried surface after each application; coat with gold size, then with the leaf; varnish; heat over a chafing-dish; varnish.

Varnish gilding, for carriages, etc. The same as above, except that the surface is varnished before receiving the gold, repeatedly varnished afterwards, and polished with tripoli and water.

Wash gilding; apply amalgam of gold and volatilize the mercury by heat.

Water gilding, same as *wash gilding.*

To state more in full: —

1. Gilding by gold-leaf is divided into, —

a. Burnish gilding.

b. Oil gilding.

a. In *burnish gilding*, the surface of the looking-glass or picture-frame stuff is prepared by *priming* of *white stuff*, laid on with a brush and followed by several thicknesses of the same material (hot size and whiting), but of a thicker consistence. This surface is smoothed and polished, then covered with several coats of a *size* made of pipe-clay, red chalk, black lead, suet, and bullock's blood, reduced by a solution of gelatine to the required thickness, to be laid on by a brush.

In gilding, the surface is wetted by a camel's-hair brush, the leaf is raised from the *cushion* by a tool called a *tip*, and laid upon the adhesive surface.

It is then burnished by a flint or agate burnisher, except in those parts where the gold is to have a *dead* or *frosted* appearance, called *matt*, and which are subsequently covered with size.

The tools of a gilder are a *cushion*, *knife*, and *tip*.

The *cushion* is flat, made of several thicknesses of cloth, and covered with leather. It has a marginal wall of parchment at one end and half-way along two sides.

The *knife* is pointed, straight-edged, and is not very sharp.

The *tip* is a layer of camel's hairs, whose but-ends are held between two cards which are glued together, forming a very light and elastic brush.

The gold-leaf is supplied by the gold-beater in books of 25 leaves, each measuring 3¼ × 3 inches.

A leaf being transferred from the book to the cushion is cut up by the knife into strips and pieces of the proper size and shape to lay upon the work, to which they are transferred by the *tip*. This tool being laid gently upon the leaf, the latter adheres slightly to the hairs, and is thereby raised and deposited in its place on the surface to be gilded.

b. Oil gilding differs from burnish gilding in the preparation of the surface, which is by coatings of *white stuff*, *clear cole* (a priming prepared with size instead of oil), and oil gold-size. The latter is a mixture of boiled linseed-oil and ochre, laid on by a brush.

The gold-leaf is laid on as in the former process, and is covered with a clear size.

Where parts are to be burnished, they are left for treatment by the *burnish* process just described.

2. An amalgam paste (see AMALGAM) is applied with a brush to metallic articles, which are prepared for its reception by aqua-fortis. Heat, carefully applied, drives off the quicksilver; the surface may be improved by burnishing. The name *water gilding* is also applied to this process. See WATER-GILDING.

3. A bath consisting of a chemical solution of

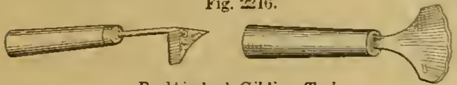
gold is prepared, and the object to be gilded is rendered electro-negative, and suspended in the liquid. A galvanic current being passed through the article suspended in the liquid, the gold becomes deposited upon it. Non-metallic articles may receive a coat of plumbago, to induce deposition thereon. A plate of gold is suspended in the liquid to feed the latter as it becomes impoverished. See ELECTRO-PLATING.

4. The form of gilding by soldering on a plate of the metal is seldom applied with gold, but is common with silver. A cheaper metal forms a basis or foundation to which is soldered a plate of gold. The two are then rolled down together, becoming gradually attenuated until they reach the required thickness, when they are worked together into the shape or object required.

Porcelain or glass is gilded by a magma of gold, quicksilver, gum-water, and borax. It is laid on with a hair-pencil, being thinned with turpentine and oil, like paint. It is black when used, but its natural tint is restored by burning in the enamel-kiln. The borax acts as a flux to unite the gold to the ceramic or vitric material. It comes dead-colored from the kiln, but is brightened by the burnisher.

1. (*Bookbinding.*) In gilding, the book is placed in the press between two boards, and the edges being covered with *glaire* (albumen), a layer of gold leaf is laid on and rubbed with an agate burnisher, fixing it to each leaf and at the same time giving it a polish.

Fig. 2216.



Bookbinders' Gilding-Tools

In tooling, the portion of the cover is covered with glaire, the leaf laid thereon, and a heated tool carrying the desired ornament is pressed thereon. The tool may be a hand-stamp, as in the figure, or a roller or fillet having a periphery on which the pattern is repeated all round. The other appliances of the gilder are the cushion, knife, tip, etc.

Or: the surface is dusted with gum-mastic; the heated tool laid on the gold, which it catches up and transfers to the cover; pressure causes it to adhere.

Brass buttons are gilded by throwing them into a pan with a little amalgam of gold, and as much diluted aqua-fortis as will wet them all over; stir till they appear silvery, then wash, dry, and heat to volatilize the mercury.

Glass and porcelain are gilded by blending powdered gold with gum-water and borax to the biscuit, heating in a muffle, and polishing with a burnisher.

2. (*Photography.*) The treatment of the finished daguerreotype-plate with a salt of gold, generally sal d'or, — the hyposulphite of gold and soda, — which determines the deposition of finely divided gold upon the vaporous mercurial deposit of which the picture consists. By this means permanence is imparted to the picture.

Gild'ing-size. A viscid composition laid upon an object to hold a surface of gold-leaf. The bookbinder uses *glaire*, white of egg. The *oil-gilder* uses a mixture of linseed-oil and ochre.

Gill. 1. A *hackle.* A series of points which divide the ribbons of flax fiber into finer parallel filaments ready for drawing and spinning. A *porcupine.*

2. A timber vehicle consisting of a pair of wheels and a frame.

3. A measure of a fourth of a pint.

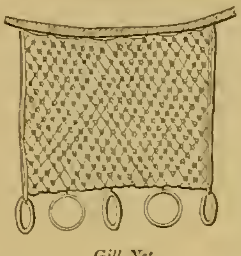
Gill-frame; Gill-head. A machine in which *stricks* of flax are drawn out into *slivers;* doubled and combined with other slivers, and redrawn until they assume the character of *rovings*, and are ready for the spinning operation. A *spreader.*

The name *gill-frame* (Fr. *aiguille*, needle) is derived from a number of vertical needles forming a comb, through which the *line* passes to the drawing-roller; the *gill* is attached to a *faller-bar*, which rises and falls at intervals, and alternately detains and releases the *line*, which, by a series of operations, is converted from a *strick* to a *sliver* and then to a *roving.* See SPREADER.

Gill'ing-ma-chine'. A draw-head machine for flax. A GILL-FRAME (which see).

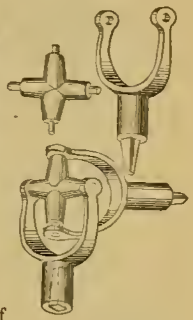
Gill-net. One suspended in a stream, having meshes which allow the heads of the fish to pass, and which catch in the gills to prevent the fish from detaching itself.

Fig. 2217.



Gill-Net.

Fig. 2218.



Gimbal-Joint.

Gim'bal-joint. A form of *universal* joint. (From *gemellus*, Latin, twin.) A two-part joint having articulations on axes at right angles to each other. Invented by Hooke. It is used as a shaft-coupling in the tumbling-rods of horse-powers, in drilling and sheep-shearing machines and elsewhere.

Gim'bal-ring. A single gimbal by which the cock-eye of the upper mill-stone is supported on the spindle to permit vibration. A *rynd.*

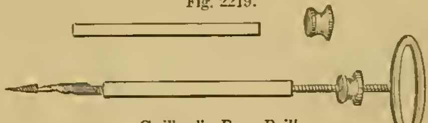
Gim'let. A small boring-tool. It has a leading screw, a grooved staff, and a cross handle.

Its invention is ascribed by Pliny to Dædalus, an artificer of Athens, about 1240. He considered it a point of honor to give an author in each case. In England it was formerly called a *wimble.*

The Grecian gimlet (*teretrion*) is frequently mentioned.

Gaillard's instrument for the insertion of steel pins in the treatment of fractures has four pieces, the handle, screw, sheath, and nut. The silver sheath is passed down to the bone, which is then bored by the gimlet. The nut is then screwed down to draw the parts into apposition, and is left until bony adhesion takes place.

Fig. 2219.



Gaillard's Bone-Drill.

Gim'mal. A pair, or series, of interlocked rings. A *gimbal* (from *gemellus*, twin).

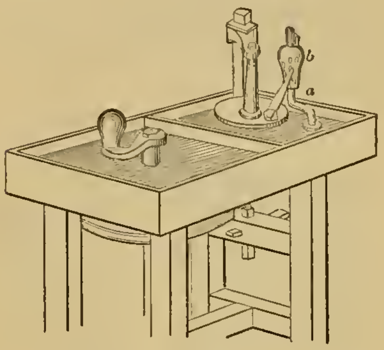
Gimp. (*Fabric.*) Silk twist interlaced with wire or a coarse cord. Used for trimming.

"My wife's black silk gown is now laced all over with black gimp lace, as the fashion is, in which she is very pretty." — Pepys's *Diary*, 1661.

Gim-peg. A rest for the arm of a lapidary, consisting of a rod of iron bent into a cranked form *a*, and fitted with a flange that bears upon the surface of the bench.

It also serves as a holder for a block *b*, which is slipped thereon, and which serves as a guide for the vertical angle in cutting facets. The end of the stick is placed in one of the series of holes in the block, according to the angle required for the facet.

Fig. 2220



Gim-Peg.

The tang of the gim-peg is secured beneath the bench, and the block is secured by a wedge to the gim-peg.

Gimp-ma-chine′. A narrow-ware loom having devices at the edge of the warp to catch the woof and form loops or patterns, the gimp cords of various sizes being carried by independent shuttles or needles.

Gimp-nail. A small forged nail with a rounded head, used by upholsterers.

Gin. 1. A portable hoisting-machine *a* whose frame is a tripod, one leg being movable so as to vary its angle of elevation, and thus determine the hight of the apex; the other two legs preserve their relative distance, and form standards for the drum, around which the rope is wound by power applied to the hand-spikes. For heavy weights a fall and tackle is used; and for hoisting a bucket from a well or mine, simply a couple of pulleys to change the direction of motion of the rope. One pulley is suspended from the apex, and the other attached between the two permanent legs, so as to change the rope to a horizontal position, for the attachment of draft horse.

The gin *b* with fall and tackle is used for loading heavy objects, mounting ordnance, moving heavy castings in foundries. It is the most convenient form of portable hoisting-machine in places where traveling cranes and elevators cannot be had. The *shears* has two legs and the *derrick* one; the latter two require guys. See Crane; Derrick; Whin; Capstan; Windlass; Winch; Elevator.

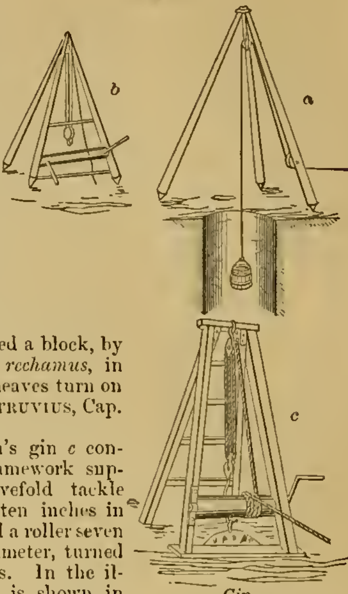
In the United States military service gins are divided into three classes, — *field*, *garrison*, and *casemate*. Each is comprised of the same pieces, differing only in size and minor details of construction. The parts are the *legs*, the *prypole*, which is in fact the third leg, the *braces*, the *clevis*, and the *block* and *fall*.

A similar contrivance to the gin is mentioned by Vitruvius (about 40 B. C.): —

"Three pieces of timber are prepared, suitable to the weight to be raised, connected at the top by a pin, but spreading extensively at the feet; these are raised by means of ropes made fast to the top, and when raised are kept steady; to the top is fixed a block, by some called *rechamus*, in which two sheaves turn on axles." — Vitruvius, Cap. 11., lib. 10.

Richardson's gin *c* consists of a framework supporting a fivefold tackle with blocks ten inches in diameter, and a roller seven inches in diameter, turned by iron levers. In the illustration, it is shown in its application to raising surface stone for removal out of the way of the plow.

Fig. 2221.



Gin.

2. A pump operated by windmill.

3. A coal-hoisting machine. See Whin.

4. A snare for birds or animals.

5. A spirit distilled from grain and flavored with juniper berries.

6. A machine for separating cotton-fiber from the seeds.

Eli Whitney's cotton-gin, invented in 1793, revolutionized the culture and manufacture of the fiber by providing a mode of putting it into merchantable order at a reasonable price.

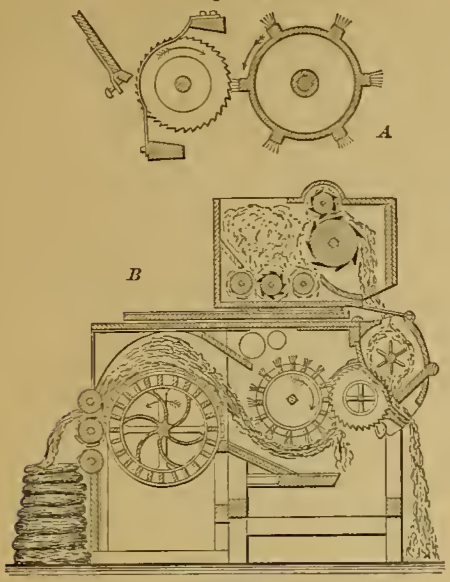
When done by hand, a man can clean but one pound per day. The *roller-gin* of India and China cleans from 40 to 65 pounds in a day. It has two rollers, which catch the fiber between them and carry it away, while the seed is detained by a comb.

The combing instrument used in the Spanish colonies for removing the seed from the cotton-fiber is called *almarraes*. The syllable *al* indicates the Saracenic origin of the tool and its uses.

In Whitney's saw-gin (*A*) the cotton is placed in a long and narrow hopper, one side of which is formed by a grating of strong parallel wires $\frac{1}{8}$ inch apart. Close to the hopper is a roller with circular saws $1\frac{1}{2}$ inches apart. These, as they revolve, pass within the grating to a certain depth, and seize the fibers of cotton, dragging them between the wires which detain the seeds. The cotton is swept from the saws by a revolving cylindrical brush.

In the lower view (*B*) is a more modern form of the same invention. The feeding-chamber is mounted above the gin, serving the double purpose of picking open and thoroughly separating all lumps and matted seed-cotton, and feeding it steadily and uniformly the whole width of the gin in small pellets or masses to the chamber below, in which is a roll-supporter, which presents the cotton regularly to the saws, and is itself driven by the action of the saws upon the under side of the roll. The brush cylinder removes the lint from the saws and delivers it into a chamber, which has for its bottom a revolving gauze cylinder, through which the air escapes while

Fig. 2222

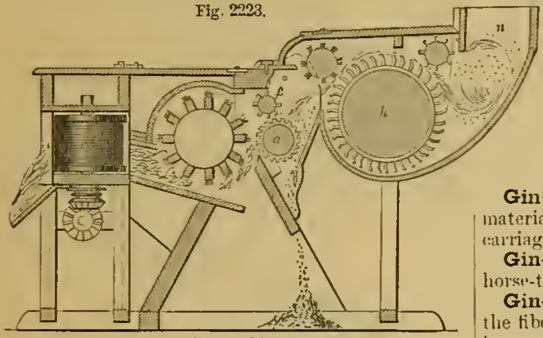


Cotton-Gin.

the lint is arrested and gathers upon the surface of the cylinder in a continuous bat, and is discharged by doffing-rollers ready for the press.

Fig. 2223 shows a form in which the cotton is taken by a toothed feeding-cylinder *h* from the hopper *n*, a stripper keeping superfluous cotton in the hopper; a brush-cylinder delivers the cotton from the feeding-cylinder *h* to the ginning-cylinder *a*. *c* is the brush-cylinder, and *v* one of a pair of wire-cloth covered condensing rolls, which press the cotton into a sliver and at the same time conduct away the dust and motes.

Fig. 2223.



Cotton-Gin.

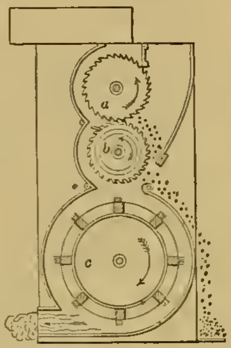
Other gins operate by means of rollers and knives and pinching devices which grasp the lint and tear it from the seeds, as in the roller-gin of India, already mentioned. In one case, as the combs alternately move up and down, they act upon the cotton, which is drawn in by the continuously revolving rolls, and comb back the seeds by working against the upper and lower edges of the bar.

In another, the fiber is grasped by positive devices close by the seed, and is so held while another part pushes the seed away from the fiber. The holders work intermittingly, or two sets alternately, one set holding the fiber or drawing it away, while the other set pushes the seeds away.

Another has a roller-knife acting in combination with a gin-roller, and *doctor* or pressing-knife, the roller-knife having fixed thereon a series of circular plates or disks, the edges of which come nearly in contact with the edge of the doctor or pressing-knife, and also with the surface of the gin-roller, in such a manner as to cause the seed and refuse to be beaten off, and at the same time to cause the fibers and seeds to be moved to and fro along the edge of the doctor.

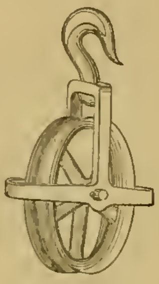
Calvert's toothed-roller gin has a guard-toothed roller *b*, which acts in conjunction with a guard-roller *a* to remove the lint from the hopper and keep back the seeds. The brush-roller *c* removes the lint from the roller *b* and conducts it to the exit.

Fig. 2224.



Calvert's Gin

Fig. 2225.



Gin-Block.

Gin-block. A tackle-block with a hook to swing from the gib of a crane or from the sheer of a gin.

Gin'gal. An East Indian breech-loading fire-arm carrying a ball of from four to eight ounces. See JINGAL.

Ging'ham. (*Fabric.*) A linen or cotton goods, colored in the thread.

Ging'ing. The lining of a shaft with bricks or masonry.

Gin'gly-mus. An elbow-joint which permits no other motion than in one plane, having no rolling articulation. Such a joint is the ordinary two-leaved hinge which moves on a pintle; such are also most *toggle* joints.

Gin'ny-car'riage. A railway car for conveying materials; probably English provincial for engine-carriage.

Gin-race. (*Mining.*) A miner's term for the horse-track of a whin or hoisting apparatus.

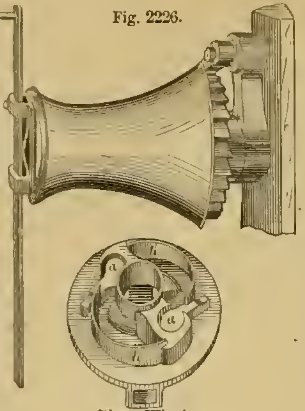
Gin-saw. One used in a cotton-gin for drawing the fibers through the grid, leaving the seed in the hopper. See GIN.

Gin-wheel. 1. A wheel in a cotton-gin. It may mean a wheel with curved pointed teeth or claws, which act as the teeth of the usual saws in drawing the fiber through the grid; or the brush-wheel, which cleans the lint from the said wheel or saw. See GIN.

2. The wheel or drum of a whin.

Gip'sy-winch. A small winch having a drum, ratchet, and pawl, and attachable to a post. The handle of the winch is attached by stirrups to a cap revolving on the axis. This cap is provided with a pair of pawls *a*, which, by means of springs *b*, are forced against ratchet teeth in the interior of the small end of the barrel. By this means two motions can be applied to the winch, the ordinary rotary method

Fig. 2226.



Gipsy-Winch.

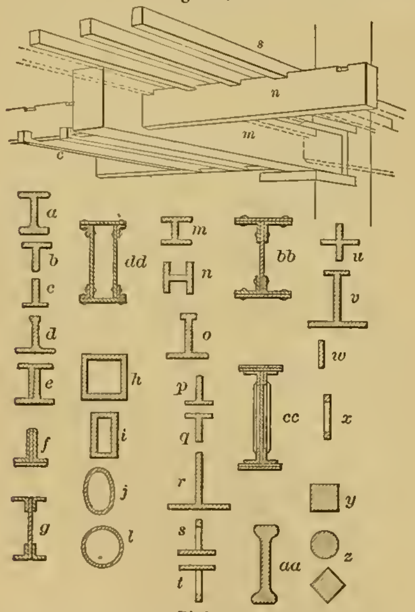
of working the handle, and a reciprocating motion in which the handle is worked up and down like a pump-handle. In the ordinary rotary motion the ratchet movement of the cap is not utilized; but, when the maximum power of the apparatus is required, the pumping motion is adopted. The handle is extensible according to the power required, and about ten times the usual power may be obtained by the reciprocating motion, owing to the leverage obtained and the favorable position for the workman to throw his weight upon the handle, as in working a windlass. See also Bracket-crab.

Gir'an-dole. A branching candle-holder or chandelier. A *gasalier.*

Gird'er. A principal beam of a floor, spanning the distance from wall to wall, and affording a place of attachment for the *binders*, to which the floor and ceiling joists are connected.

In roofs of a less compound structure, the girder or summer-beam, sometimes trussed, spans the building longitudinally, and the joists proceed from it to the walls on each side. See Floor.

Fig. 2227.



Girders.

Girders are often compound, the timbers being scarfed together and stayed by truss-work or fished at the junction.

Smeaton bent the girders upward and trussed them in that position.

In double-framed floors, the *binding-joists n*, instead of resting on the walls, are supported by large timbers *m*, called *girders*. The *bridging-joists s* rest on the binding-joists *n*, and the *ceiling-joists c* are secured beneath the girder *m*.

a to *l* are forms of wrought-iron girders.

m to *z* are forms of cast-iron girders.

Plate-iron girders are made of several forms.

The *I-girder a a* is rolled in one piece.

The *compound I-girder b b* has flat top and bottom plates secured by *angle-irons* to the *web.*

Another form of *compound-beam c c* has upper and lower members built of several layers of plates riveted to each other, and to a pair of angle-irons whose other arms are riveted to the web, which is strengthened by vertical T-irons.

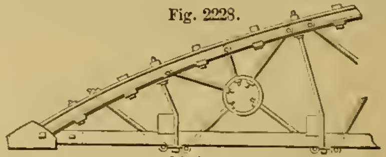
The British rule for wooden floor girders is as follows: —

Length of Bearing. Feet.	Depth. Inches.	Width. Inches.
10	9	7
12	10	8
14	11	9
16	12	10
18	12	11
20	13	11
22	14	12
24	15	12
26	16	12
28	16	13
30	16	14

The *box-girder* or *box-beam d d* has a double vertical web. It is stated by Rankine to have been long employed in the platforms of blast-furnaces, and to have been first used in railway bridges by Thomson, on the Pollok and Gowan Railway, in 1832.

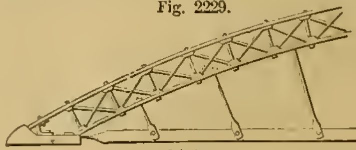
Figs. 2228 and 2229 are forms of arched girders for bridges. The former has for an arc a flanged iron beam and tension trussing in panels. The arch of the latter is formed of upper and lower concentric iron arcs connected by diagonal and radial braces. The chord is connected to the arch by radial rods. The ends of the arch and chord are secured in the metallic shoe. See also Lattice-girder; Half-lattice Girder; Bowstring Girder; Lattice; Truss; Arched Beam, etc.

Fig. 2228.



Girder.

Fig. 2229.



Girder.

The Girard Avenue Bridge over the Schuylkill, at Philadelphia, has five spans of wrought-iron lattice girders, and is illustrated under Iron Bridge. Under the same title are also shown a number of cast-iron and wrought-iron bridges.

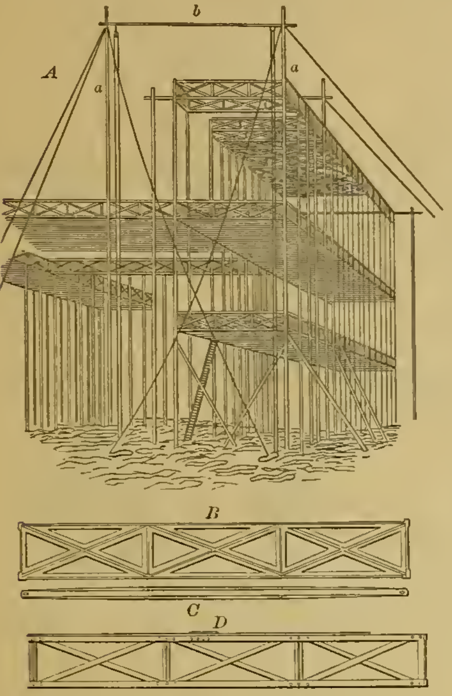
See also Pivot-bridge, where are girder-trusses resting at midlength on piers. See also Steel Tubular-bridge; Tubular-bridge.

See also Iron, Angle, where a large number of forms of angle-iron are shown.

Fig. 2230 *A* represents a portion of the framing of the London Crystal Palace of 1851, showing the means adopted for getting it into position. This was effected by means of upright poles *a a* connected by a cross-piece *b*, and steadied by guys. The supporting columns were, by means of tackles attached to the cross-piece, hoisted into vertical position and there bolted, after which the girders were hoisted up in a similar way and secured to the columns.

B is an elevation, and *C* a plan of one of the cast-iron girders. They were 23 feet 3¼ inches long, and 3 feet deep, and connected at top and bottom to the columns. Their great comparative depth enabled the latter to resist great lateral thrust, and imparted extreme stiffness to the structure, with the least possible weight.

Fig 2230.



Paxton's Girders (*Crystal Palace, London*, 1851).

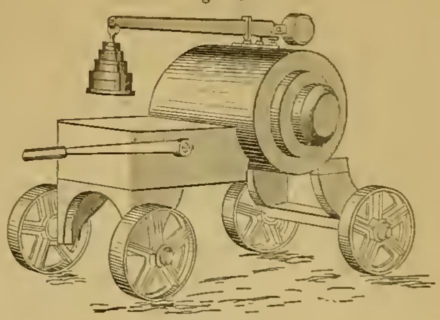
D is a form of wooden truss employed in the same structure.

Gird'er-bridge. A bridge supported by beams resting upon abutments at the ends. The beam is usually compound. A *truss-bridge.*

Gird'er-test'er. A form of hydrostatic press for testing the strength of girders. The form shown is on wheels, and has a safety-valve. By bolting two girders together, and placing this machine between them, they may both be tested at one time.

Gird'le. (*Diamond-cutting.*) The point of greatest marginal circumference of a *brilliant-cut* diamond, at which it is grasped by the *setting*. The projecting portion, rising about the *setting*, is the *bizet*, and has one third of the depth of the stone. It has thirty-two facets, and terminates in a flat face called the *table*. The imbedded portion of the stone has two thirds of the depth of the gem, and is called the *culasse*; it has twenty-four facets and terminates in a flat face, the *collet* or *culet*. See Brilliant.

Fig. 2231.



Girder-Tester.

Girt. A small girder. Used in roofs or bridge-frames.

A *girth.*

Girth. A band passing around the body. A *surcingle.*

More specifically: a band passing beneath the belly of a horse and buckled at each end to a girth strap of the saddle.

Girt-line. (*Nautical.*) A whip-purchase, depending from a lower-mast head and used in hoisting rigging and gear of the mast.

Gis-arm. A weapon formerly used. It had a long handle, a curved blade, and a prong projecting from the back of the blade.

Git. (*Founding.*) The entrance for molten metal into a mold. A *gate.*

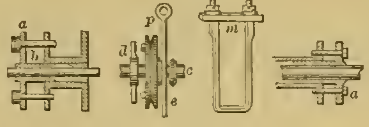
Gla'cis. (*Fortification.*) The superior slope of the parapet of the *covered-way*, forming a gentle slope towards the *country*, and protecting the *revetment* of the *scarp* from an enemy's fire. See Bastion.

Glad'stone. A four-wheeled, two-seated pleasure-carriage, with a driver's seat and dickey.

Glaire. (*Bookbinding.*) White of eggs. Used as a size in gilding.

Gland. 1. The cover of a stuffing-box. The cylindrical sleeve *b* presses upon the packing around the piston-rod to make a steam or air-tight joint. The exterior flange *a* is perforated for the passage of the bolts by which the gland is tightened.

Fig. 2232.



Glands.

2. The common clutch consists of a loose pulley *p* which is slipped upon the shaft *c* by means of the lever *e*, so that the studs on the pulley engage with the *gland d*, which is fast to the shaft. This causes the motion of the pulley to be imparted to the gland and shaft. The contrary motion of the lever disconnects the power from the shaft.

3. (*Founding.*) A hooked bar by which the parts of a molder's flask are clamped together.

4. A plate *m* through which the ends of a band or tightening clevis pass. A clip-plate.

Glass. 1. Glass is a compound substance formed by fusing together mixtures of the silicates of potash, soda, lime, magnesia, alumina, and lead. The proportions vary in the different kinds of glass.

Silica fused with alkalies yields a transparent glass; if the proportions of alkali and silica be as three to one, the compound is soluble in boiling water, and is called *soluble glass*, *water-glass*, or soluble silica. The greater the proportion of silica the less fusible is the compound.

Silica fused with lime, magnesia, baryta, or alumina yields an insoluble porcelainous compound, fusible only at a high heat.

Glass is divided into —

Flint-glass; used in making table ware and many articles of domestic furniture and fittings. The molten glass is taken from the pot by a *ponty*, and is blown or pressed into shape, or, by a combination of operations, is held in a mold while being blown.

Crown-glass is taken by the ponty from the pot, and is then blown and whirled till it becomes globular. A ponty tipped with molten glass is applied to the bulb, the blowing-tube detached, leaving a hole. The globe being again whirled, the glass flashes into a circular disk adhering by a boss in its center to the ponty. See CROWN-GLASS.

Sheet-glass. The glass withdrawn by the ponty from the pot is blown and whirled till it assumes a cylindrical form. The ends being cut off and the cylinder slit longitudinally, the sheet is heated, pressed, and rubbed until it is flattened out. This is also called *cylinder-glass; broad-glass* (which see).

Plate-glass is made by pouring it upon a table which has a marginal ledge of a hight equal to that designed for the thickness of the glass. A roller travels over the table, resting on the ledges and flattening out the glass, which is thus made of equal thickness throughout. See PLATE-GLASS.

Bottle-glass has nothing peculiar in the mode of its manufacture, but is made of coarse ingredients.

The proportions of materials in different kinds of glass vary with different places, as many notable proportions are, as it were, accidental; that is, are present in the sand which is most readily accessible, or are used to correct such faulty admixture. The following analyses are approximate: —

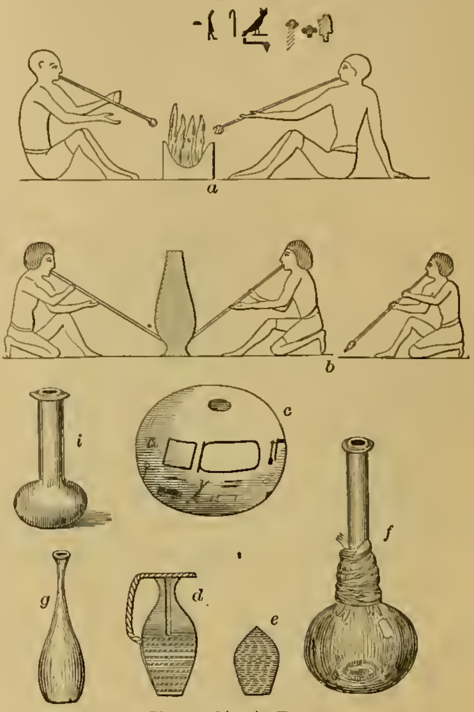
	Plate.	Broad.	Crown.	Flint.	Bottle.	Tube.	Optical.
Silica	78	69	63	52	59	73	43
Potash	2		22	14	2	12	12
Soda	13	16			10	3	
Lime	5	13	12		20	11	
Alumina	2		3	1	2	1	1
Oxide of lead . . .				32			44
Oxide of iron . . .		2		1	7		
	100	100	100	100	100	100	100

Glass was known in Egypt in the reign of Osirtasen, 1740 B. C. He may have reigned about thirty-four years when Joseph came to Egypt. In the tombs of Beni-Hassan of this date, the glass-blowers are shown at work (*a*), each with a bulb of glass on the end of his blow-pipe, into which he is blowing, while he keeps his glass hot by exposure to the fire. The same operation is depicted in other Egyptian tombs of various epochs. The glass at the end of the blowpipe is colored green in the original painting.

Another representation (*b*) of the same process is shown in a tomb at Thebes, where one workman labors at the bulb of glass in the earlier stage of its formation, and two unite to inflate the bottle when it has acquired some size. In figure *i* is shown a glass bottle found in Thebes. The bottle came to represent wine in the hieroglyphics.

c shows a glass bead belonging to Captain Henvey, and the hieroglyphics contain the name of a monarch who lived 1500 B. C. The Egyptians attained an excellence in the manufacture of counterfeit amethysts and other precious stones which has not been excelled, and Winckelmann considers their skill in all departments of vitreous art to be in advance of any succeeding age. They made glass of various colors, imitation pearls, and two films of glass were made to inclose gold plates.

Fig 2233.



Glass-making in Egypt.

Athenæus states that the glass of Egypt was famous. Strabo says that one very perfect kind could only be made in Egypt.

Herodotus speaks of rings of melted stone (no doubt, glass) as decorating the ears of the sacred Egyptian crocodiles.

The manufactures of glass among the Egyptians were of bottles, vases, and other utensils, probably lamps; wine was brought to table in glass bottles, handed to guests in glass cups, and bodies were sometimes buried in glass coffins. They also made glass beads, charms, amulets, and images.

The inscriptions on the Egyptian articles of glass were probably cut by diamonds or the dust of diamonds or other hard gems. The Israelites learned the art from them, and from the skill thus obtained were enabled to engrave the stones in the breastplate of the high-priest.

Some glass bottles among the Egyptians were inclosed by wicker-work like the *damagán* of Khorassan, a city of Persia, once famous for its glass-works. (Hence our *demijohn.*)

Others were covered with rushes like the Florentine flask. Others were partially covered with leather.

d is a bottle with a partial leathern cover.

e is a glass damagán.

f is a glass bottle encased in papyrus.

Remains of painted glass have been discovered in the ruins of Assyrian, Egyptian, Greek, Roman, and Etruscan cities.

In the magnificent collection, happily housed in New York, discovered and disinterred by General di Cesnola at Golgoi and Idalium, island of Cyprus, are nearly 2,000 specimens of Greek and Phœnician glass. The effect of decay or some rearrangement of the particles during the thousands of years of burial has rendered these articles dazzlingly iridescent.

"The boundless array of objects, reflecting from broad or curved surfaces tints positively outside of all experience, confuse the most accurate observation. Broad dishes, marbled with hues like those of incandescence; pots and jars and bottles, now plated over with strong surface-color like a coat of burnished metal, now sending light, pearly hints of variegated radiance, from elusive depths; or cups fantastically pied with scales of iridescence over their own strong original colorations, are scattered around a considerable apartment, defeating all sense of strict estimation, and cheating the mind with the notion of a possible perfection in the manufacture only compatible, as it seems, with decay. Some of the platters look as if Turner had painted skies on them in his maddest mood, and had been allowed to use flames for colors. The general effect seems to suggest that all the sunsets that have glimmered over Cyprus since these crystals were lost in the earth had sunk into their hiding-place and permeated their substance." — *N. Y. Nation.*

Most of the pieces are of simple inflated shapes, but some are pressed, having monograms and inscriptions in relief, opaque glass in mingled colors, sticks of twisted colors.

Small glass bottles from the Phœnician tombs, beneath the level of the Greek necropolis, show a reddish color when transmitting sunshine.

It would be tedious to enumerate the articles of glass found by Dr. Abbott in the tombs of Egypt. The myth related by Pliny and so widely copied in relation to the invention of glass-making by certain Phœnician mariners, has been exploded by researches in the land of the Nile. A few pieces in the collection may be noticed: —

Two beads of blue glass attached to a gold necklace stamped with the name of Menes, the first Pharaoh of Egypt (over 2000 B. C.).

A cylindrical ring of blue glass.

Glass bottles from Sakkarah, Gizeh, etc.

Glass beads, — white, blue, red, green, and black.

Variegated glass ornaments.

Semi-translucent glass imitations of alabaster.

Opaque red and blue glasses.

Tazzas and images of green, blue, and other colors.

Beads of colored glasses in layers.

Ornaments of mosaic glass.

A glass model of the crown of Upper and Lower Egypt.

Grotesque faces and portraits in glass.

Glass imitations of precious stones.

Glass rings of various colors.

Glass artificial eyes.

Glass spoons, shaped and colored in imitation of shells.

Layard, in his interesting work on Nineveh, says: "I was rewarded by the discovery of two small vases, one in alabaster and the other in glass, both in the most perfect preservation, of elegant shape and admirable workmanship." Each bore the name and title of the Khorsabad king, written in two different ways, as in the inscriptions of Khorsabad. The cuneiform inscription on one small green glass vase was to "Sargon," king of Assyria, the founder of Khorsabad, about 709 B. C. He also found a plano-convex glass lens $1\frac{1}{2}$ inches in diameter and $\frac{9}{16}$ of an inch thick.

The lachrymatories (*g*) of ancient Phœnicia were of glass or pottery, and are found in great numbers on opening the tombs and sarcophagi of that land. Thompson records the opening of an ancient tomb in a garden of the city of Beirut, which contained scores of these tear-bottles in thin glass or unglazed pottery. They have a slender neck, a broad bottom, and a funnel-shaped top. David says: "Put thou my tears into thy bottle."— Psalm lvi. 8. These bottles are probably coëval with the sweet singer of Israel.

A record of the Phœnician trade on the western coast of Africa is still preserved in the peculiar glass beads found there.

The pillar of emerald seen by Herodotus in the temple of Hercules at Tyre (Book II. 44) was probably of glass. "Of all stones," says Pliny, "the emerald is most easily imitated" (XXVII. 12).

The Tyrians erected the first glass-houses mentioned in history, and practiced the manufacture for many ages before other contemporary nations attempted it. From Syria the art was brought by the Crusaders to Europe (1177), and established in Venice, which long had a monopoly therein and attained great excellence. See p. 976.

Theophrastus, the pupil and successor of Aristotle, notices the fitness of the sand at the mouth of the river Belus for the manufacture of glass.

Lucretius termed it *vitrum.*

Cicero mentions glass, linen, and paper as the common articles of Egyptian merchandise.

Scaurus, 58 B. C., introduced it in the scena of his gorgeous theatre, which was divided into three tiers: the lower of marble, the middle of glass, the upper of gilded wood.

The price of a glass drinking-cup in the time of Strabo was half an *as.* The *as* was about one cent.

The Museo Borbonico of Naples contains about 2,400 specimens of ancient glass, recovered principally from Pompeii and Herculaneum. They represent numerous forms of glass ornamentation in green, opal, blue, red, white, and yellow.

The Barberini vase, now known as the "Portland vase," was discovered about 300 years since, a short distance from Rome, in the tomb of Alexander Severus, who was killed by Maximinus, A. D. 235. The body of the vase consists of dark blue glass, on the surface of which are delineated in relief elaborately wrought figures of opaque white enamel. So admirably is it made that it was long supposed to be a genuine sardonyx.

Fictitious gems in glass were known in Rome, as were also mosaic glass, glass plates for paving, wall-lining, windows.

Lucretius (95 – 51 B. C.) accounted as follows for the fact that sound would pass through some objects while images would not: —

"The voice can pass unbroken through winding pores of bodies, *though* images refuse *to pass through them;* for the *latter* are broken to pieces unless they go through straight passages, such as those of glass, through which every image flies." (Book IV. 613 – 619.)

Opalescent glass is referred to by the Emperor Hadrian in a letter to the consul Servianus, thanking him for a present of three curious cups of glass which "reflected like a pigeon's neck a variety of colors."

Flexible glass is referred to by Pliny, Petronius, Dion Cassius, and others who copied from them.

The two former refer to vases made in the time of Tiberius. It is not fully credited.

Julius Cæsar found the Britons in possession of glass beads, which they probably obtained of the Phœnicians in return for tin. Rome had few glass windows till the reign of Nero. Some are found in the ruins of Pompeii, buried 79 B. C.

Pliny describes the mode of making glass, and states that Sidon was *formerly* famous for its glass-houses, and that its people first invented mirrors. In this day, says he (A. D. 79), throughout the Spanish and Gallic provinces, glass is made of white sand and niter by a double fusion. He also speaks of flexible glass, stating that "he hardly believed the story," which was a wonderful thing after telling such a farrago of stuff about medicines and magic. In his day — he says — glass had quite (? nearly) superseded the use of silver and gold for drinking-vessels.

He noticed the effect of lenses, stating that "globular, glass vessels, filled with water, when brought in contact with the rays of the sun, become heated to such a degree as to cause articles of clothing to ignite." He omitted to notice that the glass remained cool, and only transmitted and concentrated heat.

Previous to the introduction of glass into Europe in quantities to make it available for ordinary household use, a mineral substitute was employed.

Crystals of gypsum are generally in the form of more or less compressed rhomboids, which are easily divisible into thin laminæ by splitting them parallel to their two broad planes. Such laminæ were employed at Rome in the reign of Tiberius for many of the purposes for which we at present use glass. Spain and Cappadocia furnished the best, sometimes of the length of five feet. This variety of gypsum was known by the name of Lapis Specularis, from the use to which it was applied, namely, in glazing windows and conservatories in which were placed fruit-trees, to protect their produce from the winter's cold, and in the construction of beehives, as Pliny expressly informs us, for the purpose of enabling the curious to observe the proceedings of these interesting insects. The temple of Fortune at Præneste was built of slabs of gypsum, through which the light came and fell on the statue of the goddess, which was placed in the center of the edifice. The *specular stone* of the ancients often signifies *mica*.

Glass panes for windows are mentioned in the writings of Gregory of Tours, who flourished in the last quarter of the sixth century. He stated that churches were furnished with windows of colored glass in the fourth century of our era.

Jerome, A. D. 422, states that glass was melted and cast into plates for windows. In the sixth century Paulus Silentarius notices that the windows of the Church of St. Sophia at Constantinople were glazed.

The oldest glass windows now in existence are of the twelfth century, and are in the church of St. Denis, France.

In the thirteenth century, the Venetians exceeded all others in glass-making.

Æneas Sylvius states that, in 1458, the houses in Vienna had glass windows. He regarded it as a sign of opulence.

In France, church windows were generally glazed in the sixteenth century, though there were but few glass windows in private dwellings.

Talc, isinglass, horn, oiled paper, and thinly shaved leather were generally used instead of glass throughout the civilized world.

Blue glass, colored by the addition of cobalt to the frit, was discovered about 1550 by Christopher Schurer of Platten, Bohemia.

Glass was imported into England, A. D. 1177 ; the manufacture was established in that country, 1557. In Savoy, the same year.

Plate-glass was made at Lambeth by Venetian artists, 1673.

The British Plate-Glass Company was established 1773.

An active manufactory of glass exists at Hebron, in the land of Palestine, — the same Hebron where is the cave of Machpelah, bought by Abraham for a sum of money of Ephron, one of the sons of Heth. The tombs are preserved in rigid seclusion from Jew and Christian ; of the latter, not one lives in the town of 5,000 people. Dr. Thomson gives an account of it in his work, "The Land and the Book," but could not reach the vault.

The manufacture consists of party-colored glass bracelets for the Jerusalem market, and lamps for Syria, Palestine, and Egypt. The solid articles are formed from a bulb of glass adhering to the end of an iron, being shaped by the aid of a long knife. The glass is twisted, pressed into an approximate shape, then reheated and stretched by another rod.

The Crystal Palace of London was built in 1851, after the designs of Sir Joseph Paxton, soon after the abolition of the excise duty on glass, and was considered to celebrate that event in a worthy and effective manner. The roof and sides were, to a great extent, of glass, the sash being of wood, and the frame of the building a combination of wrought and cast iron. The following are some of the data and dimensions : —

Length		1,848 feet.
Width		408 feet.
Area roofed in		772,784 square feet.
Floor area of galleries		217,100 square feet.
Sash-bars		200 miles.
Glass		896,000 square feet.
Wrought-iron		448,000 pounds.
Cast-iron		8,512,000 pounds.
Visitors		6,039,195 persons.
Receipts		£506,100
Expenses		£292,794
Value of exhibited articles		£2,000,000
Number of exhibitors, —		
British	7,381	
Foreign	6,556	
		13,957

In 1838, Mr. Robert Lucas Chance, of Birmingham, England, successfully introduced the manufacture of Bohemian sheet-glass into his district. Mr. James Chance perfected the process of grinding and polishing sheet-glass, now known as *patent plate*.

"The 'London Builder' gives, as derived from an eminent member of this firm, the following record of improvements in the glass trade, during the last fifty years : —

"1. The substitution, about the year 1830, of carbonate of soda as the alkaline ingredient in glass in the place of kelp, and subsequently, for crown and sheet glass, of sulphate of soda in the place of carbonate.

"2. An increase in the size and improvement in the workmanship of the plates, sheets, and tables produced.

"3. An improvement in the color of the glass by the use of purer materials and modifications in the process of melting.

"4. Numerous improvements in the flattening of sheet-glass, resulting in the removal or diminution of many imperfections.

"5. The use of the diamond in the process of splitting cylinders in the place of a red-hot iron.

"6. An increase in the size of the melting-pots and furnaces, with the view of economizing coal and labor.

"7. The adoption, in the casting of plate-glass, of various mechanical contrivances. The origin of some important improvements of this class is due to the present manager of the Birmingham Plate-Glass Company.

"8. The use of the same pot for the two processes of melting and casting plate-glass, superseding the old method of transferring the contents of the melting-pot into the vessel used for casting.

"9. The substitution of small coal or slack in the melting processes in the place of the large coal or lumps.

"10. The application of Siemen's regenerative process to the melting of glass, by which the amount of smoke is greatly diminished, the color of the glass is improved, a greater control is obtained over the furnace, and a saving of fuel is effected wherever, by this process, slack can be substituted for large coal or lumps. These advantages are to some extent counterbalanced by the increased cost of the furnace, and its increased liability to get out of order. The process, however, as applied to glass-making, is so new that there has been scarcely time as yet to overcome the difficulties which have presented themselves.

"Messrs. Chance are widely known for the production of dioptric apparatus for lighthouse illumination. Mr. Alan Stevenson remarks: 'Nothing can be more beautiful than an entire apparatus for a fixed light of the first order. It consists of a central belt of refractors forming a hollow cylinder six feet in diameter and thirty inches high; below it are six triangular rings of glass ranged in a cylindrical form, and above, a crown of thirteen rings of glass, forming by their union a hollow cage, composed of polished glass ten feet high and six feet in diameter. I know of no work of art more beautiful or creditable to the boldness, ardor, intelligence, and zeal of the artist.' More than one hundred and fifty of these dioptric lights have already been produced by Messrs. Chance, for almost all parts of the world."

A vitreous, opaque material, called from its translucent, milky appearance, "hot-cast porcelain," is now made in Philadelphia. It is understood to be made from cryolite or feldspar, whose natural and added fluxes render them fusible at a comparatively moderate temperature, yielding a mass viscid and tractable while hot, lustrous and strong when cold.

It was proposed to make the headstones for the graves of Union soldiers of this material. One side of the mold would have a tablet in which the letters of the inscription would be set up. It would seem to be impossible to find an equally good material for the purpose. Glass (ordinary), marble, or enameled iron are inferior and more frangible.

Plates of ice are used instead of panes of glass in the Siberian *yurts*, or winter-quarters, which are partly subterranean.

(*Optical Glass.*) Crown and flint glass are combined in the construction of achromatic lenses. The former of these is a compound of silex, potash, and lime; the latter contains in addition oxide of lead. This tends to sink to the bottom of the melting-pot, rendering the glass of unequal texture and consequent refracting power. In this consisted the principal difficulty in obtaining object-glasses of large size. So late as 1830, the largest object-glasses of satisfactory performance which were produced did not exceed five or six inches in diameter. Previous to this, however, Guinand, a melter in a glass-manufactory at Soleure, in Switzerland, succeeded in making large disks, but he kept his process secret, and died without disclosing it, though it continued to be practiced by his son and afterward by M. Pfeil of Paris, who exhibited at the Exposition of 1867 a disk of the diameter of 72 centimeters, — over 28 inches. The process of making these disks consists substantially in uniting numerous small selected masses of uniform density and refracting power into one large mass by pressure while in a plastic state. In 1855, Messrs. Chance of Birmingham exhibited at the Exposition of that year a pair of disks, crown and flint, about an inch larger than those of M. Pfeil. See LENS.

2. (*Nautical parlance.*) *a.* A telescope.

b. The barometer.

c. The half-hour or sand-glass which regulates the watches.

d. The half-minute or quarter-minute sand-glass used with the ship's log.

See under the following heads: —

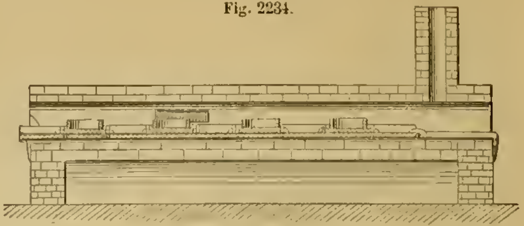
Adapter.
Amaasa.
Anaclastic glass.
Annealing arch.
Argentine-glass.
Aventurine-glass.
Balloon.
Bead.
Beaker.
Bell-glass.
Binocular glasses.
Blebby-glass.
Blowing-iron.
Blow-over.
Blowing-tube.
Bocal.
Bocca.
Boccarella.
Bohemian-glass.
Bologna-vial.
Bolt-head.
Bombolo.
Bottle.
Bottle-glass.
Bottle-holder.
Bottle-stopper.
Bottoming-hole.
Broad-glass.
Bruiser.
Bugle.
Bull's-eye.
Bunting-iron.
Burning-glass.
Calcar.
Calx.
Came.
Capping-off.
Cap-pot.
Carboy.
Carquaise.
Casher-box.
Casting-slab.
Casting-table.
Cave.
Cheval-glass.
Circulus.
Cistern.
Cranny.
Crown-glass.
Cryolite-glass.
Crystal.
Cullet.
Cupping-glass.
Cut-glass.
Cuvette.
Cylinder-glass.
Drop.
Egg-glass.
Email ombrant.
Embossing-glass.
Emerill.
Enameled-ware.
Eye-glass.
Fascet.
Ferret.
Ferretto.
Field-glass.
Filigree-glass.
Fine-arch.
Firing.
Fish-globe.
Flacket.
Flashing.
Flatting.
Flatting-furnace.
Flint-glass.
Flux.
Frache.
Fret-work.
Frit.
Frit-brick.
Fritting-furnace.
Frosted-glass.
Fusible-porcelain.
Gage-glass.
Gem. Artificial
Gilding-glass.
Glass.
Glass annealing-furnace.
Glass-blowing.
Glass-cement.
Glass-coach.
Glass-coloring.
Glass-cutting.
Glass-enamel.
Glass-engraving.
Glass-furnace.
Glass-gall.

Glass-grinding.
Glass-house.
Glass-maker's chair.
Glass-maker's soap.
Glass-metal.
Glass-mold.
Glass-mosaic.
Glass-oven.
Glass-painting.
Glass-paper.
Glass-polishing.
Glass-pot.
Glass-press.
Glass-rolling.
Glass-silvering.
Glass-soldering.
Glass-spinning.
Glass-staining.
Glass-tongs.
Glazier's diamond.
Glazing-tool.
Glory-hole.
Graduated-glass.
Grozing-iron.
Ground-glass.
Hand-glass.
Harbor.
Hopper.
Horizon-glass.
Hour-glass.
Index-glass.
Knob.
Lamp-chimney.
Lead-light.
Leer.
Lens (varieties, see Lens).
Lens-grinding.
Log-glass.
Looking-glass.
Lunette.
Magnifying-glass.
Marver.
Massicot.
Matted-glass.
Metal.
Milk-glass.
Millefiore-glass.
Minute-glass.
Mirror.
Mosaic-glass.
Mouth-glass.
Mucilage-bottle.
Multiplying-glass.
Nose-hole.
Object-glass.
Omnibus.
Opaline.
Ouvreaux.
Paste.
Perspective-glass.
Phial.
Pier-glass.
Pinching-tongs.
Plate-glass.
Platenizing-glass.
Plattening-glass.
Poling.
Polishing-glass.
Polverine.
Pontil.
Potichomanie.
Pot-metal.
Pressed-glass.
Priscillas.
Pucellas.
Pulse-glass.
Quarrel.
Quarry.
Reticulated-glass.
Runner.
Sadwei.
Sand-blast.
Sand-glass.
Sandiver.
Sand-washer.
Schmelze.
Shanks.
Sheet-glass.
Sheet-glass machine.
Shell.
Siege.
Silvering-glass.
Singing-glass.
Skylight.
Smetz-glass.
Smoke-bell.
Snap.
Snapdragon.
Soluble-glass.
Spreading-furnace.
Spreading-plate.
Spring-tool.
Spy-glass.
Square.
Stained-glass.
Storm-glass.
Strap.
Strockle.
Table.
Template.
Test-tube.
Tin-glass.
Tisar.
Vault-light.
Venetian-ball.
Venetian-glass.
Vial.
Vitrics.
Vitrio-de-Trino.
Watch-glass.
Water-glass.
Weather-glass.
Window-glass.

Glass An-neal'ing-fur'nace. One in which articles or sheets of glass are kept for a while in a heated condition, and allowed gradually to cool. A *leer.* (See Annealing.) In the illustration, which is a *leer* for glass jars, the trays of ware are put into the arch at one end and pushed in succession to the discharge-end. The heat of a furnace is thrown into the *leer* at a point between feed and discharge ends, so that the heat is graduated both ways.

Glass-blow'ers' Lamp. A gas or alcohol lamp. See Blow-pipe.

Fig. 2234.



Glass Annealing-Furnace.

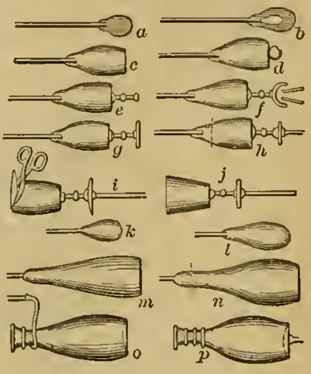
Glass-blow'ing. A mode of manufacturing glass-ware and window-glass by taking a mass of viscid glass from the melting-pot on the end of the blowing-tube, and then inflating the mass by blowing through the tube, rolling on the *marver*, and exposing it at the furnace opening where its contained air is expanded and itself enlarged. Glass-blowing enters into most of the operations with glass, but the process is modified to suit varying circumstances. See Crown-glass; Cylinder-glass; Flint-glass, etc.

Glass-blowing is also used in connection with molds, which give the exterior form to the article, and in the ingenious operations of making glass articles and toys under the Blow-pipe (which see).

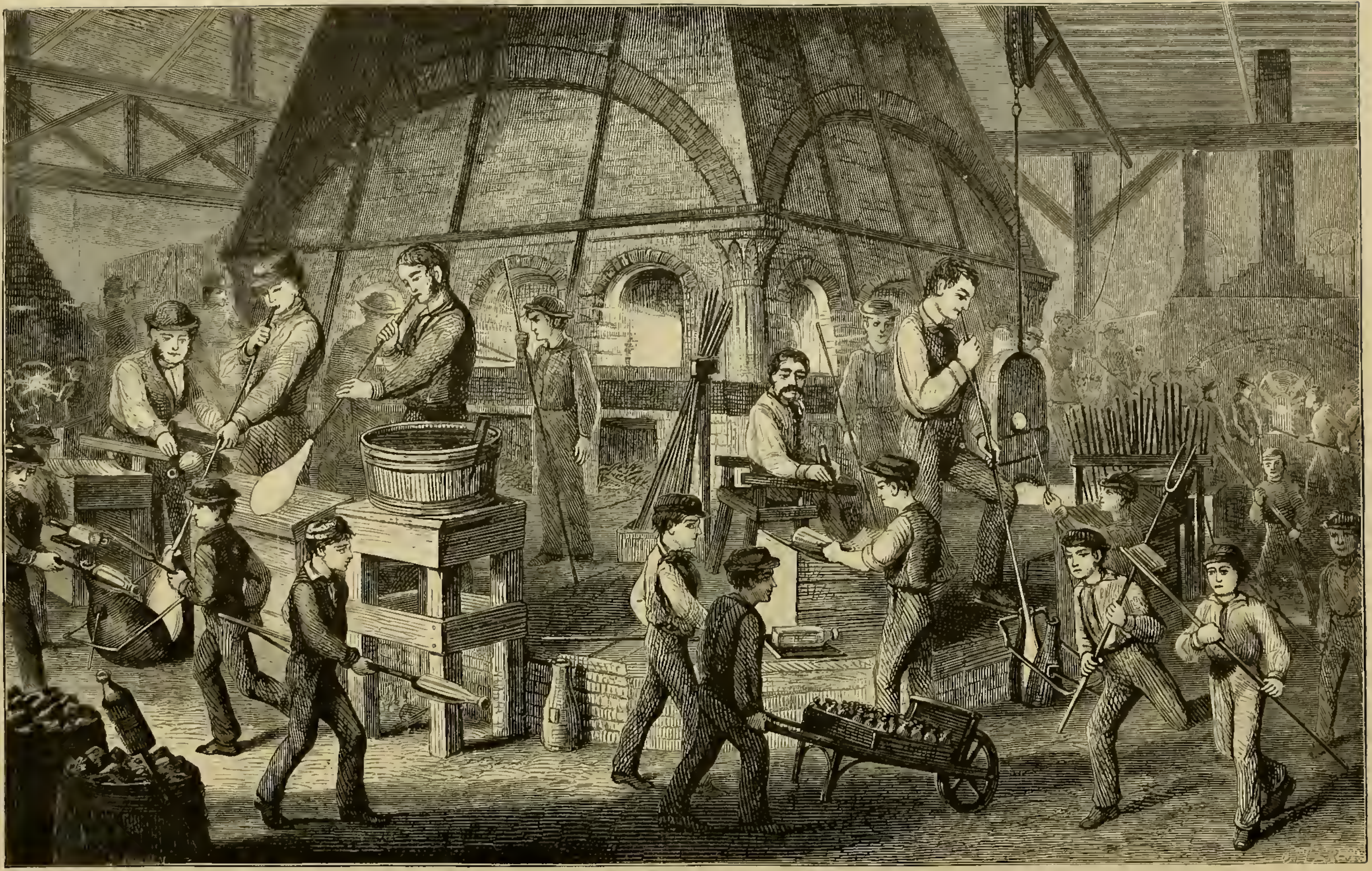
The art of glass-blowing long reigned supreme at Murano, one of the islands of the maritime city Venice. After some preliminary matters, an observer states: —

"At the present moment you may set before Antonio Seguso or Antonio and Giovanni Barovier, of Murano, any specimen of old Venetian glass, and they will copy it with all its perfections, and, if you choose, its imperfections, and hand you a fac-simile in color, form, and *weight*, made under your own eye. On my first visit, the head workman was requested by Salviati to make me any article I might fancy. I chose a wineglass with deep bowl, initial stem, and broad, ruby-tinted foot. The man dipped his hollow iron rod into a pot of molten white glass, caught up a lump, rolled it on an iron slab, popped it into the furnace, blew through his rod, tossed it aloft, and a hollow ball appeared. His assistant handed him a rod of metal, in which a green serpent seemed coiled in a white cage; this he caught, and, quick as lightning, formed two initials, touching the bowl with the tip of the M, to which it adhered. Then his assistant offered more white glass, which was joined to the bottom of the M, spun round, opened with the nippers, and so the foot was formed. Again into the furnace, and then the shears opened and hollowed the deep and slender bowl. Then the assistant handed a scrap of ruby molten glass, which the master caught a hair, as it were, wound it round the rim of the bowl and of the foot. Once more into an upper oven, where it must remain till the morrow to cool."

Fig. 2235.



Glass-Blowing.



GLASS-BLOWING.

BROOKLYN, N. Y.

PLATE XX.

See page 976.

Fig. 2235, *a* to *j* show the forms assumed by a ball of molten glass in the manufacture of a wine-glass. *a* shows the ball as taken up on the point, heated nearly to redness, of the blowing-iron. After being rolled on the marver and slightly expanded by blowing, it takes the shape *b*, when it is farther shaped and flattened by the battledore, as represented at *c*; a solid ball is then attached *d*, which is by the lathe or the use of the pucellas while being rotated on the glass-maker's chair formed into the stem *e*. To this a globe is attached, which is opened out and flattened by the pucellas while being rapidly rotated on the chair constituting the foot, as shown at *f g*. A small knob of glass is now by means of the pontil attached to the foot *h*, after which the cold pucellas are applied at the dotted line shown in *h*, after which the bowl is sheared *i* preparatory to flashing and finishing. The finished glass *j* is then taken up by means of a forked rod and transferred to the annealing arch.

In making a ringed decanter, the ball *k*, after being slightly distended, is swung round, causing it to assume the shape *l*; this is farther expanded and battledored at the end, taking successively the forms *m n*, the pontil is attached to the bottom and the neck broken off at the point indicated by the dotted line, and the mouth warmed up and shaped. The rings are formed by taking up small quantities of glass on the pontil and applying them as shown in *o p* to the neck of the decanter, which is rotated for the purpose.

Glass-ce-ment′. To stop cracks: —

Dissolve caseine in cold saturated solution of borax, and with this solution paste strips of hog's or bullock's bladder (softened in water) on the cracks of glass, and dry at a gentle heat; if the vessel is to be heated, coat the bladder on the outside, before it has become quite dry, with a paste of a rather concentrated solution of silicate of soda and quicklime or plaster of paris.

To unite broken parts: —

Two parts isinglass are soaked in water until well swollen, the water poured off, and the isinglass dissolved in warm alcohol; one part mastic is dissolved in three parts alcohol and added to the above solution, then one part of gum ammoniacum is added. The solution is well shaken and evaporated to the consistency of strong glue, then allowed to cool and solidify. When used, both cement and articles to be mended must be warmed. See also p. 507.

Glass-cloth. (*Fabric.*) A fabric produced by interweaving fabrics of glass, which are, in a very attenuated state, extremely flexible.

Glass-coach. A carriage of the superior order. The term is nearly obsolete, but it originally expressed that the vehicle had glass windows instead of opaque panels or curtains.

Glass-col′or-ing. Tinting glass by incorporating metallic oxides in its substance.

Articles which exhibit different colors upon the same specimen, and at different depths in the thickness of the glass, are formed by dipping the article, first made in white, transparent glass, into a pot of fused, colored glass. A coating adheres, and is afterwards cut away in portions, so as to expose the clear glass.

The colors are obtained by the following: —

Oxide of cobalt imparts deep blue.

Dioxide of copper imparts ruby red.

Protoxide of copper imparts green.

Protoxide of iron imparts shades of green.

Peroxide of iron imparts yellow brown.

Oxide of gold imparts ruby red.

Yellow oxide of iron, muriate of silver, oxide of zinc, and white clay, impart a yellow tinge; oxide of cobalt, oxide of manganese, and oxide of iron, impart a black tinge.

Red oxide of iron prepared by nitric acid and heat imparts red.

Purple of Cassius, precipitated from muriate of gold by protomuriate of tin, imparts violet.

Oxide, chloride, or phosphate of silver imparts yellow.

Peroxide of manganese imparts a shade of violet.

Oxides of chromium impart shades of green and red.

Uranium imparts opalescent yellow.

Binoxide of tin imparts opalescent white. In excess, opaque enamel.

Arsenic imparts bluish-white opal with changeable red tints.

Green may be obtained by staining one side of the glass blue, the other yellow.

Orange by similar combination of red and yellow.

Colored glass is known as *flashed*, or as *pot-metal*: in the former case a film of colored glass is laid over the white; in the latter, the color is stirred up with the *metal* in the pot, imbuing its whole substance.

Glass-cut′ting. Glass was known to the ancient Egyptians and Assyrians, and the art of gem-cutting was also known; the engraved gems of the Jewish high-priest's breastplate were cut by artists trained in Egypt.

Glass was cut upon a lap by the Greeks, and Pliny refers to the same, Book XXXVI. 26.

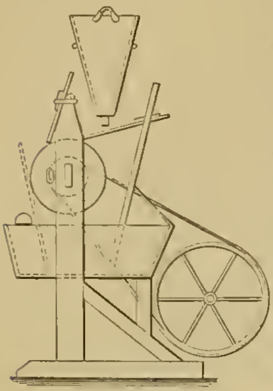
It has been affirmed that the art of glass-cutting was invented at the beginning of the seventeenth century by one Caspar Lehmann, of Prague, who was patronized by the Emperor Rodolphus II. Schwanhard, an apprentice of Lehmann, removed to Nuremberg, where he worked for many of the principal nobility, and hence this city acquired the reputation of being the birthplace of the new art; which was afterward much improved by the introduction of new tools and cheaper methods.

Previous to this, however, figures had been cut or engraved on glass by means of the diamond. The first mention of writing on glass with the diamond only dates back to the time of Francis I. of France (1520), but about the year 1562 festoons and other ornaments cut with a diamond were very common on Venetian glasses, which at that period were accounted the best.

What is known commercially as "cut-glass" is glass with incisions and ornaments with smooth surfaces, appearing as if cut by a sharp instrument. This operation is chiefly confined to flint-glass, which, being more tough, soft, and brilliant than the other kinds, is more easily wrought, and produces specimens of greater luster. An establishment for cutting glass contains a great number of small wheels, of stone, metal, and wood, which are made to revolve rapidly, by a steam-engine or other power. The cutting of the glass consists entirely in grinding away successive portions, by holding them upon the surfaces of these wheels. The first or rough cutting is sometimes given by wheels of stone, resembling grindstones. Afterward, wheels of iron are used, having their edges covered with sharp sand, or with emery, in different states of fineness. To prevent the friction from exciting so much heat as to endanger the glass, a small stream of water continually drops upon the surface of the wheel. The last polish is given by brush-wheels, covered with putty-powder, which is an oxide of tin and lead.

The customary grinding and polishing of glass articles for various uses is effected by revolving

Fig. 2236.



Glass-Cutting.

wheels of iron, stone, or wood, horizontally mounted, and supplied with a stream of water from a hopper or can above the wheel. The water is led by a sloping channel to the upper edge of the wheel, and a slightly sloping board is placed just in front of the point of its delivery to distribute it equally over its edge. A splash-board in front catches the water as thrown off by centrifugal force, and leads into a trough beneath. A second splashboard is sometimes placed in front to protect the workman from wet. The wheels employed are generally from six to twenty inches in diameter; they are mounted on separate spindles, so as to be exchangeable, and have flat, rounded, angular, or concave edges.

The two former are used for producing the flat or slightly concave faces of the work, called *flutes;* the angular produce the angular grooves or *splits* on the sides of decanters and similar objects, and the concave form the convex ribs called *pillars*. The wheels for first or rough grinding are of iron, and a considerable quantity of sand is employed; the work is then smoothed upon fine grit stones, rendered circularly true and very smooth, less water and no sand being used; after which they are polished upon wooden wheels with pumice and rottenstone and water, and the final luster imparted by wet putty-powder applied on similar wheels.

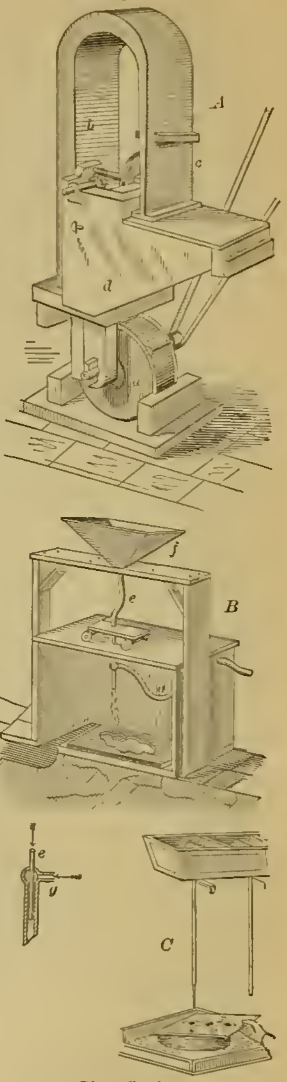
Tilghman's process for cutting glass or stone by means of a blast of air or steam carrying a stream of sand is adapted for piercing or for engraving the surface, and has many adaptations. In Fig. 2237, *A* is an apparatus for roughening sheet-glass. The air-blast is produced by the fan *a* below, and the air rises through the curved tube *b*, carrying the sand up with it, which is thrown into the air-tube by an endless belt of scoops arranged in the lower part of the angular box *d*. The sand is carried up by the air and brought over and down the front air-tube *c*, where it discharges with great force upon the surface of the glass, which is contained within the front box, and is carried by a belt gradually forward under the sand blast. The sand falls from the glass into the lower part of the angular box, whence it is scooped and thrown again into the air current.

Another form of apparatus for boring or engraving is shown at *B*, and the sand is driven in this case by steam, on the principle of the injector. The sand descends through a tube *e* from the hopper *f*, and in its course the vertical sand-pipe is joined by a lateral steam or air pipe, which gives a sudden impulse to the sand and drives it down upon the glass below with great force. The sand-tube is flexible, its extremity is carried on rollers, by which it may be moved back and forth to suit the requirements of the work.

C is still another form, in which corundum-powder is dropped from a hight upon the surface of glass to roughen or engrave it.

In each of the cases cited, the abrading material is directed by a tube upon the part desired to be bored or cut, the plate, if necessary, being moved beneath the sand-blast so as to bring each part in succession under the action of the cutting particles. When a pattern is to be engraved, a portion of the surface is protected by paper, oil-paint, a sheet of rubber, cloth, or lace, as the case may be. The sand bounds from these resilient materials, but indents the glass or stone with its points and edges, so as to roughen and gradually wear away the face, or even bore through it if the process be long continued. With a steam jet of 300 pounds' pressure, a hole 1½ inches in diameter was cut through a piece of corundum 1½ inches thick in 25 minutes. The rate is dependent upon the hardness of the material to be cut, the force of the blast, and the sharpness of the powder; the latter is much dependent upon its hardness, as corundum will outwear mere quartz sand.

Fig. 2237.



Glass-Cutting.

This beautiful process has many applications. Glass partially protected by a fern-leaf receives a frosted ground leaving a bright leaf; protected by wire gauze it may be turned into glass gauze. Ornamental letters may be made on glass, marble, or granite, either bright on a rough ground, or conversely. It has even been used to etch through negative films of bichromated gelatine, the penetration being greater in proportion to the thickness and hardness of the film.

Glass may be cut by a jet of hot air or gas, directed upon the object in the line of the desired fracture. This is then damped, and the glass contracts and divides on the line. The same may be done by a hot poker carried along the line to be broken; commence with a file cut to start the crack, apply the poker and the crack will follow the iron.

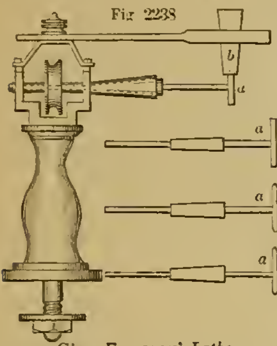
Glass may be readily drilled by a hard steel drill kept moist by turpentine. Dilute sulphuric acid or carbolic acid are good lubricants. It is said that at Berlin glass castings for pump barrels are drilled, planed, and bored like iron ones, and in the same lathes and machines, by means of sulphuric acid. See also Glazier's Diamond.

Glass-en-am'el. This is applied to a semi-lucid or an opaque glass, which owes its milkiness to the addition of binoxide of tin. The transparencies which are hung in windows or form shades for lamps are of the semi-lucid character, and are miscalled *porcelain transparencies*. Watch-dials have an opaque, glass-enameled face on a metallic backing. See Enamel.

Glass-en-grav'ing. The engraving of flint-glass is substantially the same as the ordinary glass-cutting, but is of a more delicate character. It is effected by the use of very small disks, generally of copper, and moistened at the edges with emery and oil.

Bodier's improvements (French) in glass-engraving were made in 1799. The engraver sits at a small lathe with a little rack before him, containing about a score of the copper disks, varying in size from the diameter of a cent down to one-fiftieth of an inch, each mounted on a spindle and sharpened on the edge. He paints a rough outline of the design on the surface of the glass, and selecting a disk he touches the edge with emery and oil, inserts it in the mandrel, sets it spinning, and holding the glass against it from below, the little wheel eats its way in with astonishing rapidity. The glass, held lightly in the hands, is shifted about continually, till all the greater parts of the figure are worked out; then, for the lesser parts, a smaller disk is used; and at last the finest touches, such as blades of grass, the tips of antlers, eyebrows, and so forth, are put in with the smallest. Every minute he holds the glass up between his eye and the light, watching the development of the design; now making a broad excavation, now changing the disk every ten seconds, and giving touches so slight and rapid that the unpractised eye can scarcely follow them.

Fig. 2238.



Glass-Engravers' Lathe.

The illustration shows the lathe-post with its band-pulley, spindle, and disk *a* in position. *b* is a slip of wood mounted on an arm, and designed to keep the wet powder from being thrown against the operator. For polishing, a leaden disk and pumice-powder are used.

Glass-fur'nace. There are several furnaces in a house for making *crown-glass*: —

The *reverberatory-furnace*, or *calcar*, for fritting or calcining the materials. Also known as the *fritting-furnace*.

The *glass-furnace* containing the pots in which the materials are melted.

The *blowing-furnace*, at which the pears of glass are enlarged into globes.

The *bottoming-hole*, where the globe is flattened.

The *flashing-furnace*, where it is expanded into a circular plate.

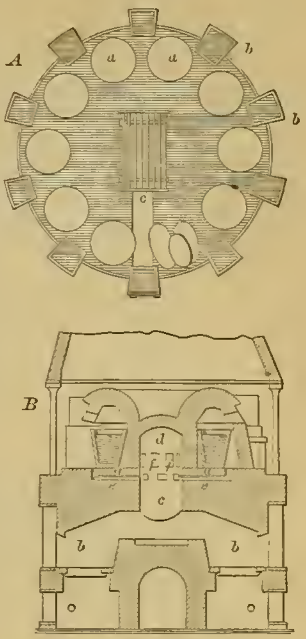
The *annealing-arch* or *leer*, where it is allowed to cool gradually.

The *reverberatory-oven*, where the pots are heated and seasoned.

Fig. 2239, *A* is a plan of the furnace in which the frit in pots is converted by fusion into glass.

a a, etc., are the flues between which the pots are placed, resting on the intervening spaces, so that each flue heats one side of two pots. The working holes *b b*, etc., are opposite each pot and between the flues. *c* is the grate. Flame and smoke pass through apertures called *linnet-holes* at the upper part of the sides of the furnace, which has a dome-shaped top. The furnace *B* has an annular bed with projections *a a* on which the crucibles rest. It is provided with two fireplaces *b b* communicating with a central flue *c*, through which the caloric current passes to an upper chamber *d*, whence it is distributed to the crucibles by the openings *c c f f*.

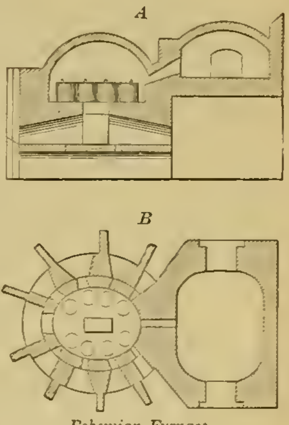
Fig. 2239.



Glass-Furnaces.

Fig. 2240, *A* is a longitudinal section, and *B* a plan of a Bohemian furnace employed in making window-glass. Above the vaulted ash-pit is the fireplace, having three compartments from which the heat passes through a central opening to the oven containing the glass-pots, which are placed closely together for economy of space. The pots are introduced through a front opening which is then bricked up. The working-holes are between the pillars of the structure. A flue conducts the heat to the annealing-stove, exterior to which is usually a drying-kiln, not shown in the figure, and there are adjoining stoves called *arches* for drying and annealing new pots.

Fig. 2240.



Bohemian Furnace.

Glass-gall. Scum on the glass, in the pot. *Sandiver.*

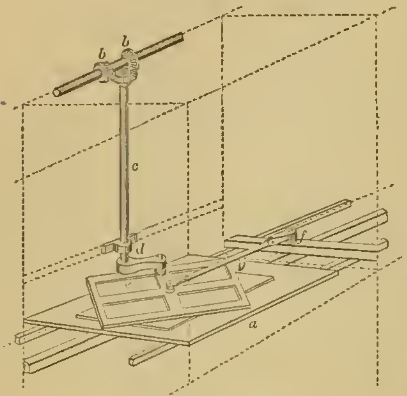
Glass Grind'ing and Pol'ish-ing. Plate-glass from the table requires grinding and polishing, which is performed by machinery. The under plate is imbedded in stucco on a solid table, and the upper one in a cast-iron frame, which has a motion around its own center and around a point on the lower plate. The latter is on a movable table, and has a slow motion in the direction of its length and its breadth. Moistened sand is applied between the two. Afterwards different grades of emery are used.

The polishing is effected by rubbers of hat felt or leather, with a paste of colcothar and water. Finally, a putty, oxide of tin, is used.

Fig. 2241 illustrates a machine for grinding and smoothing the plates to a true and even surface preparatory to finally polishing them.

The dotted lines indicate the framework of the machine supporting the bed *a*, to which a sheet of glass is cemented. Two bevel wheels *b b* rotate the axis *c*, which carries the crank *d* attached to one side of the movable table *e*, imparting to it a circular motion about the point *f*, where the radius-rod *g* is pivoted; the bed *a* also has a slow longitudinal reciprocating movement imparted from a bar beneath. The lower part of the table *e* is faced with slate, to which a sheet of glass is cemented. Clean sharp sand and coarse emery are used for grinding, and finer emeries for smoothing; the apparatus being carefully washed at each change from coarser to finer material.

Fig. 2241.

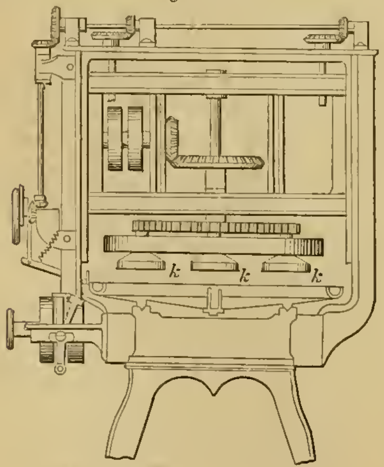


Glass-Polishing Machine.

By the combined rotary and longitudinal movement the abradants are caused to operate with equal energy on every point of the plates. Weights are placed upon the back of the table *e* to insure sufficient pressure.

The final polishing is completed by leather-covered rubbers attached to reciprocating rods; the glass being fixed upon a table having a slow transverse movement so as to present every part of the surface of the glass successively to the rubbers.

Fig. 2242.



Machine for Grinding Glass Plates.

Old plate-glass is usually repolished by hand, the rubber being attached to the lower end of a pole suspended from a horizontal spring overhead, which gives an adequate pressure on the glass, the workman having merely to push the rubber backwards and forwards. The polish attained in this way is inferior to that produced by machinery.

Fig. 2242 shows a glass grinding-machine in which the plate to be ground is held upon a reciprocating table under the rotary grinders *k k k*, whose supporting frame is capable of vertical movement in guide-ways, an automatic downward movement being imparted to the grinders at the end of each movement of the carriage by the action of gearing upon the screws on which the frame is hung.

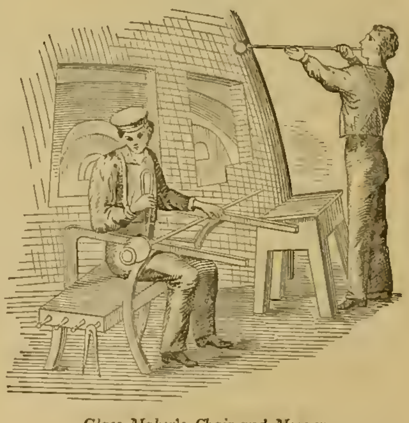
Glass-house. A place where glass is made.

Glass'ing. (*Leather.*) The operation of dressing leather on the grain side by a tool consisting of a glass slip set in a wooden handle.

Glass-lined Pipe. One in which the metal of the outer pipe is protected from corrosion by any liquids, except strong alkalies, or hydro-fluo-silicic acid. The glass lining is held in the outer metallic pipe, which is usually of iron, by an intermediate lining of cement, or plaster of paris, or similar substance, which lining serves to hold the glass in place and protect it against injury from unequal expansion of the glass and metal, besides acting as a non-conductor of heat.

Glass-mak'er's Chair. A seat having two arms upon which a glass-blower rolls with the left hand his pontil or blow-tube, while with his right he fashions the bottle, lamp-shade, or other article he is making, by means of the *pucellas.*

Fig. 2243.



Glass-Maker's Chair and Marver.

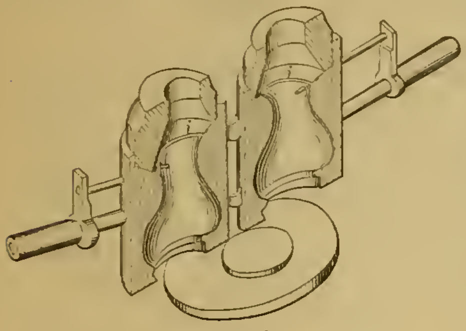
Glass-mak'er's Soap. A name given to manganese, from its cleansing action in its association with glass-making materials.

It is used to rid the materials of color arising from carbonaceous matters and protoxide of iron. An excess of it gives a purple tinge to the glass; much admired by some, and supposed — by some — to have a specific effect in urging vegetation in conservatories.

Glass-met'al. Glass in fusion in the pot.

Glass-mold. A metallic shaping-box in which glass is pressed or blown to form. In the case of solid articles, the glass for the knob or ornament is placed in a plastic condition in the mold, and then a plunger drives it forcibly into all the recesses of the mold. After a few moments of "setting," the mold is opened, and the object is taken out and carried to the annealing-oven. This is the usual mode of making glass insulators for telegraph-wires, paper-weights, drops for chandeliers, and the solid kind of inkstands where the glass is so much in excess of the ink-hole. The latter is made by a plunger, which is driven into the plastic glass in the mold. See Glass-press.

Fig. 2244.

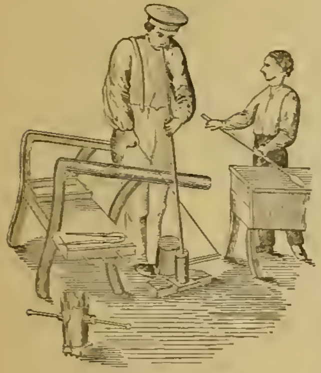


Glass-Mold.

Hollow articles, such as fruit-jars, may be made by blowing (see Glass-blowing), the *blowing-tube*, *chair*, and *marrer* being the principal tools employed, the jar being held by its lip end while being blown, and then by transferring the *pontil* to the bottom while the lip is finished by the *shears* or the *pucellas*, or the jar may be grasped by the *snap-dragon*, if preferred.

The modern fruit-jar has usually some arrangement for locking down the lid or cover, and involves a threaded neck or one with lugs or projections. These can be made by tongs, which clasp the neck of the bottle, but not so readily as by clamping the bulb of glass in a mold and then blowing it so as to expand fully against all parts of the interior of the latter. The mold is then opened, and the formed article removed to the *leer*. Fig. 2244 shows a glass-mold open, the side parts being hinged together over the plate which forms the bottom. In this example, the shoulder *i* really forms the lip of the ware, and the flaring recess above it is the *blow-over*, in which superfluous glass is received, the shoulder affording a thin point where the portion readily breaks off. Fig. 2245 shows the man at work. He has taken the pontil from the boy, who had dipped the proper amount of glass out of the pot in the furnace, and had blown it partially and rolled it on the *marrer*; the workman blows it still farther, rolls the pontil on the chair-arm while he fashions it by the shears, which are seen lying on the bench, and then slips it into the open mold and closes the latter by a spring while he blows it to its final expansion.

Fig 2245.

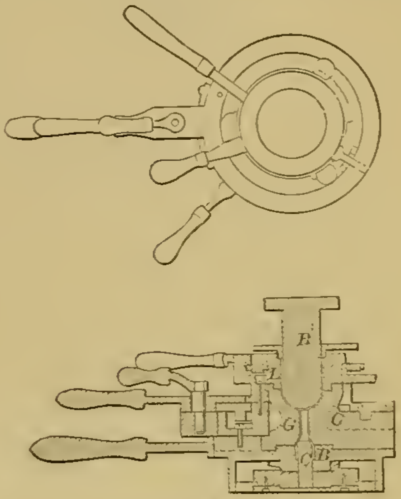


Glass-Blowing in Mold.

In some cases water is made to circulate through the molds, to abate the heat and allow the work to proceed more speedily. Molds are sometimes made to be closed by a treadle. See Plate XX.

Fig. 2246 shows a mold for making tumblers, — foot, stem, and bowl. The complication of form and the hollow character of the bowl require that a number of parts shall be employed, so that the ware may be taken out after molding. The foot is molded in cup form by the plunger *C* and matrix *B*, and is afterwards expanded. The stem-mold consists of three sections *G G*, which open radially over the foot-mold. The body matrix *L* is held down upon the stem sections by a clamp. The portions have separate handles. For bottles which contain the names of the contents and medicines, the interior surface of the mold has intaglio engraving with the inscription, medallion, and what not.

Fig. 2246.



Goblet-Mold.

Glass Mo-sa'ics. Glass mosaics are constructed as follows: —

In the first place, the materials of glass are mixed with various coloring materials, chiefly metallic oxides, so as to form opaque colored enamels; these enamels are cast into slabs or flat cakes, and the slabs are cut into very small cubes or rectangular pieces. Not only is every color imitated, but every gradation of tint in each color, insomuch that at the great mosaic establishment at Rome, maintained by the Italian government, they have no less than *thirty thousand* different tints of colored enamels, all classified and registered. With these little colored cubes a picture is built up, copying some celebrated work of the Italian or other masters. The pieces are inserted, one by one, in a bed of cement, which dries to extreme hardness; each piece is ground at a kind of lathe to the exact shape required by the particular tint in each part of the picture; and when the picture is completed by this extremely slow process, the surface is ground down and polished.

The two specimens of glass mosaic described by Winckelmann and Count Caylus, in the last century, seem to have been of a somewhat different kind, for they presented a complete picture on each surface. They consisted of colored glass fibers fitted together with the utmost exactness, and cemented by fusion into a solid mass.

Glass-ov'en. A heated chamber in which just-made glass in sheets or ware is placed to cool gradually. A *glass-annealing furnace*; a *leer*. See Annealing.

Glass-paint'ing. *Glass-painting* is thus distinguished from *glass-staining*: the former has a design painted upon it with colors which are burned in; the latter receives its color in the process of manufacture, or the separate pieces are colored after having been cut to the required shapes out of white glass.

In one case it is a painting of enameled colors on sheets of glass.

In the other, it is a painting made up of pieces having the required colors, fitted together and held by leaden *cames*. See Glass-staining.

Even with this distinction the subjects become somewhat involved as the processes have been combined.

The growth of the art has developed four modes: —

1. The *mosaic*. This is the earliest, and was known in Byzantium at an early date. It is not known that colored-glass windows were known in Rome, though white-glass windows are found at Herculaneum and Pompeii. The art is supposed to have been brought from Byzantium to Venice and Marseilles, and was practiced by the Saracens throughout the cities of the East.

Stained-glass windows were in the basilica of St. Sophia and other churches in Constantinople, in the sixth century; painted glass windows not till two or three centuries later, notably in the reign of Charlemagne. Some windows executed in the tenth to the twelfth centuries are yet in existence in Europe. The fifteenth century (*cinque cento*), under Albrecht Dürer and others, produced many beautiful specimens, some of which still remain; for instances, the Church of St. Jacques at Liege, and windows ornamented by the Crabeths at Gouda, in Holland.

2. The *mosaic stain*. In this mode the window is made up of detached pieces, as in the *mosaic*; but the shades are given by a stain of brown, which seems to have been the first color which the artists succeeded in *firing* on to the pieces of glass.

3. The *enamel*. By this all the required colors (see Glass-coloring) are painted upon the same piece of glass and fired in the kiln, producing the effect of an oil-painting. William of Marseilles (1475 – 1537) was a distinguished enameler on glass.

4. The *mosaic enamel*. In this mode *colored* glass is used as a groundwork to paint on, instead of *white*.

Glass-pa'per. The fragments of broken wine-bottles, etc., are carefully washed to remove dirt, the glass is crushed under a revolving stone and sifted into six sizes, as in manufacturing emery. It is sifted through sieves of wire-cloth, which are generally cylindrical, like the bolts of flour-mills. The cloths have from sixteen to ninety wires to the inch.

A surface of thin glue is spread on the paper, and the pulverized glass dusted over it with a sieve.

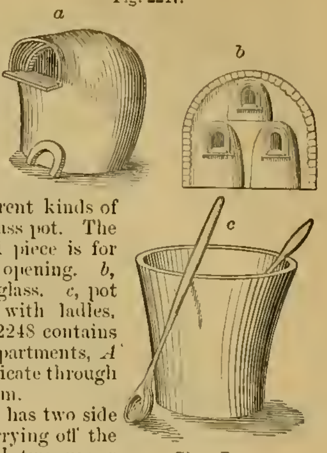
Sometimes two coats of glue and glass are applied. Under Edwards's patent (English), cotton cloth is used instead of paper.

Emery, sand, and powdered flint are used instead of glass, and constitute *emery*, *flint*, *sand* paper.

Glass-pot. The pot in which the *frit* is fused into glass. They are made of pure refractory clay, mixed with about one fifth its weight of old pots pulverized by grinding, are built up instead of being formed on a mold, and baked by being subjected to a white heat. Different forms are used for different kinds of glass. *a*, flint-glass pot. The horseshoe shaped piece is for contracting the opening. *b*, pots for colored glass. *c*, pot for crown-glass, with ladles. The pot in Fig. 2248 contains two or more compartments, *A B*, which communicate through openings at bottom.

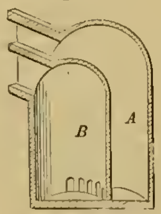
Newman's pot has two side flues *D D* for carrying off the heated gases, and two upper flues *H H* for supplying hot air to insure more speedy liquefaction of the charge.

Fig. 2247.



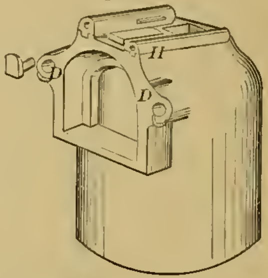
Glass-Pots.

Fig. 2248.



Divided Glass-Pot.

Fig. 2249.



Newman's Glass-Pot.

Glass-press. A device to apply pressure to glass in a mold while in a plastic state. In the press shown, the plunger is hung on a sliding head moving upon guides and operated by connection with a rock-shaft. The cover of the mold is held down by followers, and the mold slipped in and out at the requisite periods. Power is applied by a lever, which is counterpoised by a weight.

Glass-roll'ing. About 1849, Bessemer obtained a patent in England for a process of rolling glass, to make plate-glass and avoid the undulating surface incident to blown window-glass.

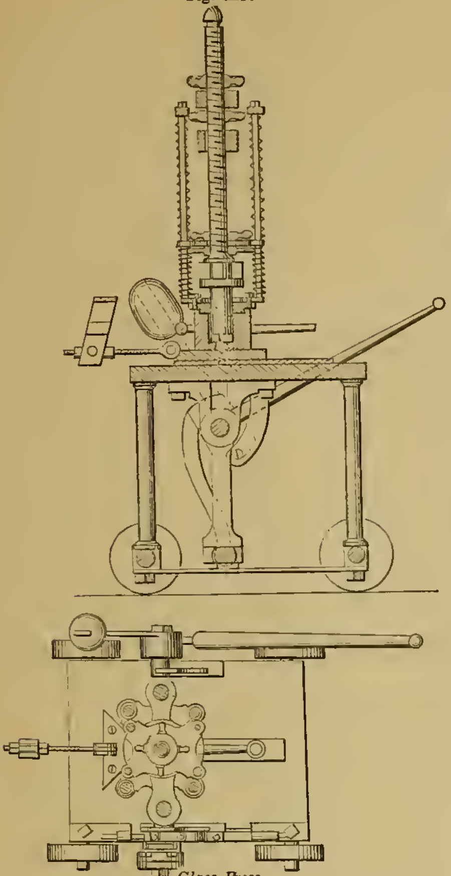
Messrs. Chance, of Birmingham, expended £100,000 in trying to perfect the machinery therefor, but failed to accomplish it, and abandoned the enterprise. The glass, in its pasty condition, was passed from a hopper between two rollers on horizontal axes and was received on a flattening-table.

Glass-sil'ver-ing. Glass for mirrors or ornamentation is silvered by one of two methods; the first is merely factitious: —

1. *The amalgam method.* A sheet of tin-foil is spread evenly on a smooth marble table; on this mercury is evenly spread with a hare's foot until the amalgam is produced. Mercury is then poured to a certain depth, — the English rule is, "as deep as the thickness of a crown-piece," — and the clear, dry sheet of glass slipped over the surface of the liquid metal, excluding all bubbles of air, or dirt, or floating dross. Pressure and standing in a slanting position to drip conclude the operation. See Mirror; Silvering; Platinizing.

For convex and concave surfaces, a mold of plas-

Fig. 2250.



Glass-Press.

ter is formed to fit the amalgamated foil to the surface.

Globes and hollow vessels are silvered by application of amalgam, such as lead, 1; tin, 1; bismuth, 1; melt; cool to lowest point they will remain liquid, and add mercury, 10. Stir with an iron rod.

Or, lead, 1; tin, 1; bismuth, 2; mercury, 4. Warm the vessel, pour in the amalgam, turn the vessel round and round, and, at a certain heat, the amalgam will be found to adhere to the glass.

2. *The humid way.* A mixture of nitrate of silver, 1, liquor ammonia, $\frac{1}{2}$, water, 2, is settled and filtered, and to this is added alcohol, 3, and a few drops of oil of cassia. This is floated on the glass, being restrained by a wall of putty. Pour off, and varnish the metallic surface. Hollow vessels are silvered by pouring in the solution and turning them round and round. Other oils or grape-sugar are also used.

Vohl has a solution of gun-cotton in caustic potassa, to which is added a solution of nitrate of silver, followed by sufficient liquor of ammonia to redissolve the precipitate. The resulting argentiferous liquid is applied to the glass, which is heated over a water-bath until effervescence ensues, when the silver is deposited.

Cooley recommends: Mix saccharic acid with solution of nitrate of silver, decant, apply, precipitate by solution of ammonia, and heat to render deposit brilliant.

Glass-soap. Peroxide of manganese used to remove from glass the green color due to the presence of iron.

Glass-sol′der-ing. Guinand, of Brenetz in Neufchatel, acquired the art of soldering together pieces of glass. When the line of junction was marked by globules of air or particles of sand, he ground out the latter on the wheel, then replaced the mass in the furnace, so that the vitreous matter might expand and fill up the spaces. He thus combined good pieces of glass, so as to build up lenses of flint-glass of fine quality. Guinand joined Frauenhofer in Munich in 1805, and returned to his native canton in 1814, where he died, and was succeeded in his business by his sons.

Glass-spin′ning. Brunfaut of Vienna works a process in which he makes curled or frizzled yarn of glass. The composition is a secret. One workman with a wheel having a diameter of 5 Austrian yards will spin 3,500 yards per minute. It is used for many descriptions of fabric and for many purposes, cushions, carpets, table linen, shawls, neckties, etc.

Bonnet's European patents for cloth of glass are dated in 1837. The warp is of silk, the weft of glass spun by steam-engine power, about sixty threads to the inch.

Glass-stain′ing. *Stained-glass* is colored in the process of manufacture.

Painted-glass is a colored or white glass on which a metallic paint is laid, and subsequently fixed by fusing, — *fired in*, as it is termed.

Stained-glass windows are executed in pieces of colored glass, which are cut to the shape of the patches of color in the original design and are brought together in the manner of *mosaic.* These pieces are set in leaden frames called *cames.* This is the most ancient practice and is still in use.

The design is first sketched on paper, the colors and the exact arrangement of the pieces are then determined, so that it may be known just how many will be required, and their proper shapes and sizes. Some windows are composed of more than 10,000 pieces.

The material used is crown-glass made in large sheets expressly for the purpose. The greater portion of that used in this country is American, but some of the very fine colored glass, as ruby, blue, purple, and green, is imported.

The sheets are cut to their proper shape and size with a glazier's diamond, and then painted by laying on with a flat brush a thin, uniform coat of the proper color. These colors are all mineral, as they have to be long subjected to an intense heat in order that they may become firmly united to the substance of the glass.

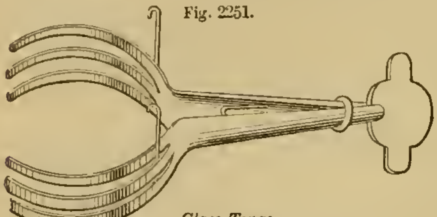
Crown-glass is used as being less fusible than that containing a large proportion of lead. Being comparatively intractable, it does not fuse when the enamel colors melt and unite with it through the medium of the flux with which they are incorporated.

Reds and yellows are produced from silver and antimony; another red, from oxide of iron; white, from block-tin; black, from manganese; green, from copperas; and purple, from gold. See GLASS COLORING.

The colors are pulverized and mixed with a flux composed of red lead, flint-glass, and borax, which are melted together in crucibles. This composition made into a paint is laid on as previously described, and allowed to dry, when the sheets are transferred to the kiln, an oven of brick about 5 × 4 feet in dimensions, and provided with shelves made of iron plate on which the pieces of glass are piled twelve or fifteen deep, when the doors are closed, and a heat sufficient to heat the glass red hot is maintained for eight hours, when the fires are drawn and the glass is allowed to slowly cool for forty-eight hours for the purpose of annealing it. By the fusion of the flux and partial surface fusion of the glass, the colored coating is thus inseparably united to the latter.

Glass-tongs. Grippers for hot bottles, etc., in course of manufacture, or for handling bottles containing heated or freezing mixtures.

Fig. 2251.



Glass-Tongs

Glave. A weapon formerly used, consisting of a curved blade on the end of a pole.

Glaze. A vitrifiable composition for covering earthenware or porcelain. Glaze on earthenware has several objects: —

1. To render the ware impermeable to liquids.
2. To impart luster.
3. To preserve colors and patterns.

It must adhere firmly to the ware, and expand and contract in the same proportions therewith, so as to avoid cracking and scaling.

It should resist acids, so as not to be dissolved by vinegar and other acid substances.

It should not have such an affinity for the ware as to sink into the latter when in a biscuit condition.

Glazes are of several kinds: —

Felspar is the base of a vitreous glaze which melts at a high temperature. It is found in natural combination with quartz; or is mixed therewith, sometimes with lime. It is principally used on porcelain or china.

A second class of glazes includes salt, potash, boracic acid, phosphate of lime, and sulphate of baryta; used on stoneware.

A third class is a glass, mainly consisting of silica and lead.

The fourth class includes the oxides of lead, tin, manganese, and copper.

Glazes are further subdivided into —

Transparent.

Opaque.

Colored.

Transparent glaze is a glass.

Opaque glaze is compounded with oxide of tin.

Colored glazes derive their peculiar tints from metallic oxides, manganese, copper, iron, cobalt, chromium, etc. See ENAMEL.

Glaze is applied in various ways: —

Some common earthenwares are glazed by throwing salt into the kiln at certain stages of the firing process. A partial vitrification of the surface takes place at the expense of the silica of the paste.

The salt is sublimed, producing a saline atmosphere throughout the kiln, the soda enters into combination with the silica of the ware, forming for the alumina, etc., a flux; and producing a glassy surface on the ware.

Porcelain and fine ware, while in the biscuit condition, are dipped into a thin solution of the glaze. The ware in this condition is very absorbent, and the water passes into the biscuit while the body of the glaze adheres to the surface. In this case the glaze consists of vitreous matter fritted in a furnace and reduced to powder. The powder is stirred up in water and held suspended while the ware is dipped.

Articles only requiring an interior glaze receive it by pouring a quantity into them, swashing it around and pouring out the surplus.

Other ware is glazed by means of a brush.

Glazes are ground in water to a thin cream, forming a *slip*, in which clay-ware in the form of *biscuit* is dipped. The heat of the kiln fuses the *glaze*.

Glazes are white or colored, they differ only in that the latter have coloring ingredients.

For earthenware. *Lead glaze:* white lead, 53; quartz, or ground flints, 36; felspar, 16; white flint-glass, 5.

For chemical vessels. Fine sand, 48; potassa, 39; lime, 9; niter, 4. Oxide of tin or cobalt may be added to correct color.

For porcelain. Felspar, 27; borax, 18; fine sand, 4; niter, soda, and kaolin, 3; mix, frit, powder, and add calcined borax, 3.

For painted stoneware. White felspar, 26; soda, 6; niter, 2; borax, 1; frit. Of the product take 13; red lead, 50; white lead, 40; ground flint, 12.

M. Richard, ceramic manufacturer at Saint-Christophe, near Milan, has communicated to the Society of Encouragement, Paris, his process for varnishing pottery, and applied by him to different products exhibited at the Champ de Mars (Group III. Class XVII., Italian Section). The following are the ingredients and their proportion to be fritted: Carbonate of soda, 1.000; boracic acid, from Tuscany, 0.800; kaolin, 0.125; carbonate of lime, 0.250; sulphate of lime, 0.250; crystallized felspar, 0.750; quartz from the Tessin, 0.280; fluate of lime, 0.150. Manganese of Piedmont is added to obtain the desired tint. The whole frit is ground fine, and then mixed with 110 parts of kaolin and 52 parts of felspar for every 460 parts of the above frit. It is applied as usual in glazing, but, as the specific gravity is less than the leaden coating, the same weight of the new glaze will cover a greater quantity of pieces.

Vitreous glazes originated with the Chinese, and passed from them to India, and successively to Persia, Arabia, Spain, Italy, and Holland.

Previous to the introduction of glazes, the Greeks and Romans covered their pottery with wax, tallow, or bitumen. The Peruvians used tallow spread upon the ware while hot and thereby partially carbonized. The Etruscan ware has a similar appearance. In Italy and Spain, ancient and modern, wine-jars are rubbed with wax to render them impervious to liquids.

Among the early instances of glazing may be mentioned the tomb of Sultan Mohammed Khoda-Bendeh, at Sultanieh in Persia. He was the 12th prince of the house of Genghis Khan, and died in 1316. The tomb has green enameled tiles on the outside and blue on the inside.

The "painted mosque" of Gour in India, built in 1475, derives its name from the number of glazed tiles with which it is ornamented.

The Caravansérai of Mayar, near Ispahan, built by the mother of Shah Abbas, about 1550, has a covering of green glazed tiles on the front of the principal gateway.

The Alhambra, a Moorish palace and fortress near Granada, was founded by Mohammed I. of Granada about 1253. Some of the rooms are ornamented by glazed tiles.

Coffins of green glazed pottery are found at Warka in Mesopotamia, and are ascribed by Rawlinson to the period of the Parthian occupation of that country. This is a startling supposition. The style of ornamentation and the figures stamped upon them forbid the supposition that they were imported from China, and yet this single fact of glazed pottery in that place at that time is almost irreconcilable with the observed contemporary progress of the art of making pottery in general. See Fig. 1377, p. 587.

Glazed Board. A kind of mill-board having a hard, smooth surface, to give a smooth face to the paper or fabric pressed between such boards.

Glaze-kiln. (*Pottery.*) A kiln in which glazed *biscuit*-ware is placed for firing. It is analogous to the *glost-oven*.

Glaz'er. 1. A cutler's or lapidary's wheel of a grade between the grinding and the polishing. It is made of disks of wood so arranged as to present the grain outwardly, that is, radially. The wooden surface is fed with emery-cake. Mahogany, oak, apple, beech, or birch, are employed.

Other *glazers* have a covering of leather or a cap of lead or tin alloy to carry the emery for grinding or glazing cutlery.

Lapping is done on metallic wheels.

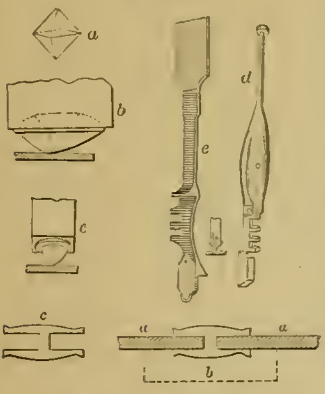
Polishing on leather-covered wheels.

Buffing on leather with rouge.

2. A calendering or calico-smoothing wheel.

Gla'zier's Di'a-mond. An implement for cutting glass consisting, as now universally made, of a handle, by which it is held between the fingers and guided, and having swiveled at its lower end a holder or block, in which a small diamond with one of its natural angles exposed is inserted. By this arrangement, invented by Joshua Shaw, the cutting edge of the diamond constantly tends to maintain its parallelism with the straight edge or pattern which guides it, so as to make a clean, smooth cut. The knack of using this tool properly, and judging of the proper vertical angle at which it should be held, requires some practice. The sound indicates whether or no a clean cut is being made. The normal crystalline form of the diamond is octohedral, and the faces are usually convex. Upon this latter peculiarity, according to Dr. Wollaston, its efficiency depends, the rounded edge slightly indenting the glass and then slightly separating its particles, forming a shallow fissure with a splitting rather than a cutting action, none of the material being removed. This fissure is readily extended through the glass, a slight degree of force serving to separate the two parts. He succeeded in producing the same result with several other hard gems by giving them the same form, but the natural edge of the diamond being so much harder and more durable, renders it much more economical than any other material for the purpose. *a* shows the primary crystalline form of the diamond, a regular octohedron. *b c*, diamonds with rounded faces forming a more or less acute angle. *d*, an improved form having teeth for breaking apart the two pieces after making the cut. *c*, an implement denominated the "universal glazing-tool," for cutting and setting glass. This has a small thin roller pivoted at its lower extremity, which in its passage over the glass separates the particles in a manner similar to the diamond.

Fig. 2252



Glazier's Diamond and Vise.

The spatula at the other end is used for puttying, etc.

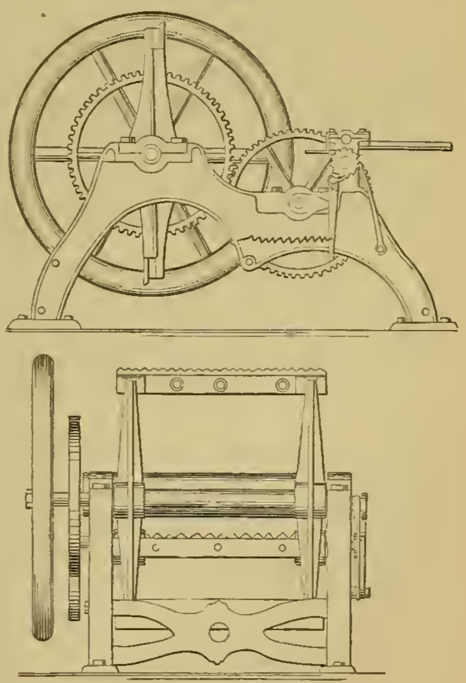
The diamond is crystallized carbon. Diamonds were first brought to Europe from the mine of Sumbalpoor. The Golconda mines were discovered in 1534. The mines of Brazil in 1728. Those in the Ural in 1829. The great Russian diamond weighs 193 carats; cost, £104,166 13*s.* 4*d.* in 1772. The Pitt diamond weighed 136 carats; sold to the king of France for £125,000, in 1720. The Koh-i-noor was found in 1550. It belonged in turn to Shah Jehan, Aurung-Zebe, Nadir Shah, the Afghans, Runjeet-Singh, and Queen Victoria, 1850. It originally weighed 800 carats, was cut down to 289 carats by an unskilful Italian, and then to 102¼ carats to perfect its shape. See Diamond.

Pliny speaks of *adamant* as the hardest of all materials, and it may mean the uncut diamond. We do not know that diamond-cutting was practiced, and it is not certain that diamond-dust was employed in gem cutting and engraving, although there are several indications of its use. He says: "Diamonds are eagerly sought by lapidaries, who set them in iron handles, for they have the power of penetrating anything, however hard it may be." He farther cites that all gems are engraved by the diamond.

A German authority states "they used, for the purpose of cutting sheet-glass, emery, sharp-pointed instruments of the hardest steel, and a red-hot iron by which they directed the rents at their pleasure."

An early notice of the use of the diamond in cutting, or rather scratching, glass is associated with a love-quarrel, in which Francis I. of France, 1520,

Fig. 2253.



Glazier's Points Machine

wrote with a diamond set in a ring, on a pane of glass in the castle of Chambord, a couple of lines to Anne, Duchess of Estampes. It seems to have been the subject of a patent to Gaspar Lehmann of Prague early in the seventeenth century, and granted by the Emperor Rodolph II.

Gla'zier's Knife. A knife used by glaziers in clearing out the remains of old panes from the fillisters of sash, and puttying in new ones. Such knives are known as *hacking*, *stopping*, and *putty* knives.

Gla'zier's Point. A small, triangular piece of tin plate, employed to secure a pane of glass in the sash previous to puttying. They are made in a machine in which the sheet of metal is fed to the rotary cutters, and the points are cut off in two or more rows at each rotation. The face of the cutter is notched like a saw-blade, and snips from the edge of the plate a row of triangular pieces.

Gla'zier's Vise. (*Plumbing.*) An apparatus for forming leaden bars for the reception of window-glass. The bar is called a *came*, and the mode of glazing is called *fret-work*. The came is formed by drawing a plain bar of lead between two rollers *a a* (Fig. 2252), of thickness equal to that of the glass, and having corrugated edges which draw the bar forward between two pieces *b b*, causing it to assume the shape *c*. The whole device constitutes the glazier's vise.

Glaz'ing. 1. Placing panes of glass in sashes.

2. Giving a vitreous coat to pottery.

3. Polishing metal on a wheel dusted with polishing-powder.

4. Spreading a semi-pellucid cover over a painting to soften asperities.

5. (*Gunpowder.*) All good powder is glazed in order to enable it to more perfectly resist moisture and bear transportation. For this purpose the grains from the breaking rollers, after having been assorted by sieving, and while still containing three or four per cent of water, are placed to the amount of several hundred pounds in a glazing-barrel; this is journaled at the ends, and is caused to rotate for some ten or twelve hours, breaking off the angular projections of the grains and causing them to assume a smooth and glossy surface.

Pulverized plumbago is sometimes added to produce a deceptive appearance of high glazing.

Glaz'ing-ma-chine'. A press with two polished rollers to calender paper.

Glaz'ing-wheel. A wooden wheel covered with leather charged with emery, and used by cutlers, especially for grinding and sharpening knives, tools, etc.

It is also used instead of filing for leveling and surfacing many metallic articles; for removing the scale from casting, and for trimming small castings, such as builders' hardware.

A wooden wheel without any leather covering is used by lapidaries in smoothing soft and rounded stones. These wheels are fed with flour, emery, and water.

Glass-cutters employ similar wheels with pumice-stone and water for smoothing, or putty-powder and water for polishing.

These wheels, commonly called *glazers*, are made of wooden disks or quadrants, so arranged as to present the end of the grain outwardly. They are fed with emery-cake; and by cutlers the wooden surface is frequently used without any leather covering.

Globe. A sphere on which is represented the heavenly bodies; a *celestial* globe. A round model of the world, representing the land and sea, and usually the political divisions. A *terrestrial* globe.

A celestial globe was taken from Egypt to Greece, 368 B. C.

A terrestrial globe is said to have been made in the time of Anaximander of Miletus, about 550 B. C. This is highly improbable. The determination of the latitude and longitude of places was of a later date, and is a necessary incident of a terrestrial globe.

The celestial globe of Billarus was taken away from Sinope by Lucullus (Strabo). The same writer mentions the sphere of Crates; Cicero that of Archimedes. Perhaps this was a planetarium.

The planisphere of Dendera in Egypt is a circular diagram of the zodiacal signs, and the most ancient and interesting of all representations of celestial scenery.

Gerbert, who studied astronomy among the Saracens in Spain, and was afterwards Pope Sylvester II., A. D. 1000, used in his school at Rheims a terrestrial globe brought from Cordova.

"While Rome was asserting, in all its absurdity, the flatness of the earth, the Spanish Moors were teaching geography in their common schools from globes. In Africa there was preserved, with almost religious reverence, in the library at Cairo, one of brass, reputed to have belonged to the great astronomer Ptolemy (about A. D. 130). Al Idrisi made one of silver for Roger II. of Sicily (A. D. 1131), and Gerbert used one he had brought from Cordova in the school he established at Rheims" (about A. D. 975). — Draper.

The globe of Gottorp is a concave sphere, 11 feet in diameter, with seats inside for spectators. Its concavity represents the constellations of the heavens, and its exterior is a terrestrial globe. It was constructed after the designs of Tycho Brahe, and turned on its axis. Dr. Long's globe was 18 feet in diameter, and held thirty persons, who viewed it while it was in motion. Mr. Wyld erected in Leicester Square a globe 60 feet 4 inches in diameter. Its concavity represents the terrestrial surface. It was lighted by openings during the day and by gas at night. Its interior was occupied by ladders and platforms, from which its painted surface was viewed. It was closed in 1861.

Martin Behaim on his "world apple," the celebrated globe which he finished in 1492, and which is still kept in the Behaim house in Nuremberg, places the coast of China (by estimate), only 100° west of the Azores. Marinus of Tyre had advanced the Chinese coast to the longitude of the Sandwich Islands, being misdirected by the calculations in the Asiatic itineraries, and thereby giving to the old continent a breadth of 225° instead of 129°. Ptolemy's geography estimated the Chinese coast at the longitude of the Carolinas. So Columbus started west on an uncertain expedition, and, believing Behaim, with whom he had been associated at Lisbon, 1480–84, concluded that in reaching land he had found Cathay. He caused the whole crews of his squadron (about eighty sailors) to swear that they *believed* he might go from Antilia (Cuba) to Spain by land, keeping west. Having letters from the Catholic monarchs to the Great Mogul Khan in Cathay, he sent on shore a baptized Jew who was acquainted with some of the Oriental languages, but his messenger failed to make connection. Columbus died before the error was discovered; he named the natives "Indians," and so much of the matter remains to this day. See Map; where the globes of Behaim and Schöner are compared with the previous maps of Ptolemy, Strabo, Hecatæus, and others.

"Then to Moxon's, and bought there a payre of globes; cost me £3 10*s*."— Pepys, 1663.

In the history of globe-making, the name of Ferguson, the mathematician, has an honorable place.

Modern globes are made of paper and plaster, are perfectly balanced on their axes, and are proof against changes of temperature.

The first thing is a wooden mold, which is of a spherical form, and has two axial pins at its poles. This is placed in a frame, and, as it revolves, is covered over with wetted strips of strong paper. This is covered with successive thicknesses of pasted brown and white paper, laid in strips. The mold, with its paper covering, is then dried. Being dry, it is mounted in a frame on the axial pins, and the paper envelope is cut in two equatorially. The hemispheres are removed from the mold and are nailed to the ends of a central wooden rod, in whose ends are pins which project from each pole. The rod and pins form the axis. The hemispheres are joined at their edges by glue.

The shell is then placed on its axis in a frame and revolved as a compound of whiting, glue, and oil is plastered upon it. A semicircular scraper removes the redundancy and insures the spherical form. This coating is repeated four or five times, being dried between each coat. The sphere is then polished; then balanced by letting in shot in certain places to remove any want of equipoise.

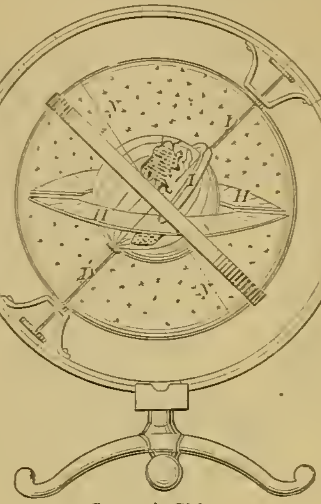
The parallels and meridians are now drawn on the globe by a beam-compass, to serve as guides for placing the engraved strips. These are fourteen distinct pieces. The arctic and antarctic circles are two circular pieces, and the other twelve are for the other portions, six on each side of the equator. The pieces of paper are thin, tough, and wet, and are rubbed down upon the globe, spreading them so as to make their edges exactly coincide with the lines on the globe. The globe is then colored according to geographical divisions, varnished and mounted.

A slate globe has lately been invented, having the meridians and parallels of latitude marked upon it, to be filled in by pupils as a geographical study. It is a powdered slate surface placed on the paper shell. A globe has been made in papier-maché, divided into forty-eight pieces, to be taken apart and put together at pleasure; the object being to facilitate package and removal, and the convenient study of any one part. Another novelty is a globe made of tissue-paper and inflated with air; such a globe may be made twelve feet in diameter, and is useful in a lecture or school room. A very cheap paper globe is now met with, in which the printed gores are brought together edge to edge by a string, not exactly to a spherical form, but sufficiently so for familiar reference.

Globes are also made by Goodyear, of inflated india-rubber, or of silk coated with india-rubber solution. Adams has made them of gutta-percha, with surface in relief, and in detachable zones and sections.

Globes of paper pulp have been suggested, molded inside of shells whose inner surfaces have intaglio representations of the inequalities of the earth's surface, so that the globe shall represent the mountains and valleys. It would be necessary to exaggerate the altitudes to make them visible. A model earth twenty-one feet diameter gives us only one thirty-second of an inch to a mile; on such a globe, one-hundred-acre farms would of course be utterly invisible to the naked eye, and the loftiest ranges of mountains might be represented by a few grains of rifle powder; and the entire human family, estimated at one thousand millions, might be gathered, without uncomfortable crowding, upon a spot less than one twelfth of a superficial inch. The greatest depths which man has yet been able to reach, in the way of mining or otherwise, would not exceed the thickness of thin card-board, and the entire animal portion of the earth now living would scarcely fill a child's thimble. The extent of the sensible atmosphere would not exceed one inch and a quarter; and if man shall ever be able to penetrate the earth to the depth of ten miles, it would be but little more than a quarter of an inch on this 21-feet model; hence the model earth must be many times 21 feet in diameter in order to show to the naked eye any of the great works of mankind on a like scale.

Fig. 2254.



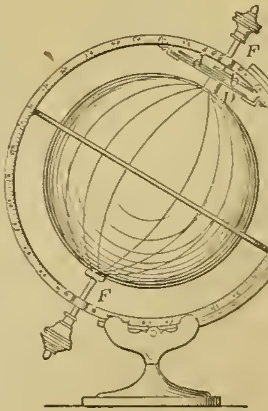
Concentric Globes.

Rigaud used the paper surface of a 36-inch globe to estimate the relative quantities of land and water. Carefully cutting the land and water apart with scissors, he weighed the two in a delicate balance, and found it, water 734, land 266.

Fig. 2254 represents a concentric arrangement of a terrestrial globe, and a transparent celestial globe with the constellations on the surface of two hollow hemispheres, which have also the line of the ecliptic *N*, and the solstitial and equinoctial colures. The universal horizon *H* is suspended from the forked arms *I* of the axis *D*. The line of the junction of the hemispheres marks the celestial equator. Ziebermayer's globe is of glass, with a glass shell marked with the constellations.

Globe-clock. A globe so mounted as to revolve once in twenty-four or twelve hours, as the case may be, so as to indicate the time on any meridian by an hour circle, or the noon at the time of observation by means of the meridian circle. In the example, the works of the chronometer are in the interior, and are wound up by the lower arbor *F*; these works turn the globe, the axis

Fig. 2255.



Globe-Clock.

of the daily wheel of the chronometer being coincident with the axis *F*. *d* and *b* are hour and minute hands, which move around over the dial *D*.

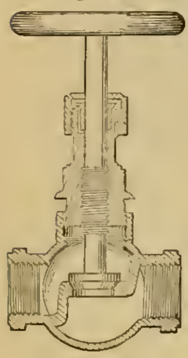
Globe-cock. Formerly a sphere with a stem by which it was moved towards and from its seat; now a circular disk of similar use, and retaining the name, although but a zonal segment of a sphere is used. See GLOBE-VALVE.

Globe-fil'ter. A filter having a chamber of spherical form, whose hollow interior has a perforated diaphragm or a body of filtering material.

Globe-valve. 1. A ball-valve; one of a spherical shape, usually operated by a screw stem. The valve is now but seldom spherical, but is a disk or frustum of a cone fitting against a seat of corresponding shape, as in the figure.

2. A valve inclosed in a globular chamber.

Fig. 2256.



Globe-Valve

Gloom; Gloom-stove. (*Gunpowder Manufacture.*) The drying-oven.

Glo'ry-hole. (*Glass-making.*) An opening in the wall, exposing the brilliant white of the interior of a glass-furnace.

Gloss'ing. An operation upon silk thread by which it is moistened with steam and stretched to develop a gloss.

Glos'so-co'mon. A form of winch with gear-wheels and pinions, and used for raising heavy weights.

Glost-ov'en. (*Porcelain.*) An oven in which glazed ware is fired.

Glove. 1. A covering for the hand (A. S. *glof*; Ger. *Handschuh*) differing from the mitten in having a separate compartment for each finger.

Gloves are made from a great variety of materials, as textile fabrics of cotton, linen, wool, silk, the pelts of the thinner-skinned animals, india-rubber, etc.; and in former ages steel, arranged in the form of plates or rings to afford flexibility, was employed for the gloves or gauntlets of the mailed warrior.

The skins principally employed for the finer kinds of gloves are those of the kid and goat, but other kinds of fine and flexible leather are also used. It has been asserted that large numbers of "kid" gloves were made from the skins of rats caught in the catacombs and sewers of Paris, but this assertion does not appear to be warranted by fact.

Great quantities of kid gloves are now made in this country, the process of manufacture, beginning with preparing the skins, being as follows.

In dressing kid or goat skins for gloves they are first soaked in water and "fleshed," and are then thrown into the vats of lime-liquor, where they remain from three to six weeks, being occasionally moved and turned until the hair is sufficiently loosened. They are then stretched upon the *beam*, and the hair removed with the blunt drawing-knife, carefully preserving the grain. They are next put into a *drench* of bran and water, or, more properly, moistened bran, where they remain for a considerable time. This softens and renders the skin very pliable. On being removed from this, the *tawing* process, which is a substitute for tanning with bark, takes place. The skins are covered by a mixture of salt and alum, which makes leather of them. After being cleansed and dried they are ready for the finishing processes. They are suspended and *staked*, that is, evened by a blunt knife drawn over the surface. Afterwards they are spread out upon a flat surface and rubbed with a sponge dipped in the beaten yolk of eggs. This preparation is absorbed by the leather and serves to make it elastic.

The next and last process is coloring. Liquid dyes are used for this purpose, and they are applied to the surface or grain of the leather with a brush. After all the processes of trimming, finishing, and dyeing are completed, the skin is stretched upon a marble table and rubbed with a blunt knife. It is then cut through the middle, and a strip for the palm and back of a glove cut, just wide enough for the purpose, from one end of each piece. Being cut in this way the pairs are alike, of similar finish, thickness, and tint. In some factories gloves are cut in part by punches of steel, which have teeth that prick the holes for the stitches. The seams are then sewed by laying the edges evenly together and placing them in a vise provided with teeth one twelfth of an inch apart, between which teeth the needle passes in sewing. After the seams are sewed the embroidery is put upon the back, the wrist bound or otherwise finished, and the fastenings sewed on. The glove is next stretched, placed in a linen cloth slightly dampened, and beaten to make it more flexible. It is then pressed, and is ready for the market.

By a slightly different mode of operation, after being assorted as to quality and size the skins are transferred to the cutter, who cuts them into oblong pieces of the required size, which are turned over to the puncher, who takes two or three, pairs at a time and subjects them to the action of a press carrying a punch corresponding to the size of glove to be made, which forms the hand with all the necessary slits, openings, button-holes, gussets, etc. The thumbs and *fourchettes*, or pieces between the fingers, are punched separately. Any roughness of the edges is removed by the scissors. After undergoing final inspection to detect defective pieces they are sent out to the sewers, and on their return are "topped," the buttons sewed on, and button-holes completed.

They are then "dressed" or straightened, stamped with the maker's name, and packed.

In Europe the skins of the young kid, roughly dried in the open air, are collected by peddlers who, setting out from Italy in the early spring, extend their peregrinations to the northern confines of the continent as the season advances and the young kids attain a sufficient degree of maturity. By the peddlers the skins are sold to traders in the larger towns, whence they find their way to the great marts for such articles, as Naples and Leipsic.

The method of treating the skins is essentially the same as that adopted in this country. Some of the French manufacturers tan and dye the skins themselves, so as to insure uniformity in color and quality, while others are content to buy them ready prepared.

The dye is applied to the outer surface of the leather only by means of the hands and the assistance of a brush, and does not penetrate beyond the exterior. The best skins are colored black and other dark tints, holes or other imperfections showing more plainly in these than in lighter colors, so that the poorer kinds are used for white and other light shades. The variety of tints is about two hundred.

There are ten different sizes, from 5¼ to 8, for ladies' gloves; thirteen, from 7½ to 11, for gentlemen; and seven, from 5 to 6¼, for misses. Each of these sizes has a corresponding plate which serves as a guide to the cutter.

Buckskin or deerskin gloves also form an important article of manufacture. The skins are derived from various parts of the North American continent, from South America, and a few from Europe and Asia. After being limed, fleshed, and unhaired, they are treated with oil in a stamping or pounding mill; the oil is removed by means of soda-ash, with which it forms a soap that is washed out. The skins are then stretched and suppled by rubbing with a stretcher iron or *stake,* colored with a wash of ocher, and their surfaces smoothed by grinding on a wheel covered with emery and pumice.

The gloves are cut out with steel dies, and stitched by a machine. When finished, they are dampened, stretched upon a hand-shaped board, dried and packed for transportation.

Fur gloves are made with the inner portion or palm of kid or dog skin, and the back of fur. They are lined with flannel or an inferior quality of fur, usually the white squirrel or coney or lamb-skin with the wool on, and are used in winter traveling, driving, etc.

India-rubber gloves are intended for the use of manufacturing chemists, druggists, and photographers, or all who work among acids, alkalies, and other caustic materials. They are also adapted to the use of firemen, hatters, tanners, and dyers.

In the manufacture of india-rubber gloves, the first process is to heat slightly a mass of the gum, which is rolled into a flat sheet between revolving cylinders. From this sheet the gloves and mittens are cut by gouges similar to those employed in the cutting of leather gloves. They are then joined by placing the edges in contact, and covering them with strips of heated rubber.

A lighter style is made thus: A piece of cotton cloth or stockinet is passed through the cylinders at the same time with the gum, which by this process completely coats it. From this the gloves are cut, and joined by covering the edges with strips of heated rubber. These gloves are made of a variety of colors, are very soft and pliable, and have a very neat finish. Gloves are made with corrugated rubber palms for use in washing.

Pliny recommends the use of gloves and boots to those engaged in pulling spartium, — a variety of the broom, and used, when soaked and broken like hemp, to make coarse cordage and the commonest description of garments. He also recommended them to his secretary, that he might not be impeded by chilly fingers in noting down memoranda.

Xenophon ridicules the effeminacy of the glove-wearing Persians. (*Cyrop.* VIII. 8, 17.) They do not appear to have been worn by the ancient Egyptians, but were regarded as a part of the indicative dress of Northern barbarians.

Some dirty-handed cynics calling themselves philosophers railed at the Roman gentry for wearing gloves.

The father of Ulysses wore gloves while working in his garden. So said Homer.

The use of gloves in common life is a habit of late introduction.

During the Middle Ages the glove was worn as a badge of distinction, and also in the helmet as a token of a lady's favor. See Hall's "Chronicle," time of Henry IV.

Charlemagne recognizes in a grant the use of leather in making gloves and book-covers. Ethelred II. had a present of two pairs from a merchant company. Henry II., when he lay in state, was habited in gloves. Elizabeth wore embroidered gloves, and is thus painted: —

"Painted leather gloves, very pretty and all the mode." — PEPYS, 1663.

2. (*Hat-making.*) A smooth piece of wood for rubbing a sheet of felt, and causing the nap to adhere to the body when working at the *battery.* The *glove* is held in the palm of the hand and tied on by a string.

Glove-mak'ing Ma-chine'. The apparatus upon which gloves are stitched consists essentially of a pair of jaws opened and closed by means of a treadle, and having at their holding edges teeth between which the needle is passed back and forth in sewing, thus regulating the length of stitch. The cutting apparatus has a reciprocating head provided with movable dies of various sizes.

Glue. Glue is made of the clippings of hides, horns, and hoofs; washed in lime-water, boiled, skimmed, strained, evaporated, cooled in molds, cut into slices, and dried upon nets.

It is principally prepared from the parings and waste pieces of skins, the refuse of tanneries, and the tendons and other offal of slaughter-houses. These are steeped in milk of lime for about two weeks and afterward dried. In this state they may be preserved for an indefinite length of time. Previous to boiling they are again steeped in weak milk of lime for from twenty-four to thirty hours, and then placed in a boiler having a perforated false bottom to prevent burning. (See GLUE-BOILER.) Here the scraps are gently boiled until a firm gelatinous liquid is produced, the clear portion of which is run off into another vessel, and a small quantity of dissolved alum added thereto. Here it is kept hot by means of a water-bath, and allowed to remain for several hours in order to deposit its impurities, after which it is run into the congealing boxes and placed in a cool situation.

On the next day the sheets thus formed are turned out upon wetted boards and cut into cakes, by means of a stretched brass wire, which cakes are farther subdivided by a moistened flat knife, and placed on nettings to dry.

They are, after drying, dipped into hot water and slightly rubbed with a brush wetted with boiling water to give them a gloss, and stove-dried. This furnishes the palest and best glue.

The residuum left in the boiler is treated with fresh water, producing an inferior article of glue, and this operation is repeated again and again, so long as any gelatinous matter can be extracted from the scraps.

Glue was used by the cabinet-makers of ancient Egypt.

The Greeks used various sticky matters, such as glue, bird-lime, and cobblers' wax.

"Wood is joined together with glue, prepared from certain parts of oxen, and with such strength that the veins of boards will open in a crack, sooner than the seams of ox-glue will relax their fastenings." — LUCRETIUS, Book VI.

Isinglass glue; soak isinglass in cold water; when swelled, put in spirits of wine; heat it in a bottle plunged in a bath; add powdered chalk.

Gelatine glue; swell in cold water; immerse in linseed-oil and heat in a bath; add red lead.

Water-proof glue; boil two ounces of isinglass in a pint of skim-milk, until the required consistence is obtained.

Marine glue; shellac and caoutchouc, equal parts, dissolved in separate portions of naphtha, and then mixed.

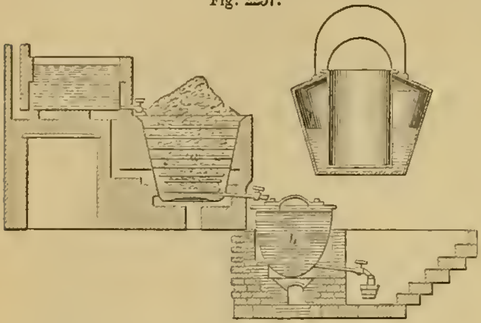
Or, india-rubber, 1 pound; coal naphtha, 4 gallons; shellac, 2 ounces.

White fish-glue, or *diamond cement,* is made of isinglass dissolved in alcohol.

Spalding's liquid glue; glue and acetic acid.

Glue-boil'er. A convenient apparatus for boiling skins into glue has three coppers, at different hights; the upper, acted on by the waste heat from the chimney, warms the water, which is then drawn off into the central one (*a*) in which the scraps are placed, and which has a perforated false bottom, and the third (*b*) receives the gelatinous solution obtained by boiling. The last vessel is double, with water between the inner and outer shells, and discharges its contents into buckets, by which the solution is transferred to the evaporating-boxes.

Fig. 2257.



Glue-Boiler.

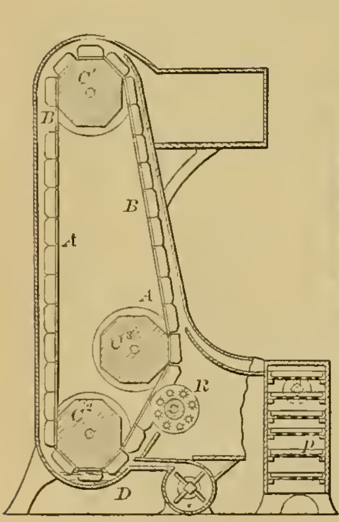
Above is shown a carpenter's glue-pot.

Glue-can. A kind of glue-pot in which the prepared glue is kept in the inner can, and it is surrounded by an outer tin vessel containing water for heating the glue.

Glue-ce-ment′. To resist moisture. Glue, 4 parts; black rosin, 4 parts; red ochre, 1 part. Or, glue, 4 parts; boiled oil, 1 part; oxide of iron, 1 part.

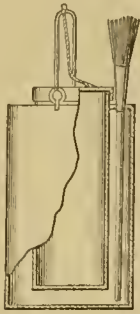
Glue-dry′er. A machine or closet for drying sheets of glue. In the example, the endless web *A B* has sections of plates which dip at their lowest position into the depression *D*, which contains liquid glue. As the octagonal roller C^1 C^2 rotates, the glue-covered plates ascend, being accompanied by a blast of heated and dry air from the blower below. An additional or intermediate pulley or drum C^3 is arranged between the two supporting pulleys, to deflect the endless chain and its plates against rotating disks carrying brushes *E*, which latter remove the glue from the plates. During their descending motion, the plates are exposed to air chemically dried in the furnace *p*.

Fig. 2258.



Glue-Dryer.

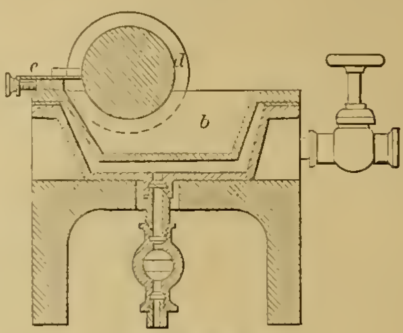
Fig. 2259.



Glue-Can.

Glue′ing-ma-chine′. One for smearing upon an applied surface a thin and even coating of liquid glue. In the example, *b* is a tank of glue kept heated by a steam-jacket. *d* is a roller, whose lower portion revolves in the tank; a scraper *e* removes the redundancy, and its upper surface is coated with a thin pellicle, suitable for application to a leather strip which is to be joined to its fellow, or a veneer which is to be attached to an object.

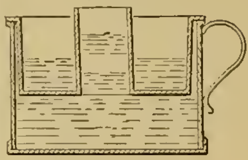
Fig. 2260.



Glueing-Machine.

Glue′ing-press. One to hold firmly together a number of parts which have been attached by glue or cement.

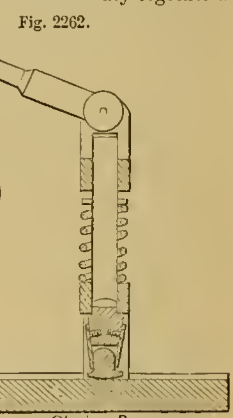
Fig. 2261.



Glue-Pot.

Glue-pot. A can or pot with a tray to hold the glue, which is melted by the heat of the water in the outer vessel.

Fig. 2262.



Glueing-Press.

Glut. 1. A wooden wedge used as a quoin, a chock in splitting timber, or as a fulcrum to a lever.

2. (*Nautical.*) *a.* A patch at the center of the head of a sail, having an eyelet for the becket-rope.

b. A choking, as by throwing the fall of a rope across the sheaves.

3. (*Bricklaying.*) A small brick or block introduced into a course to complete it.

Glyc′er-ine. A viscid, colorless liquid, having a sweetish taste but no odor, which may be derived from nearly all oily or fatty substances. It was discovered by Scheele in 1779. Its chemical combination is $C_6 H_8 O_6$. It unites readily with water, and the combination thus formed, as well as pure glycerine, is capable of solving a great variety of substances. Upon this circumstance, its non-liability to freeze at low temperatures, its slight volatility at temperatures below 200° F., and its efficacy as a preservative agent, its value in the arts chiefly depends. Glycerine is obtained by various processes, the object being to detach it from its combination with the acids, oleic, margaric, and stearic, to which it is united as a base. The refuse from soap-making contains a large proportion of it, which has been usually thrown away.

It may be obtained by treating olive-oil with oxide of lead, leaving a residuum of impure glycerine, which may be purified by sulphuretted hydrogen, and concentrated by evaporation over a water-bath.

The preferable process is by passing steam, heated to between 500 – 600° Fah., through a fatty substance in a still. The glycerine and fatty acids distill over, are separately condensed, and may be concentrated by evaporation. The purity depends upon that of the substance employed.

Glycerine is employed in medicine as a vehicle for liniments, carbolic acid, etc., and may be used for forming extracts and tinctures. It is also employed in soaps and cosmetics of various kinds, imparting a sense of moisture and coolness to the surfaces where applied; and for preserving animal and vegetable preparations, not shrinking them as alcohol does. Its non-evaporability makes it useful as an ingredient in copying-ink, and by treatment with nitric acid it forms the well-known explosive nitro-glycerine.

Glyph. (*Architecture.*) Perpendicular fluting, used in the Doric frieze.

Glyph'o-graph. A name given by Mr. Palmer to his system of relief line-engraving.

A thin ground of wax is spread upon the plate; this is etched or cut away so as to give the design in intaglio. The ground is now covered with a film of graphite, after which metal is precipitated upon the metal in an electro-bath, giving a metallic plate with the design in relief. The copper shell is backed with lead and used as an ordinary printing surface. By a similar process the engravings which illustrate this book have been made. See RELIEF LINE-ENGRAVING.

Glyp'to-graph. An engraving on a gem or a semi-precious stone.

Gno'mon. 1. *a.* The style, or pin, which, by its shadow on the dial-plate, shows the hour of the day. See DIAL.

b. A rod or pillar, from whose shadow the altitude of the sun may be determined. Such were in use in ancient Egypt, in China, and such were found at Quito by the invading Spaniards.

The astronomer Uleg Beg erected a *gnomon* at Samarcand in 1437, the hight of which was 176.89 feet. The gnomon of the sun-dial of Delhi takes the form of an elevated staircase. See DIAL.

The *gnomon* or *style* of a horizontal dial has an edge parallel to the axis of the earth, and makes with the horizontal plane of the dial-plate an angle equal to the latitude of the place.

The gnomon was anciently used in China for astronomical purposes, but this people did not excel in dialing. A measurement of the length of the solstitial shadow, made by Tschen-Kung, at Loyang, on the Yellow River, 1200 B. C., was found by Laplace (quoted by Humboldt in "Cosmos," Vol. II. p. 115) to accord perfectly with the present accepted theory of the change in the obliquity of the ecliptic.

"The sun-dial and the gnomon, with the division of the day into twelve parts, were received by the Greeks from the Babylonians." — HERODOTUS, II. 109.

Eubulus, the comic poet, quoted by Athenæus, who wrote about A. D. 220, says: —

"We have invited two unequalled men,
Philo-crates and eke Philocrates, —
For that one man I always count as two,
I don't know that I might not e'en say three.
They say that once when he was asked to dinner,
To come when first the dial gave a shade
Of twenty feet, he with the lark uprose,
Measuring the shadow of the morning sun,
Which gave a shade of twenty feet and two.
Off to his host he went, and pardon begged
For having been detained by business;
A man who came at daybreak to his dinner!"

The gnomons of Peru disgusted the invading Spanish, who, of course, had never bowed to images. One obelisk at Quito was in the center of a circle, on which was marked an east and west line indicating the equinox. The ruthless conquerors thought it was an idol, and did not comprehend that they were on the equator. The men who were expelled from Cordova about 290 years previous could have explained the use of the pillar. See DIAL.

2. An instrument, more employed formerly than now, for measuring altitudes and declinations of the sun and stars. It was usually a column erected upon level ground or pavement. An observation made at Marseilles by Pytheas in the time of Alexander the Great showed that the gnomon at that place was as the meridian shadow at the summer solstice, as 213⅕ to 600.

Cassini's celebrated gnomon in the Church of St. Petronius at Bologna was eighty-three French feet in hight.

Goaf. (*Mining.*) An excavated space from which the ore has been removed. It is sometimes made the receptacle for the *deads* and *attle* of the mine to avoid sending them up to the surface, and to support the roofs of the workings.

Gob; Gobb. (*Mining.*) *a.* A *goaf* or abandoned working in a mine from which the ore or coal has been taken, and is now used to contain refuse.

b. Attle, waste, rubbish of working. *Gobbing.*

Gob'e-lins. (*Fabric.*) A superior kind of French tapestry, deriving its name from the brothers Gobelin, the first manufacturers.

Go-cart. A small frame, without a bottom and running on casters, for teaching infants to walk.

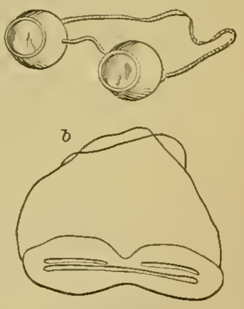
Gof'fer-ing-ma-chine'. A machine for making plaits or ruffles. See GAUFFERING-MACHINE.

Gog'gles. 1. Eye-blinds for horses.

2. Tubes or glazed cases in front of the eyes for protection from dust or intense light.

A similar arrangement for weak eyes was used by Pepys, and described by him in his "Diary" of April 25, 1669, under the name of a vizard "with tubes and glasses got to put in and out. I paid him 15 *s.*"

Fig. 2263



Goggles.

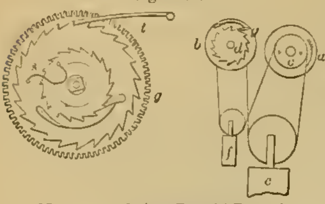
Wooden goggles (*b*) are worn by the Yukon Indians of Alaska. They are used to diminish the light and prevent the glare from producing blindness. This mode of contracting the diaphragm resembles, except in not being automatic, the device in the eye of a cat, the iris of this animal diminishing by lateral contraction instead of orbital. See IRIS-DIAPHRAGM.

Go'ing-bar'rel. (*Horology.*) *a.* A barrel containing a mainspring and having a cog-wheel on its periphery which drives the train. It supersedes the arrangement of chain and fusee.

b. A ratchet-wheel with pawl and spring on the shaft of the great wheel, by which the works are kept going while the clock is being wound up. Invented by the celebrated English watchmaker, Harrison.

In this, the larger ratchet-wheel, to which the click *t* is attached, is connected to the great wheel *g* by a spring *s*. While the clock is going, the weight acts upon the great wheel *g* through the spring; but as soon as the weight is taken off by winding, the click *t*, whose pivot is set in the frame, prevents the larger ratchet from falling back, and so the spring *s* still drives the clock-wheel during the time the clock takes to wind.

Fig 2264.



Harrison's Going-Barrel (*Brown's Mechanical Movements*).

A modification of the device was adapted by the same inventor to suit watches.

Go′ing-wheel. An arrangement invented by Huyghens to keep a clock in motion while winding. In Fig. 2264, *a* is the going and *b* the striking wheel, carrying on their axes the pulleys *c d*, which, by means of an endless cord or chain, sustain the pulleys carrying the weights *c f*, the latter serving merely to keep the chain taut; each of the pulleys *c d* supports half the larger weight, so that on turning the pulley *d*, in the act of winding, the weight *c* while being raised still continues to act with half its force on the pulley *c*, the pulley *d* turning so as to lift the weight *c*, and being prevented from going back by the engagement of the pawl *g* with its toothed exterior.

Gold. Equivalent, 98.7; symbol, Au. (Aurum); specific gravity, 19.2; point of fusion, 2282° F. Found in the native state, mechanically associated with earths and sometimes alloyed with metals. It is a heavy, yellow, lustrous, malleable, ductile, nonoxidizable, soft metal. Its uses are for coin, plate, ornaments, and articles of luxury.

Its principal sources are California, Australia, the western coast of Africa, and the Ural. It is a very widely disseminated metal, but is only found in paying quantities in a few countries. Wicklow, in Ireland, parts of Nova Scotia and of Virginia and North Carolina, yield this metal.

The principal supplies of gold in the land of Egypt were derived from the gold mines in the desert of the Upper Country. Their position, according to Wilkinson, is still known to the Arabs, and is about southeast from Baháyreh, a village opposite the town of Edfou, at a distance of ten days' journey. The gold lies in veins of quartz in the rocks bordering an inhospitable valley and its adjacent ravines, and yields a small quantity in proportion to the labor required. Water is scarce, the locality is remote from food and the materials necessary for the prosecution of the work, and do not seem to offer any prospect of reward for reopening.

They were run by slave power at a time when the sacrifice of human life by hardship was a matter of little concern; as was evinced in other regal undertakings, — the building of the Pyramids, the quarrying, moving, and erection of the monoliths, and the digging of the canal from the Nile to the Red Sea.

Agatharcides states that the toil of extracting the gold of these mines was immense. The rock was pounded fine, and the gold was separated by frequent washings, and the account is confirmed by paintings on the tombs executed in the reign of Osirtasen, about 1740 B. C.

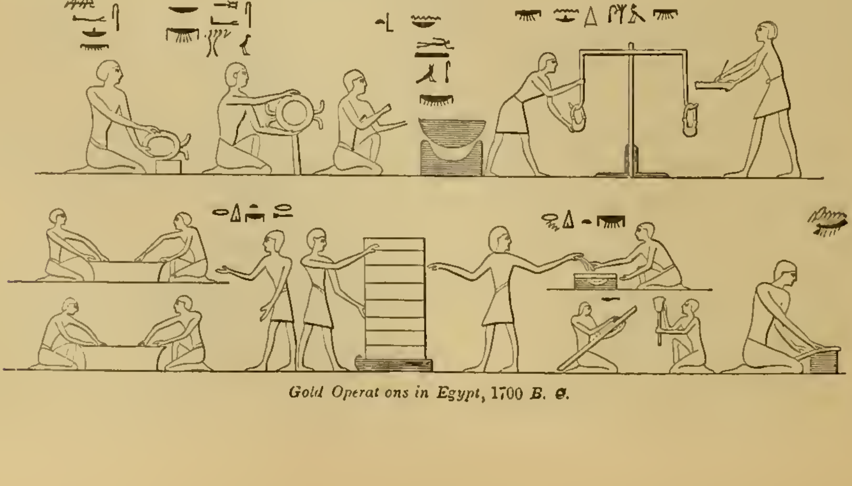
Mehemet Ali announced his intention to reopen these mines, but desisted. He was tyrant enough for the purpose, but had a method in his madness, and was doubtless deterred by mechanical and climatic difficulties. The skeletons of the victims of his rapacity in Egypt would have paved the road across the desert to the desolate hills devoted to the *auri sacra fames*.

These mines are said to have yielded $35,000,000 per annum in the times of Rameses II., fourteenth century B. C., and were still worked under the Ptolemies.

The "*molten* calf" and the fact that Aaron "fashioned it with a graving tool" show that casting and engraving metals were known 1490 B. C., and the character of the articles found in the tombs, as well as the paintings and sculptures, point in the same direction. A curious series of pictures at Beni-Hassan point out with some clearness the process of collecting and working gold. (Fig. 2265.)

Reference has just been made to the account of Agatharcides, where he describes the hardships of the gold-miners. A fuller description is given of it by Diodorus, entering into a detailed statement of the unfortunate convicts who were sent by thousands to the spot and worked under the lash without any alleviation, care during sickness, or any hope except in death. The account

Fig 2265.



Gold Operat ons in Egypt, 1700 *B. C.*

is too long to insert, but stands along with the history of Spanish operations in the gold mines of Hispaniola as an example of what can be done by men who "neither fear God nor regard man."

The illustration is taken from a tomb at Beni-Hassan, and includes the operations from the washing of the pounded ore to the making of jewelry.

The words of Diodorus, 10 B. C., throw much light on the process employed in his time. He states that the "marble shining rock" (quartz) is excavated by main force by iron picks and chisels, and carried by boys from the bottom of the shafts to the open air. It is then pounded by iron pestles in stone mortars till the pieces are reduced to the size of a lentil. It is then ground in the ordinary hand mill to a fine powder. He then proceeds to say: "At length the masters take the stone thus ground to powder and carry it away to undergo the final process. They spread it upon a broad table a little inclined, and, pouring water upon it, rub the pulverized stone until all the earthy matter is separated, which, flowing away with the water, leaves the heavier particles behind on the board. This operation is often repeated, the stone being rubbed lightly with the hand; they then draw up the useless and earthy substances with fine sponges, gently applied, until the gold comes out quite pure. Other workmen then take it away by weight and measure, and putting it with a fixed proportion of lead, salt, a little tin, and barley bran, into earthen crucibles well closed with clay, leave it in a furnace for five successive days and nights, when it is suffered to cool. The crucibles are then opened, and nothing is found in them but the pure gold, a little diminished in quantity. Such is the method of extracting gold on the confines of Egypt, the result of so many and such great toils. Nature indeed, I think, teaches that as gold is obtained with immense labor, so it is kept with difficulty, creating great anxiety, and attended in its use both with pleasure and grief."

The series of operations shown in the cut evidently refer to something similar to the process described by Diodorus. A man is spreading the auriferous mud on a board; then appears a man with a shovel, and another with an inclined chute. A fourth is working with a pan, into which water is poured by a fifth person. The latter also throws water into a riffle, which is a series of steps. Others are washing and stirring the material in pans. Next we see the scribe and the scales. Then the crucible, presided over by a man with a blow-pipe; and as a sequence are jewelers making up the gold into an ornamental form, for some purpose not apparent to the writer, though no doubt clear enough to the artist of thirty-five centuries ago.

Gold was first coined in England in A. D. 1257. The amount of gold that passed through the English mint from 1558 (accession of Queen Elizabeth) to January 1, 1840, is 3,553,561 pounds' weight, troy. The value of gold coined in the reign of George III. was £74,501,586.

An ounce of gold will cover a silver wire 1300 miles in length, and a grain of gold may be extended into a leaf of 56 square inches. Gold-leaf may be reduced to the 290,000th part of an inch. See AMALGAMATOR; GOLD-LEAF.

Gold-al-loys′. Those in which other metals are added to gold to confer hardness, as in coin, or to cheapen the product, as in some jewelers' alloys and solders. See ALLOYS, pp. 62, 63.

Gold-beat′er's Ham′mer. A hammer with two somewhat rounded faces, used in beating the pack of alternate gold ribbon and vellum or gold-leaf and skin. As the work progresses smaller hammers are used.

The *forging-hammer* is used in reducing the ingot of gold to one sixth of an inch thickness. The anvil is a steel block 4 × 3 inches on the face.

The hammer for the first course of beating is short handled and weighs 15 or 16 pounds. The hammer for the next beating weighs 10 pounds.

The French series of hammers is: —

The *flat* or *enlarging hammer*. Its head is slightly convex, and has a diameter of 5 inches. Its shape is a truncated hexagonal pyramid, the face being the base. It weighs 14 or 15 pounds.

The *commencing-hammer* is more convex than the flat, has a face of 4 inches, and weighs 6 or 7 pounds.

The *spreading-hammer* (*marteau à chasser*) is still more convex, has a head 2 inches in diameter, and weighs 4 or 5 pounds.

The *finishing-hammer* is still more convex, has a face 4 inches in diameter, and weighs 12 or 13 pounds.

Gold was beaten into thin sheets by the ancient Egyptians, and used in ornamenting furniture, coffins, and numerous other articles.

Gold-beat′er's Skin. Prepared from the peritoneal membrane of the cæcum of the ox. Used to separate the leaves of gold while under the hammer.

Gold-beat′ing. See GOLD-LEAF.

Gold-block′ing. Pressure of an engraved or composed block upon gold-leaf spread upon a book-cover. Without the leaf it is called *blind-blocking.*

Gold, Chlo′ri-na′tion of. See CHLORINATION.

Gold-fur′nace. This resembles a brass-furnace (see BRASS-FURNACE), but is usually built above the floor, occupying one side or more of the shop, and appearing like a stunted wall. The aperture for the fuel and crucible in each furnace is 9 to 16 inches square, and 11 to 20 inches deep. The front edge of the wall is horizontal and stands about thirty inches from the floor, but the top inclines backward at an angle of about 30°, and a ledge holds the *tiles* which close the tops of the furnaces.

The crucibles are usually of black-lead.

The auriferous copper ore of Colorado is thus reduced. The pyrites are roasted in kilns, wood being the fuel, expelling about half the sulphur. The black mass, protosulphide of iron, is calcined in brick ovens, being stirred with iron rods. The resulting black or brown powder is placed on the hearth of a reverberatory smelting-furnace, with such mixture of auriferous, argentiferous, and cupriferous ores as shall produce the reactions which will separate the materials into a floating dross and a pool of metal. The ferruginous slag is drawn off at an upper hole, and a mixture of gold, silver, copper, and iron at a lower hole, forming a *matt* which is shipped to Swansea, Wales, for complete separation.

Gold, Im-i-ta′tion. *Mock-gold.* See JEWELER'S ALLOYS, p. 63.

Gold-leaf. Gold-leaf was made in Egypt 1706 B. C. Homer refers to it. The temple of Solomon was profusely gilt. Pliny states that in his time a single ounce admitted of being beaten out into 750 leaves, four fingers in length by the same in breadth. This tenuity is very far exceeded at the present day. In the practice of the art in Europe, the skin of an unborn calf was first used; afterwards a fine pellicle from the entrails of cattle. This continues to be used (see *supra*). "About 1621," says Beckmann, "Merunne excited general astonishment, when he showed that the Parisian gold-beaters could beat an ounce of gold into 1,600 leaves, which together covered a surface of 105 square feet. But in 1711, when the pellicles discovered by the Germans came to be used in Paris, Réumer found that an ounce of gold, in the form of a cube, 5¼ lines at most in length, breadth, and thickness, and which covered a surface of about twenty-seven square lines, could be so extended by the gold-beaters as to cover a surface of more than 1466½ square feet."

The Egyptian mummy-cases were sometimes profusely gilded, and in some instances the body itself.

A small percentage of silver and copper is added to gold for beating, perhaps about 1¼ per cent of alloy. The ingot is rolled into a *ribbon* by repeated passage between rollers, and this ribbon has a thickness of $\frac{1}{800}$, a surface of 500 square inches to an ounce of gold.

The gold-beater takes 800 pieces of the "skin," which is a tough, thin membrane from the intestines of an ox, and thus proceeds: A hundred and fifty bits of ribbon gold an inch square are interleaved with as many vellum leaves four inches square, forming a *cutch;* this pack is beaten for a long time with a ponderous hammer on a smooth marble slab until the gold has thinned and expanded to the size of the vellum. How the workman manages so as to beat all the pieces equally, and yet beat none into holes, he alone can answer; it is one of the mysteries of his craft. The gold is liberated from its vellum prison, and each piece cut into four; the hundred and fifty have thus become six hundred, and these are interleaved with six hundred pieces of gold-beater's skin, forming a pack called a *shoder*.

Another beating then takes place, more careful, more delicate, more precise than the former, until the gold, expanded as far as its envelope will admit, requires to be again released. The leaves are again divided into four, by which the six hundred become twenty-four hundred; these are divided into three parcels of eight hundred each, and known as *molds;* each parcel is subjected to a third beating. Heavy as the hammers are, there are yet degrees of heaviness; first, a 16-pounder for the *cutches*, then one from nine to twelve pounds for the *shoders*, and lastly a hammer of from six to seven pounds is employed.

Gold-min'ing. The different modes of collecting gold in the placers of California — and the same is true of some other places, Australia, for instance — are familiarly known as *panning*, *winnowing*, *cradle-rocking*, washing with the *long-tom* or the *quicksilver-machine*, *jamming* or turning the course of a river, *burrowing* or *tunneling*, *ground-sluicing*, *sluice-boxes* in connection with the *hydraulic process*, or water-jet. See list under METALLURGY; MINING.

In *panning*, the operator takes his station by the edge of the water, dips his pan, which he holds by the rim, and then imparts to it a rotary and oscillatory motion, occasionally stirring up the earth and mashing the clods. The large stones are thrown out and the water caused to circulate around the inside circumference of the pan, the heavier portions, including the gold, collecting in the center, and the lighter matters being discharged over the edge. The residue, consisting of fine gold and black sand, is separated after being dried.

The *winnowing* operation is practiced where water is not available, and consists of tossing in a blanket the finely powdered and dry earth, depending upon the wind to blow away the lighter particles.

The *cradle* is a box about 3½ feet long, 20 inches wide, and 18 inches deep. The top and one end are open. Upon the rear half of the top is fitted a box with a perforated sheet-iron bottom. This box receives the earth, which is disintegrated therein, and passes through the holes as the cradle is rocked to and fro. Water is bailed by hand from the stream, and the gold is arrested in its passage by wooden cleats placed on the inclined bottom of the cradle, while the lighter matters are carried out at the end by the stream of water. See CRADLE.

The *long-tom* consists of a shallow, inclined trough, from 10 to 20 feet long and perhaps 16 inches wide. At the lower end is an upwardly inclined perforated plate to arrest the gold which falls through the holes into a box below, while the tailings pass over the end by the force of the stream of water which is introduced into the upper end of the trough. The gold is collected by *riffles* in the box, and quicksilver is added to amalgamate the finer particles, if necessary.

The *quicksilver-machine* is somewhat similar to that last mentioned, but is intended to bring all the gold in contact with mercury, the amalgam being afterwards treated for the removal of the mercury. See AMALGAMATOR.

In *jamming*, the water of a river is turned into a temporary channel while the bed is explored for gold.

Burrowing or *tunneling* are adopted as a more economical means of reaching the lower strata or more valuable deposit upon the hard pan, or ancient river bottom, instead of digging away or working over the whole mass of superincumbent earth.

Ground-sluicing consists in turning a stream upon a bank of earth to remove it and uncover the more valuable strata below, the auriferous deposit in the upper portion being detained by its gravity to be washed with the lower denuded layer of *pay dirt*.

Hydraulic-mining by jet and sluice-boxes has given rise to some of the greatest engineering works of California. A series of boxes about 14 inches in length and 3 feet wide, called *sluice-boxes*, are fitted together at the ends so as to form a continuous trough, as long as may be desired, sometimes extending several thousand feet. The earth and stones are washed through this sluice by the force of a strong current of water, often brought from a great distance. The sluice has a flooring of wooden blocks which offer some impediment to the passage of the earth, and afford crannies for collecting the gold, and for holding the quicksilver by which the finer particles of gold are arrested and amalgamated. The bank of auriferous earth is washed into the sluice, thus prepared, by means of a powerful stream conducted through and directed by a pipe in the manner of a fire-engine. The water is brought to the scene of operations from immense distances, in some cases over one hundred miles, and the flumes and canals which form a network over the country are among the most remarkable local features (see FLUME). To quote from the description of "A Miner of 1849," Harper's Magazine, April, 1860: —

"To shovel a mass of several millions of tons of earth into this sluice for washing would be too expensive. By means of water directed through hose and pipe the labor of many men is cheaply performed, and the hill torn down to its base. The water is led through india-rubber or double canvas hose, and generally from a great hight above the scene of operations. It is consequently thrown with such force as to eat into the hillside as if the latter were sugar or salt. Several of these streams directed upon a hillside bring down more earth than could be thrown by one hundred men with picks and shovels. But the art of the miner does not rest here. He undermines as well as breaks down, working in a single cavern in the hillside with his water batteries until the earth topples over like an avalanche." See HYDRAULIC-NOZZLE.

By a combination of shovels and the current of water the earth is then carried into the sluice in which it is disintegrated and washed down with great rapidity, the gold catching, as has been observed, in the interstices between the blocks which form the floor of the sluice. See AMALGAMATOR.

Gold-pen. A pen with a gold *nib* pointed with rhodium or iridium.

In 1823, Hawkins and Mordan (English) made tortoise-shell and horn nibs with diamond and ruby points. These were followed by plates of gold attached to the tortoise-shell nibs.

Doughty's pens were of gold with ruby points.

Wollaston's pens were of two flat strips of gold tipped with rhodium.

In 1851, the Birmingham Exhibition in London showed gold, palladium, and silver pens tipped with iridium and osmium.

Gold pens are now usually tipped with iridium, making what are commonly known as *diamond points*. The iridium for this purpose is found in small grains in platinum, slightly alloyed with this latter metal. The gold for pens is alloyed with silver to about sixteen carats fineness, rolled into thin strips, from which the blanks are struck. The under side of the point is notched by a small circular saw to receive the iridium point, which is selected with the aid of a microscope. A flux of borax and a blow-pipe secure it to its place. The point is then ground on a copper wheel with emery. The pen-blank is next rolled to the requisite thinness by means of rollers especially adapted to the purpose, and tempered by blows from a hammer. It is then trimmed around the edges, stamped, and formed in a press. The slit is next cut through the solid iridium point by means of a thin copper wheel fed with fine emery, and a saw extends the aperture along the pen itself. The inside edges of the slit are smoothed and polished by the emery-wheel; burnishing, and hammering produce the proper degree of elasticity.

Gold-print′ing. Work printed with gold-size and the letters then covered with gold-leaf, or Dutch-metal.

Gold-rain. (*Pyrotechnics.*) Small cubes ½ inch square, used instead of stars for rockets, etc.

Their composition is niter, 16; sulphur, 10; mealed powder, 4; lamp-black, 3; flowers of zinc, 1; gum arabic, 1; treated in the same manner as for stars.

Gold-shell. Powdered gold or gold-leaf ground up with gum-water and spread on shells. Used by artists.

Gold-size. A size used as a surface on which to apply gold-leaf.

The *oil gold-size* is a mixture of linseed-oil or *fat-oil* and ocher ground by the muller and used in *oil gilding*.

The *gold-size* used in *burnish-gilding* is a peculiar composition, consisting of pipe-clay, red chalk, black-lead, suet, and bullocks' blood, compounded and thinned with a solution of gelatine.

Gold-sol′der. Gold, 12; silver, 2; copper, 4. See SOLDERS, p. 63.

Gold-thread. Otherwise *spun-gold.* A flatted, silver-gilt wire, wrapped or laid on a thread of yellow silk by twisting with a wheel or bobbins.

Gold-tis′sue. Cloth interwoven with gold-thread.

The Persians in the time of Darius were prodigal in vestments of gold embroidery and silk. The nuptial robes of Maria, wife of Honorius, discovered in her coffin in Rome in 1544, on being burned yielded thirty-four pounds of pure gold.

Gold-tool′ing. Ornaments impressed by the hot-tool upon gold-leaf laid on book-covers, causing the metal to adhere. In contradistinction to *blind-tooling*, which is the tool-mark without the leaf. The gold is fixed to the surface of the leather by gold-size, and the surplus is wiped off after the tool has been applied.

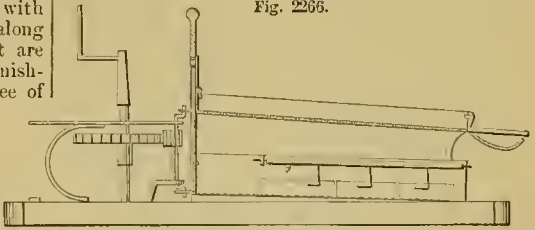
Gold-var′nish. (*Metallurgy.*) A yellow, transparent varnish spread over silver-leaf to give it the appearance of gold. The invention seems to have originated about 1680 with Antonino Cento, an artist of Palermo. It was introduced into England by Evelyn, 1680. The varnish is made of gum lac digested in spirits of wine.

Gold-wash′ers. Pliny speaks of the method of gathering gold by means of an artificial river and sluices, the water being brought from a distance by canals, and precipitated upon the auriferous earth, which is carried down the trenches, the particles of gold being arrested by the leaves of a prickly shrub planted therein. He says that the water is sometimes brought as much as one hundred miles, the channel being hollowed out of the faces of the precipices and carried by aqueducts across valleys. The prickly plant, the *ulex*, is then dried and burned, and the ashes washed to obtain the gold.

"In the country of the Saones [in the Caucasus] the winter torrents are said to bring down even gold, which the barbarians collect in troughs pierced with holes and lined with sheep fleeces; hence the fable of the "golden fleece" (STRABO). Colchis may be considered the California of old times.

Gold-washers are of various kinds, a number of which are cited under GOLD-MINING, the machines and devices being also enumerated in the specific index METALLURGY (which see). The pan, the rocking-cradle, the shaking-table (Fig. 2266), the inclined chute, the series of settling-vats, the trough with slats or riffles, the vertically reciprocated sieve, are types of machines which have many varieties and names. The nomenclature of mining is very full, but a large number of its terms are local. In England the miners of Derbyshire and Cornwall have, to some extent, their own sets of terms, and these differ in many respects from those which obtain in the coal regions. See specific list under MINING.

Fig. 2266.



Gold-Washer.

Edrisi, the Arab geographer (about 1150), the friend of Roger II. of Sicily, speaks of the employment of quicksilver in the gold-washings made by the negroes of Sofala as a long-known practice, and the use of this metal in gathering gold has increased with the lapse of time. See AMALGAMATOR.

Gold-wire. Gold-wire, so called, has usually a core of silver, and is made by preparing a round bar of silver, plating it thickly with gold, and then drawing it through a series of holes of gradually decreasing diameter. The gold may be $\frac{1}{100}$ of the thickness of the silver at first and shares all its mutations in the drawing, retaining the same relative thickness. Dr. Wollaston, a man of extraordinary tact in delicate experiments, made the finest wire on record. He bored out a rod of silver, put in it a core of gold-wire, then drew the rod down to wire, dissolved away the silver in nitric acid.

Gold-wire flattened by being passed between highly polished steel rollers forms a ribbon which is twisted around a core of silk to form gold-lace. The compound thread is then twisted or woven into a lace or braid.

Gol'path-en. (*Fabric.*) An Indian striped silk.

Gome; Gorm. Grease for cart-wheels (English).

Gon'do-la. 1. A Venetian pleasure-boat.

> "Didst ever see a Gondola? For fear
> You should not, I'll describe it you exactly:
> 'T is a long covered boat that 's common here,
> Carved at the prow, built lightly but compactly;
> Rowed by two rowers, each called 'Gondolier,'
> It glides along the water looking blackly,
> Just like a coffin clapt in a canoe,
> Where none can make out what you say or do.
>
> 'And up and down the long canals they go,
> And under the Rialto shoot along,
> By night and day, all paces, swift or slow,
> And round the theaters, a sable throng,
> They wait in their dusk livery of woe, —
> But not to them do woful things belong,
> For sometimes they contain a deal of fun,
> Like mourning coaches when the funeral 's done."
>
> LORD BYRON (*Beppo*).

A gondola of middle size is 30 feet long, 4 feet beam, and is rowed by one man standing at the stern and using one oar. It has a well-furnished cabin amidship, and is painted black. The stem and stern rise in pointed elevations, the former being surmounted by the *ferro*, a bright iron cleaver.

"Two Gundaloes were imported into England by the 'merry monarch' in 1661." — PEPYS'S *Diary*.

2. A flat-bottomed boat (United States).

3. A railroad platform car.

Gong. A Malayan word. A tambourine-shaped resonant bell of the East. A disk of thin bronze with an upturned flange forming a rim. It consists, according to Klaproth, of seventy-eight parts copper, twenty-two parts tin, and is a noisy affair requiring skill in the manufacture, both in the hammering and annealing. The tempering is the inverse of that adopted for iron. The bronze is of such proportions as to be naturally brittle when cast. It is heated to a cherry red and plunged into water, being clamped between iron disks till cool. It will then bear the hammer.

2. A stationary bell whose tongue is moved by a wire or string. Commonly used as an alarm or *call-bell.*

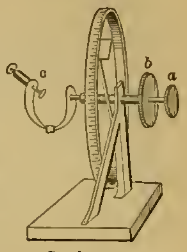
Gon-i-om'eter. An instrument for measuring angles, more particularly those of crystals.

One form of goniometer for measuring the angles of crystals observed through the microscope is attached to the eye-piece, and has a pointer and graduated circle. It was invented by Romé de Lisle, about 1783.

Schmidt's goniometer consists of a positive eye-piece with a single cobweb filament stretched diametrically across it in a circular frame capable of rotation; the edges of the frame are graduated in degrees. By rotation of the frame the filament is placed successively in line with the directions of the two sides of the crystal, and the difference in the degrees is observed.

Wollaston's reflecting goniometer consists of a graduated circle provided with a vernier reading to minutes. The axis of the circle is a hollow tube within which is a smaller axis, each of which has a milled head *a b*, allowing the smaller axis to be turned independently of the circle.

Fig. 2267.

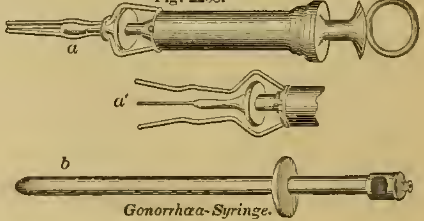


Goniometer.

The crystal to be examined is inserted in the holder *c* and fixed by wax, so that its edge may be parallel to the axis of motion; this adjustment is determined by causing a horizontal line seen by reflection from each face of the crystal to coincide with another horizontal line viewed by direct vision. The instrument is then turned until the horizontal object is seen reflected in one of the faces. The smaller axis is then held fast, and the other turned until the index of the vernier is brought to the zero of the graduated limb. The circle with the smaller axis is then turned around till the same object is seen by reflection in the other face of the crystal. The arc passed through by the circle measures the supplement of the angle formed by the two faces of the crystal, and for convenience the supplements are laid down on the circle so that the angle is read directly, avoiding the trouble of calculation.

Gon'or-rhœ'a-syr'inge. (*Surgical.*) An instrument for injecting the urethra. The illustration shows an instrument *a a'* which has a nozzle and three distending fingers. It is introduced in the form shown at *a*, and then distended so as to expand the urethral wall and expose it more fully to the action of the liquid which is ejected at the nozzle. *b* is a form of urethral irrigator having rows of holes throughout a sufficient portion of its length.

Fig. 2268.



Gonorrhœa-Syringe.

Goods-wag'on. The English term for a railway freight-car.

Goose. A tailor's smoothing and pressing iron.

Goose-neck. 1. (*Nautical.*) *a.* An iron fitted at the end of a yard or boom for various purposes.

b. A *davit.*

2. (*Hydraulics.*) A nozzle having a universal-joint connection to the stand-pipe on a fire-engine.

Goose-wing. (*Nautical.*) Another name for studding-sail.

Go-out. (*Hydraulic Engineering.*) A sluice in an embankment for allowing water to escape from tidal lands when the tide is out.

Gore. 1. An angular piece of cloth at the narrowing part of a sail.

2. An angular piece of planking used in fitting the skin of a vessel to the frames.

3. An angular piece inserted into a garment to enlarge or strengthen it. A *gusset.*

Gore-strake. (*Shipbuilding.*) A strake which terminates before reaching the stem or stern-post. Such strakes are at or near the center of the ship to lessen the *spiling* of the plank.

Gorge. 1. (*Fortification.*) A line joining the inner extremities of a work; as, —

A line drawn between the rear ends of the faces of a *redan*.

A line across the narrow portion of a *bastion*, from the points of junction of its *flanks* with the *curtains*.

2. (*Masonry.*) A small groove at the under side of a coping, to keep the drip from reaching the wall. A *throat*.

3. (*Nautical.*) The *groove* or *score* of a pulley.

Gorge-hook. Two fish-hooks separated by a piece of lead.

Gor'get. (*Surgical.*) *a.* A lithotomic cutting-instrument.

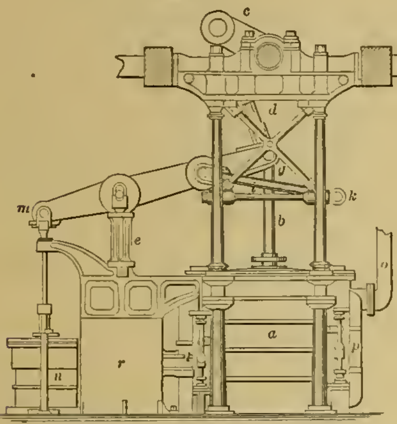
b. A canulated or concave conductor; called also a *blunt gorget*.

Gor'gon-elle'. (*Fabric.*) A Dutch cloth.

Gor'gon Steam-en'gine. A form of direct-action steam-engine, invented by Seaward (Britain), as a means of obviating the use of the beam in *marine-engines*. It is called the "*Gorgon*" engine, from having been first employed in an English government steamer of that name.

a is the steam-cylinder and *b* the piston-rod, which is connected to the crank *c* by the rod *d*. The head of the piston-rod is guided vertically by the parallel motion, as follows: *c* is a rocking standard, carrying at its upper end the fulcrum upon which the beam turns. The beam is jointed at *g* to the cross-head of the piston-rod, and also to the radius bar *i*, which turns upon *k* as a center. The outer end *m* of the beam serves to work the air-pump *n*. *o* is the steam-pipe by which steam is conducted to the valve-chamber *p*. *q* is the valve-chamber of the eduction-valve, which is connected to the condenser *r*, the upper portion of which forms the hot-well.

Fig. 2269.



Seaward's Direct-Action Engine.

Gos'sa-mer. (*Fabric.*) A very thin gauze.

Gouge. 1. (*Wood-working.*) A chisel with a curved blade adapted to make a rounded groove in cutting or turning wood.

They are known as *flat*, *middle*, and *quick*; their curves being respectively *obtuse*, *medium*, and *acute*.

The gouge existed in early ages in stone, bone, and bronze.

2. (*Bookbinding.*) A finisher's hand-tool for blind-tooling or gilding, having a face which forms a curve.

3. A shaped incising-tool used for cutting out forms or blanks for gloves, envelopes, or other objects cut to a shape from fabric, leather, or paper.

Gouge-bit. A wood-boring tool used in a brace. It has a rounded end, and a groove which contains the chips. See Bit.

Gouge-slip. Oil-stone or hone slip, for sharpening on the concave side of the edge of the gouge.

Gov'ern-or. 1. (*Steam-engine.*) A device which regulates the admission of steam to the engine according to the rate of motion. The intention is to maintain uniform velocity, and any acceleration of speed above a given rate causes a valve to be partially closed, diminishing the area of steam passage; contrariwise in case of flagging in the speed of motion of the engine. The favorite form of governor has a pair of balls suspended from a vertical shaft, so as to swing outward when the shaft is rotated. The greater the speed the greater the centrifugal force, and consequently the farther the balls depart from the axis of rotation; the inclination of the ball arms is made effective in working the valve.

This use of the device of the two suspended revolving balls, whose circle of revolution widens as the speed of the engine increases, is due to James Watt, who adapted it from an ancient device in windmills.

The full-page engraving opposite to page 998 shows fifteen variations in form and structure of the ball-governor, two forms in which a propeller-wheel acts in a liquid, and one form in which the pressure of steam is directly upon the valve.

In *a* the balls receive their rotation from the bevel gearing above, increment of speed causing the balls to fly outward and raise the sliding sleeve on the spindle. To this sleeve is connected the end of a lever arm whose vertical oscillations are communicated to the butterfly or throttle valve, as in Figs. *k* or *l*.

In *b*, the balls receive rotation by the bevel wheels, next below the sliding collar. To the collar is attached a sleeve on which the lower bevel-gears remain at rest as long as the pin on the said sleeve is not in contact with either of the studs projecting from the upper and lower surfaces of the respective bevel-wheels. This is the position shown in the cut, and is that assumed when the engine is running at the required speed. Should the speed be accelerated, the raising of the balls would raise the sleeve and its pin, and thereby rotate the upper bevel-wheel, turning in one direction the miter-wheel with which it engages. If the speed fall below the medium, the pin on the sleeve falls and turns the other bevel-wheel, moving the miter-wheel in the other direction. The horizontal shaft of the miter-wheel operates the throttle valve or gate of the pen-stock.

c acts by substantially the same means through a system of levers upon a belt-shifter. In the medium position the belt runs on a loose pulley; but when the balls rise by acceleration of speed or fall by retardation, the belt is shifted on to the upper or the lower pulley, which pulleys act upon the valve or gate requiring adjustment.

In *d*, instead of the arms being connected with a slide working on a spindle, they cross each other and are elongated upwardly, where they connect with the valve-rod by two short links.

Pickering's governor *e* has balls on springs, the upper ends of which are attached to a collar fixed on the spindle, and the lower end to a collar on the sliding sleeve. The springs bend outward proportionally to the centrifugal force of the balls, and thereby raise the sleeve, acting upon a rod which diminishes the area of induction steam opening. A diminution of speed has the contrary effect.

In *f* the balls ascend the parabolic arms as they fly outward when the motion of the engine is accelerated, and conversely. Anti-friction wheels assist the balls in the ascent. Rods from the axes of the rollers connect to a collar whose motions are communicated to a lever which acts upon the butterfly-valve.

In *g* the upper ends of the ball-arms have cogged sectors which act upon the racks on the axial-rod to depress or raise it.

In *h* the oscillating weighted arm assumes a more horizontal position with increase of speed. Its normal or stationary position is shown in the illustration, its arms being out of poise.

i has balls upon toggle-arms, and resembles figure *c*, in which they are on springs.

In *j* the elbows of the arms are connected by a spring whose midlength is attached to a sleeve which slips on the spindle as the balls rise or fall.

k shows the connection of a governor similar to *a*, with the butterfly-valve of a steam-pipe ; and *l* is an illustration of a governor similar to *d*, but driven by a band-wheel below.

Tyson's governor *m m'*, 1861, has its arms suspended from a horizontal axis which rotates with the vertical spindle. He states that his object is to avoid "the friction which resists the free movement of the weighted arms in ordinary governors and attain the desirable sensitiveness." *m* is an elevation, and *m'* a plan view looking upon the balls in motion, showing them swinging tangentially to a circle whose radius is equal to the length of the axis of suspension. When the engine starts, their inertia first comes into play, and increment of speed causes them to rise in the prescribed planes, the balls themselves describing an orbit of increasing radius. It is supposed to be more sensitive than the form in which the balls swing radially outward, but, like them, has the disadvantage of lateral pressure in its bearings, as the balls are compelled to rise in lines which are not the natural result of the forces which actuate them. In Tyson's the line of rise and fall is tangential to a circle of given radius ; in the ordinary governor it is directly radial.

In Shive's governor, *n n'*, the balls swing at an angle which is, as seen at *n'*, a compromise between the two last described. The axes of the mandrels on which the ball arms vibrate are tangential to the spindle, at a point distant about the semi-diameter of the ball from the axis of revolution of the vertical spindle. The balls thus swing outwardly and backwardly, so that the inertia as well as centrifugal action of the balls, is brought into play. They are, however, compelled to rise in the prescribed direction, a compromise between the radial and the tangential.

Degener's governor, 1856, was designed to give to the pendulum balls "a motion independent of the motion of the spindle aside from their vibratory motion, by means of the diverging spiral inclines . . . . for the purpose of obtaining a more sensitive action of the pendulums." The collar from which the pendulums are swung is allowed to turn upon the spindle. The spirals are intended to "act under the pendulums and assist in throwing them upward" when the rate is increasing, or downward when the speed is checked. The diverging spiral inclines are of a shape approximating the line of ascent and descent of the ball arms under increment and decrement of speed, and can only permit freedom of motion at one ratio of increase or decrease of speed. Freedom of motion is, however, not intended, but the inclines are intended to compel quick response.

In Knight's governor, Figs. *o*, *o'*, *o''*, *o'''*, the hinging axis of each ball arm has a capacity for adjustment in a plane at right angles to the axis of revolution, so that as the hinging axis permits the vertical motion of the ball, the adjustment in a horizontal plane of the bearing of the said hinging axis shall permit the outward swing of the ball, the two, in fact, forming a universal joint permitting the ball to follow the line of motion due to the speed and the proportions of the parts. In cases where the balls are compelled to rise in a certain plane, they can only do so with perfect freedom when running at one definite speed, and their motion on their hinging axes can never be perfectly free when running above or below the said definite rate ; this fact is recognized by the introduction of the usual guides, as at *a b c d k l*, which prescribe the path of motion, and which would be unnecessary were the actions of the balls unconstrained. Any guide or immovable axis which tends to warp the balls from their true line of motion affects the freedom of their movements, entails additional friction, and intercepts or prevents their delicate and instant response to an acceleration or retardation of speed. If, upon an increase of speed, the arms or hinging joints of the balls have a tendency by a lateral strain or pressure to bind or rub, it is manifest that the balls cannot instantly respond, but that a cumulative force and speed will be required to obtain such a response as would more quickly result were the balls perfectly free to respond in their own way ; and, in fact, the motion due to the inertia of the balls developed upon an accession of speed and manifested by their tendency to lag behind is much more immediately responsive and active than the tendency to assume a more radial relative position which presently results. In this governor the balls are free to swing in such direction as may be induced by their speed and proportions, ascending or descending under changes of speed in such curves as may result from the combined forces of gravity and centrifugal impulse, under the condition of free pivotal attachment to bearings which are permitted to rotate in a horizontal plane.

Fig. *o* is an elevation of one mode of application of this principle, the balls swinging upward.

o' is a top view of the same.

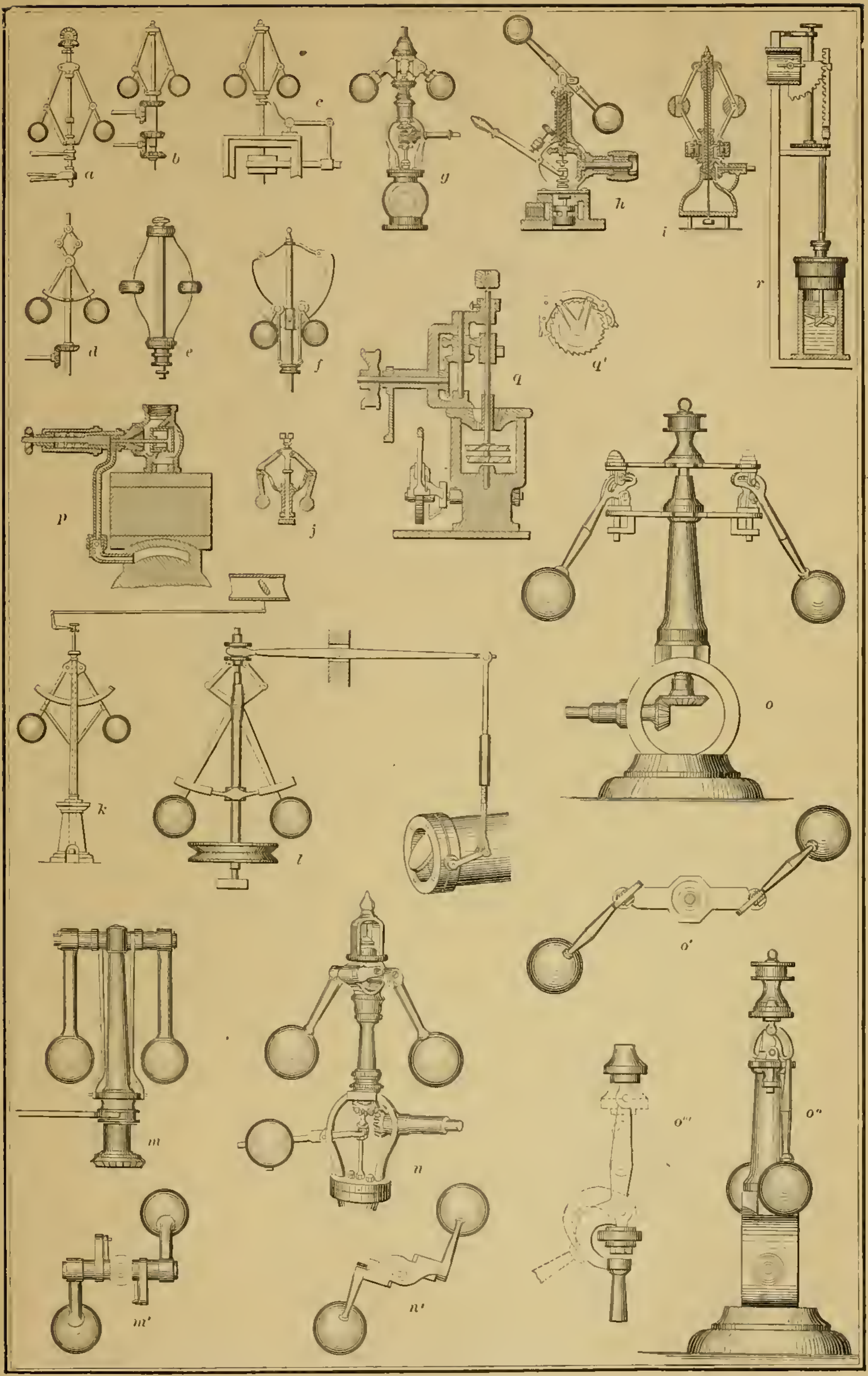
o'' shows the balls at rest ; *o'''* is another form in which a spur or finger from above the hinging joint of the governor arm projects upward, and is jointed to a link pivoted above to a spindle in the plate ; the finger and link together form a toggle, which brings the upper plate nearer to the lower one, the two ends of the toggle being hinged in bearings which are capable of horizontal rotation in the respective plates. The downward motion of the balls restores the normal position. The parts may be so arranged as to straighten the toggle by the raising of the ball, if so desired.

Modifications are shown in the patents whereby either the tangential or radial motions of the ball may be utilized, or an effect obtained from the sum of the two motions.

Some other forms than the pendulous ball may be referred to.

p is a governor in which the valve is operated by the direct pressure of steam upon a piston on its stem. The piston operates in a smaller cylinder, taking steam from the main cylinder.

q q' is Huntoon's hydraulic governor, in which a propeller-wheel works in a liquid whose resistance causes the propeller-shaft to rise in a degree proportioned to the rate of speed. The sectoral frame with its draw-pawls has a constant, reciprocating, rotary motion, and when either of the pawls comes in contact with the ratchet, it causes the ratchet-shaft to rotate to actuate the steam-valve. The rocker-frame is actu-



STEAM-ENGINE GOVERNORS.

PLATE XXI.

See page 998.

ated by the governor, and its cams bring one or other of the pawls in contact with the ratchet, according to the variation of the speed above or below the desired point.

r is a somewhat similar contrivance, in which the longitudinal position of the propeller in the water-cylinder, due to its rate of speed, determines by the connecting rack and segment the position of the valve in the steam-pipe.

Silver's momentum-wheel governor has a heavy revolving wheel, whose momentum acts upon the throttle-valve when any change occurs in the rate of motion of the engine. See also Marine-governor.

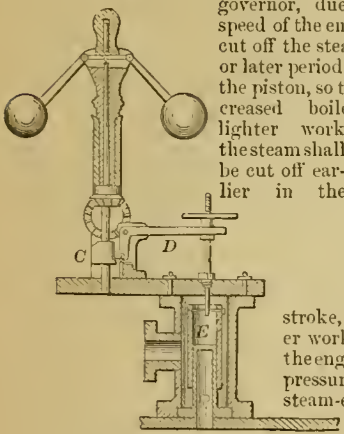
The *hydraulic governor* or *cataract* is the invention of Smeaton. A quantity of water is pumped at each stroke, and forced by counter weights through an orifice of a certain size. See Cataract.

Davis's governor (English) consists of a single hollow ball with a zone round it, having an opening through the bottom to admit of an upright spindle, attached to the ball by a joint in its center. One side of the ball and zone is made much heavier than the other, and consequently, when at rest or moving slowly, it hangs down; but when driven fast, the centrifugal force of the heavy side overcomes its gravity, and the zone assumes a nearly horizontal position. When this is the case, a small link inside the ball, jointed on one side of the axis, lowers the usual brass collar on the spindle, and shuts off part of the steam, till the diminishing speed allows the gravity of the zone to overcome the centrifugal force, and, the link being raised, the throttle-valve is opened under to admit more steam.

In Mosman's chronometric governor, one of two shafts has rotation directly from the engine, its speed being relative to that of the engine. The other shaft has motion from the engine, but its speed is regulated by a pendulum or balance-wheel. A variation in speed causes a longitudinal movement in the shaft which is connected to the governor valve.

2. (*Gas.*) A device which regulates the passage of gas from the holder to the mains, admitting it thereto in quantities determined by the rate at which it is used. The pressure in the mains determines the area of the opening through which the gas enters. See Gas-governor.

Fig. 2270.



Governor Cut-off Valve.

Gov′ern-or Cut-off. An automatic arrangement in which the acceleration or retardation of the motion of the governor, due to changes of speed of the engine, is made to cut off the steam at an earlier or later period of the stroke of the piston, so that with the increased boiler-pressure or lighter work the steam shall be cut off earlier in the stroke, and when greater work is imposed on the engine or the steam-pressure flags, the steam-cylinder shall receive steam from the boiler during a larger proportion of the stroke of the piston.

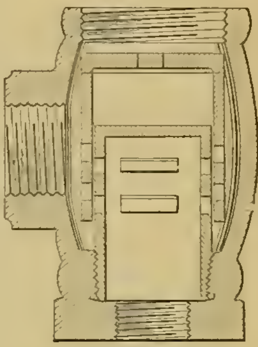
The combination of the governor with a cut-off valve-gear was first published in the "Repertory of Patent Inventions" for 1826, as the invention of James Whitelaw.

There are many forms of this device, and the applications are made to slide and to puppet valves. In the illustration it is shown as applied to a cylindrical valve. The variable cam *C* on the stem which is raised or depressed by the vertical motions of the governor-balls makes two revolutions to each stroke of the engine. The two distinct fields of the cam have different radii, and act upon the short arm of a bell-crank lever *D* connected at its other end to the stem of a balanced cylinder-valve *E*, which governs the admission of steam to the cylinder.

Gov′ern-or-valve. 1. A valve in a steam-pipe operated by the governor to vary the area of steam, opening according to the rate of moving, and consequently the requirement of the engine; the object being to maintain a uniform rate.

2. A governor cut-off is an induction-valve in a steam-chest, so connected to the governor as to be influenced in its throw by the speed of the latter. When the governor runs at accelerated speed, the period of induction of steam is at the shortest, and the steam is used expansively. When the rate is depressed, the steam induction-port is kept open for a longer time. This variation in the action of the valve is automatic, and derived from the governor. See Governor.

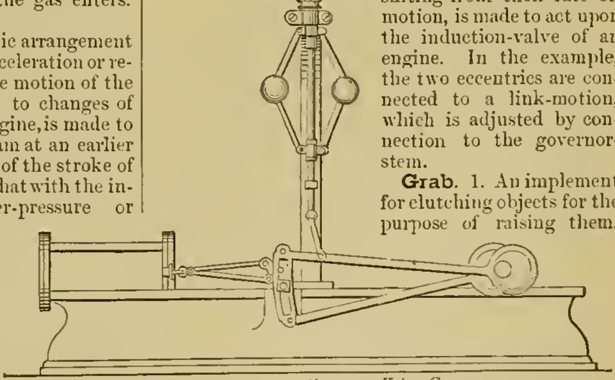
Fig. 2271.



Governor-Valve.

Gov′ern-or-valve Gear. An arrangement of parts whereby the position of the governor-balls, resulting from their rate of motion, is made to act upon the induction-valve of an engine. In the example, the two eccentrics are connected to a link-motion, which is adjusted by connection to the governor-stem.

Fig. 2272.



Governor Valve-Gear.

Grab. 1. An implement for clutching objects for the purpose of raising them. The term is specially applied to devices for withdrawing pipes, drills, reamers, etc., from artesian, oil, and other wells which are drilled, bored, or driven.

Two forms are shown: one has a pair of serrated jaws, which embrace the pipe or rod and bite upon it when the grab is lifted.

In the other form, the serrated jaws of the hollow cylinder are driven down upon the tool to be extracted, and by their inclined rear faces and locking collar grasp the same when the grab is lifted. To detach the grab, the collar is lifted by the hook.

Fig. 2273.

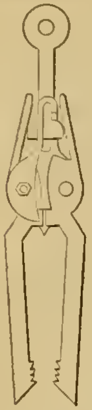
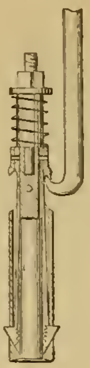


Fig 2274.



Grabs.

2. A large East Indian coaster, two masted, with a prow stern, and of from 150 to 300 tons' burden.

Grade. The inclination from the horizontal of a portion of a road or railroad. It is expressed in degrees, in feet per mile, or as a foot in such a distance; as, —

A grade of 3°.
A grade of 35 feet per mile.
A grade of 1 foot in 240. See Inclined Plane.

Gra'di-ent. (*Civil Engineering.*) The inclination of a slope.

Gra'di-ent-post. 1. (*Railroad Engineering.*) One placed by the side of the track, at a change of grade, carrying a board slanted to the slope and indicating in figures the grade in feet per 100, or otherwise.

2. A stake set in the ground and marked to indicate the proper hight of an embankment or of road metal at that point.

Gra-dine'. A toothed chisel used by sculptors. See Marteline.

Grad'ing-in'stru-ment. A level with an alidade, a transit or other sighting instrument, by which the angle of inclination of a slope may be measured, or a row of stakes driven to mark a given gradient.

Grad'ing-plow. One used for breaking up soil or plowing down banks, in order to fit the earth for being scooped up by the earth-scraper, and thereby deported.

Grad'ing-scrap'er. A large two-handled shovel drawn by a pair of horses and used as an earth-scoop for raising and removing loosened earth. It is used in road-making, scooping out beds of canals in certain situations, and otherwhere when the soil is suitable and the distance where it is to be deposited is not too great. See Earth-scraper.

Grad'u-at-ing-in'stru-ment. The work of graduating or dividing instruments of precision, though now very generally performed automatically, was formerly effected entirely by hand, by stepping off the successive divisions of the scale or circle, or by successive bisections of a line or chord. This latter naturally suggests itself with regard to a line, but with a circular arc the case is different; there, if it is desired, as is universally the case, to preserve the division into degrees, after the radius has been applied six times to the circumference, giving arcs of 60°, the farther subdivision requires trisections and even divisions into fifths, operations which are very difficult to perform in practice without the aid of very accurately constructed mechanism.

Roemer, in constructing a circle, decided rather to rely on stepping-off arcs of about 10°, and applying a subsequent correction for any discrepancy which should exist between the number actually laid down and that which should be contained in a quadrant of the circle. Dr. Hooke proposed the employment of an endless screw for dividing the edge of his quadrant, and this was actually used by Tompion in graduating Flamsteed's sector, probably under the supervision of Hooke.

Graham, who attained great reputation as an instrument-maker as well as clock-maker, adopted the principle of continuous bisections by means of a beam-compass. In the instruments constructed by him for Halley and Bradley, the arc of 60° was divided into 64 parts, making 96° instead of 90° to the quadrant. It was deemed preferable to make the proportionate correction on each angle, rather than to trust to the uncertainty of a division to thirds or fifths.

Bird, 1750, subsequently improved the system by constructing scales of equal parts, enabling him to preserve the division of 90° by successive bisections. His manual skill and care procured him merited reputation as a maker of accurate instruments.

Ramsden followed with his dividing-engine, 1766, the general principles of which, variously modified and improved by Troughton and others, are still employed in the construction of like instruments.

In this, a horizontal wheel, turning on a vertical axis, has a toothed edge, which is advanced a certain amount, say 10' of arc by each revolution of an endless screw with which it gears. The screw is turned by a treadle, the connecting mechanism being such that it may be adjusted to turn a whole revolution or any desired part of a revolution by a movement of the treadle.

For this invention he received a reward of £600 from the British government, on condition of executing the divisions on the instruments of other makers at a fixed price for each instrument. An instrument of this kind, by Troughton & Sims, is in the Coast Survey Building, Capitol Hill, Washington.

Hindley, 1740, had invented a dividing-engine, upon which this of Troughton is said to have been based. It also served for cutting the teeth for clock-wheels. See also Dividing-engine.

In addition to original graduation by the beam compass and engine, the dividing of a scale or a circle is performed (and this is the most common practice with regard to ordinary instruments) by means of a *dividing-plate*, which is itself originally graduated with great care. This consists of a circle carrying a pivoted straight-edge, and is fixed to and concentric with the circle to be divided. The straight-edge is moved, step by step, a distance, 10' or 15', indicated on the dividing-plate, and at each move a clean straight cut is made in the limb of the instrument being graduated. The knife has one flat side and somewhat resembles a graver, but is drawn toward instead of being pushed from the artist. At each degree the marks made are longer, their length, and that of the smaller divisions, being bounded by concentric circles previously described on the limb.

Froment invented a machine, driven by rotary electro-magnets, in which the object to be graduated was slowly and intermittingly pushed forward by a screw, while a fine steel or diamond point was automatically caused to make a cut at each cessation of the feeding motion. He thus succeeded in crowding 25,000 lines, with distinct and equal intervals between them, within the space of an inch. Nobert succeeded in ruling more than eight times as fine. See NOBERT'S TEST-PLATES.

Whitworth has graduated micrometers by which the almost inappreciable quantity of one millionth of an inch can be measured. See DIVIDING-ENGINE; MEASURING-MACHINE.

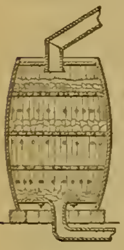
Grad'u-a ted-bot'tle. One having horizontal marks blown, pressed, or cut on its side to indicate quantity of contents at given levels. Sometimes the stopper is hollow, forms a cup, and has graduations for doses of certain amounts.

Grad'u-a'ted-cup. A medicine-cup, on whose sides are marks to indicate quantities at given levels. If of glass, they are usually impressed in the mold; if of porcelain, they are painted on the ware before burning.

Grad'u-a'ted-glass. A tube with a foot, and with horizontal marks at varying hights to indicate quantity of contents. A *measuring-glass.*

Grad'u-a'tor. An apparatus in which a solution is allowed to trickle over a large extent of surface, during which it is exposed to a current of air.

Fig. 2275.



Graduator.

This is adopted in the salt-works of Montiers, in the Tarantaise, Switzerland, where brine having 1.83 per cent of saline matter is condensed to such a degree of saturation as to be profitably evaporated by boiling. It is trickled over fagots of thorns placed in frames, and acquires a density of 22 per cent.

Another plan is to let it trickle over suspended ropes upon which it crystallizes and is broken off. The ropes last twenty-five years; the fagots, seven years.

Vinegar is manufactured by exposing a large surface to oxidation in a similar manner, the cider or alcoholic solution being suffered to trickle through a vat filled with beech shavings, through which a current of air is simultaneously passed.

Wort is cooled by trickling it over pipes through which a stream of cold water is continuously passed. (See BEER-COOLER.) In De Grand's condenser the saccharine juice is passed over a succession of steam-heated pipes, in order to condense it before reaching the vacuum-pan. See CONDENSER.

Graft'ing. 1. (*Carpentry.*) A scarfing or endwise attachment of one timber to another, as in attaching an extra length or false pile to one already driven.

2. (*Nautical.*) The tapering of the end of a rope; usually covered by weaving yarns around it.

3. (*Husbandry.*) The placing of a scion of a particular variety of tree or shrub in a stock of its own or a closely allied species.

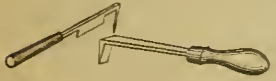
4. (*Surgical.*) The transplanting of a portion of skin to a denuded surface.

Graft'ing-chis'el. (*Husbandry.*) One for splitting a stock for the insertion of a scion.

Graft'ing-knife. A knife having a blade for splitting a limb and a wedge for opening the cleft for the insertion of the scion.

It is used in connection with a mallet.

Fig. 2276.



Grafting-Knife.

Graft'ing-saw. A tenon-saw for cutting off stocks for grafting. A *pruning-saw.*

Graft'ing-tool. A very strong spade; much curved, used in digging canals.

Graft'ing-wax. Rosin, 6; beeswax, 1; tallow, 1; melted together, to be used warm when grafting indoors. Rosin, 4 or 5; beeswax, 1½ to 2; linseed-oil, 1 to 1½, for outdoor work the proportions varying with the season and temperature. French recipe: Black pitch, 28; Burgundy pitch, 28; beeswax, 16; grease, 14; yellow ocher, 14.

Melt 4 parts beeswax; 1 part Canada balsam (balsam of fir); pour while hot on thin paper, so as to cut in strips for convenient use; a little vermilion added keeps insects from the scion.

Another grafting composition used by nurserymen is clay tempered with water, to which a little linseed-oil is sometimes added.

Graille. A *single-cut* file, or *float,* having one curved face and a straight one, used by comb-makers. See COMB.

Grain. 1. (*Weight.*) The unit of weight in the English system. 7,000 grains make one pound avoirdupois, and 5,760 grains one pound troy, or apothecary's weight. See POUND; UNIT.

2. (*Painting.*) A style of painting in imitation of the natural *grain* of wood.

3. The *hair* side of skin; in contradistinction to the *flesh* side.

4. (*Dyeing.*) Formerly, a red dye prepared from the *coccus* insect, or *kermes.* Now applied to a firm dye as one applied thoroughly; in the *wool,* not in the *web.*

5. The direction of the fibers in wood, etc., and of the strata or cleavage in stone, slate, etc.

Grain-bin. A box or a compartment in a granary or elevator in which grain is stored. In the large buildings for trans-shipping and storing grain, and known as *elevators,* the apartment at the top of the building into which the grain-cups discharge has distributing-pipes to the various bins, and these have funnel-shaped bottoms and valves for discharging their contents. See ELEVATOR.

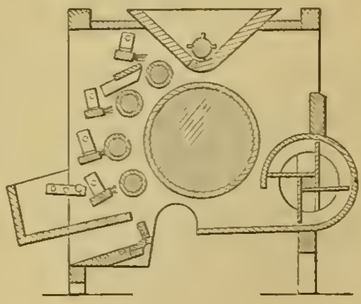
Grain-bind'er. An attachment to a harvester for binding a gavel into a sheaf. See REAPER.

Grain-bruis'er. The grain-bruiser is for mashing grain for feed, to render it more digestible. It does not amount to grinding, but crushes the kernel, corn, or oats, and puts it in a better condition for feed, for obvious reasons which need not be explained here. It is a very common practice in England, and will be here when economy is much studied. A *bruising-mill.* See GRINDING-MILL.

The machine has two iron rollers of differing diameters, which are turned by connecting cog-wheels of the same size, so that a rubbing is added to the crushing action. A fluted roller below the hopper receives the grain from the hopper and feeds it to the rolls. See OIL-CAKE BREAKER.

Grain-clean'er. 1. A machine in which wheat, oats, rye, and barley are separated from their chaff,

Fig 2277.



Grain-Cleaner.

dust, and pieces of straw, — the result of the thrashing operation. A FANNING-MILL; a WINNOWING-MACHINE (which see).

2. The shoe or cleaning portion of a thrashing-machine which acts after the thrasher and the straw-carrier. See THRASHING-MACHINE; SEPARATOR.

3. A machine in which grain is rid of cockle, garlic, etc., which are so nearly the size and weight of the grain that the size of mesh and strength of blast of the fanning-mill are ineffective. Fig. 2277 shows one form, in which the cylinder has a hard periphery which is held in contact with the smaller rollers by springs; the latter have soft surfaces, which catch the cockle, garlic, etc., and carry it away to be removed by brushes and separately discharged, while the dust is blown away by a fan.

4. A machine in which grain is rubbed, brushed, and blown to remove smut and dust. See SMUT-MACHINE.

Grain-con-vey'or. A series of cups on an endless band, an archimedean screw, or a blast of air to carry grain in a conductor from one place to another, in a *thrasher*, *grain-cleaner*, *smut-mill*, *mill*, *warehouse*, or *elevator*.

Grain-cra'dle. A light, four-fingered frame attached to the snath of a grain-scythe so as to catch the cut grain and allow it to be laid evenly in a swath.

Our four-fingered grain-cradle, whose post is braced by rods, and whose swath has a single nib for the right hand, seems to have originated in France; Loudon (1844) speaks of it as an ordinary tool in Normandy.

Grain-damp'er. A device for applying steam to grain to scald the bran and facilitate the process of decortication. A jet of steam entering a tube where the grain descends a series of inclines is a usual method.

Grain-drill. A *grain-drill* may sow one or more rows of seed, but a *drilling-machine*, by common consent apparently, is adapted for "sowing seed in equidistant rows, on a flat surface; on the top of a narrow ridge; in the interval between two ridges; or in the bottom of a common furrow. Small grain, when drilled, is usually sown in the first of these ways, turnips in the second, and peas and beans in the third and fourth." — LOUDON.

The first notice we find of a grain-drill is in that repository of the wonderful, — China. The Chinese machine is a wheelbarrow with a hopper for the seed, and three spouts, twenty-eight inches long, by which the grain reaches the ground; it thus drills three rows at once.

It appears from a communication to the British Board of Agriculture, that a rude sort of grain-drill has been in use in India from time immemorial. It is a drilling hopper attached to a plow so as to deposit the seed in the furrow.

The first notice of a European grain-drill is one invented by a German, and presented to the court of Spain in 1647. The same drill attracted the attention of the Earl of Sandwich, who sent one to England. Evelyn, who died in 1706, speaks of it as a machine of great merit, and the invention of a Spaniard, Don Joseph de Lescatello. Worlidge, in his "Husbandry," published 1669, also recommends it. It was fastened to the tail of a plow, and dropped the seed in the furrow. It was regarded as a curiosity merely, until a man appeared who was able to appreciate it.

The system of drill husbandry of Britain is the invention of Jethro Tull, a farmer of Berkshire, England, who was an original thinker and innovator. He introduced his system in 1701, and published his "Horse-hoeing Husbandry" in 1731. His special object in drilling was to put the plants in rows, which would allow them to be hoed by machinery. He brought brains and money to the scheme, and impoverished himself, being rather too far ahead of his time. As Loudon observes, he "had very few followers in England for more than thirty years." He died soon after the publication of his book, and his son died in a debtors' prison, when such things were. Not so very long ago.

Jethro Tull's first invention was a kind of plow, with drill attached, for sowing wheat and turnips in three rows at a time; it consisted of two seed-boxes with a colter attached to each, and following each other; behind them followed a harrow to cover in the seed. His object in having two separate deposits of seed, and at different depths, was that they might not sprout at the same time, and so perhaps escape the ravages of the fly; he also invented a turnip-drill.

About 1790, Baldwin and Wells of Norfolk, England, contrived several ingenious improvements to the machine, the first of which was in making a sliding axletree, by which the carriage-wheel could be extended when necessary to the width of the stitches (lands), and so enable another box with cups and more colters to be used. A drill containing fourteen colters could be thus enlarged to contain eighteen, or even twenty.

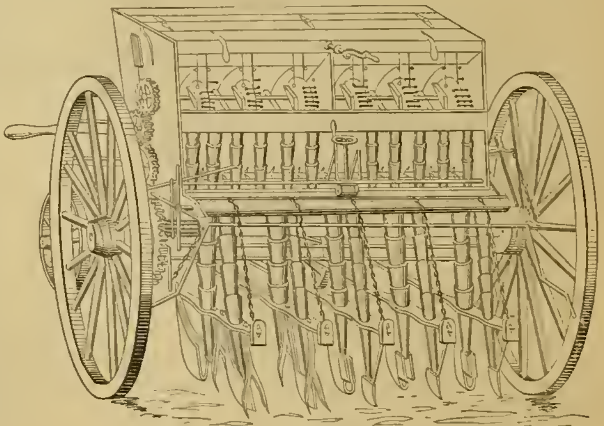
They also constructed self-regulating levers, to which the colters were attached; by hanging each colter on a separate lever, each lever swinging by an ordinary hinge-joint, and having a movable weight at the outer end to press the colter into the soil to the required depth.

After Tull, the machine was much improved by James Cooke, a clergyman, of Lancashire, England; his improvements have been adopted in almost all of the subsequent machines used in English husbandry.

Mr. Ransome states: —

"The seed-box is of a peculiar shape, the hinder part extending lower than the forepart. It is di-

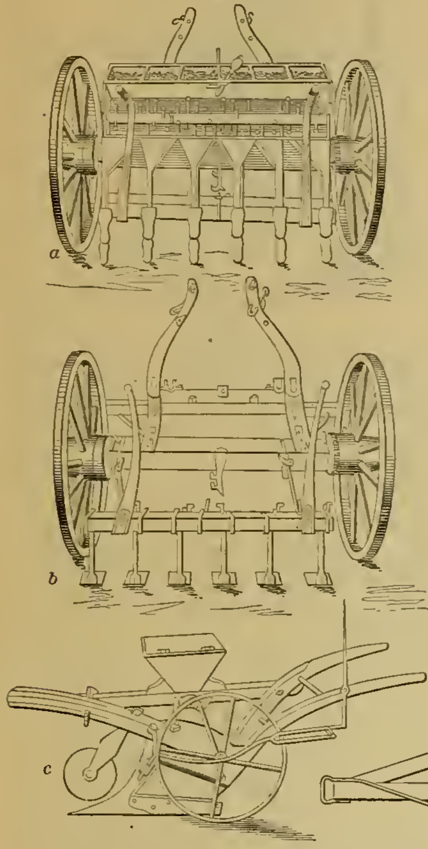
Fig. 2278.



English Grain-Drill.

vided by partitions, and supported by adjustable bearings so as to preserve a regular delivery of the seed, while the machine is passing over uneven ground. The feeding cylinder is made to revolve by a toothed wheel, which is fixed on each end of the main axle, and gears with other toothed wheels on each end of the cylinder; the surface of the cylinder is furnished with a series of cups, which revolve with it, and are of various sizes, according to the different seeds intended to be sown. These deposit the seed regularly in funnels, the lower ends of which lead immediately behind the colters, which are connected by a beam so as to be kept in an even line, and are capable of being held out of working, when desired, by a hook and link in the center. The seed, as it is deposited, is covered in by a harrow fixed on behind. The carriage wheels are larger than usual, by which means the machine is more easily drawn over uneven ground, and the labor of working is reduced."

Fig. 2279.



Combined Drill and Horse-Hoe. Bean-Drill.

Garrett's grain-drill (English) is adapted for performing all the various operations of seeding and manuring the land. All kinds of grain and seeds may be deposited at any required distances apart, and at any depth, either with or without compost or artificial manures.

They are constructed of various widths, and made to deposit the seed in rows from six to fifteen in number, and to suit all descriptions of land, whether ploughed flat or in ridges. The corn and manure are sometimes sown through the same delivery-tubes, but it is better when double tubes and colters are adopted, as the seed is then buried two or three inches deeper than the manure (as before described), and a portion of mold placed between the two. The boxes are suspended on a center in the middle of the machine, and may be elevated or depressed, at either end, by means of a lever, so as to keep them at all times in a horizontal position, and to insure a regular delivery of both on hilly as well as on flat lands. This arrangement admits of the barrels, which deliver the manure and seeds, being driven by gear at the ends of the boxes in the usual way, thus avoiding all unnecessary complication.

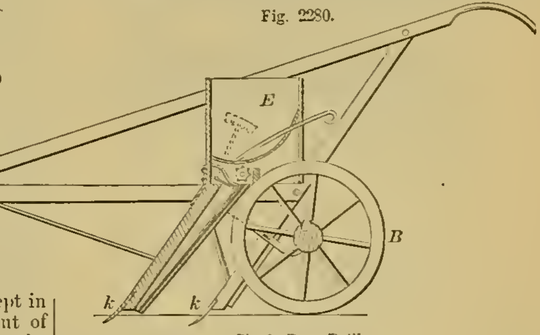
Hornsby, of England, was the first to apply india-rubber tubes as grain-spouts in place of the cumbersome tin cups.

Cooke's drill and horse-hoe *a b* (English) is a convertible machine, the seed-hoppers, shares, and grain-conductors being attached when required. When the crop is to be tended, any kind of share or colter is substituted for the seeding apparatus, as, for instance, the hoes of the illustration. These are attached to the beam previously occupied by the furrow-openers, and may be made to follow with exactness the intervals between the rows of growing plants. The beam is attached by a parallel arrangement to the carriage, and has a pair of handles by which it is swerved laterally to maintain the straight line if the horse deviate. The beam may be raised, and hooked up so as to keep the shares out of the ground during transportation or in turning.

The English bean-drill *c* draws a furrow in the prepared soil and sows a row at the same time. The wheel regulates the depth of the furrow, and a lever throws the drill out of gear when turning at the end of the land.

Fig. 2280 is a form of hand-drill, mounted upon a stock resembling a single-shovel plow, and resting upon a wheel; forward is the hollow tube shod with a share *k*, and leading the grain from the box *E*. A share *k*, following, turns a furrow upon the sown grain, and the wheel *B*, following, compacts the soil upon the seed.

Fig. 2280.

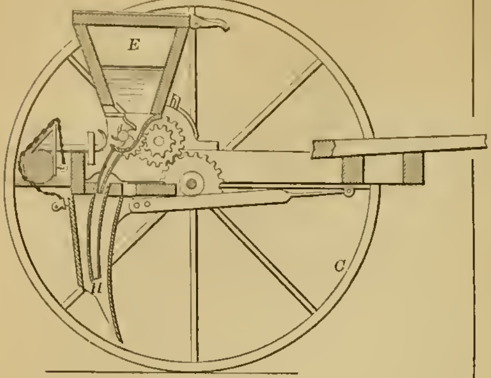


Single-Row Drill.

Fig. 2281 is a vertical transverse section of the usual American grain-drill, which is drawn by a pair of horses, and has a gang of shares in one or two banks; some varieties of this drill have a capacity for changing to a single or double bank drill.

In the example, the feed-wheel at the bottom of the grain-box *E* is driven by gearing from the ground-wheel *C*, and discharges into india-rubber spouts which lead the seed into and through the hollow share *H*.

Fig. 2281.



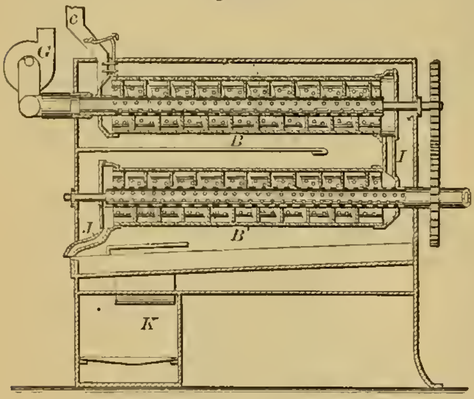
Grain-Drill.

Grain-dry′er. An apparatus or machine in which damp grain is dried, or grain in ordinary condition is kiln-dried to fit it for ocean shipment.

There are many forms of the device, which generally agree in that they afford means for exposing a shower of grain to a current of highly dried and heated air. The following kinds may be cited, and it must be understood that there are many varieties and modifications of each.

1. The *conveyor* system, in which the grain from spout *c* passes consecutively through the cylinders *B B′*, in each of which is a rotating screw conveyor driven by cog-wheels and having for axes hollow perforated tubes, through which the damp air passes from the grain, being drawn by the exhaust fan *G*. The cylinders connect by the spout *I*, and the lower one discharges by the spout *J*. The heated air from furnace *K* rises into the chamber above and surrounds the cylinders.

Fig. 2282.

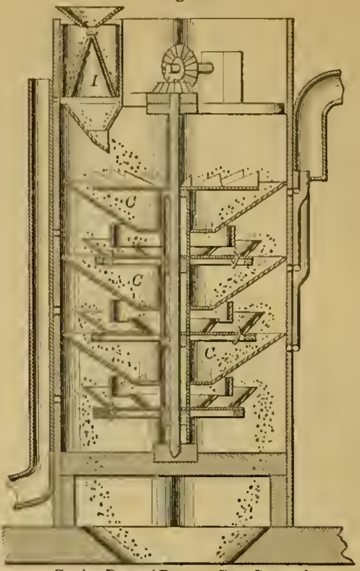


Grain-Dryer (*Conveyor System*).

2. The *revolving-cup* system. In the example the grain enters upon a heated cone *I*, and thence passes to a revolving flanged disk which distributes it to be again collected by the hopper *C*, fed to another disk, and so on down through, in descending series, to the discharge-spout. A current of heated air ascends through the chamber and envelops the grain at all times.

3. The *zigzag-incline* system, shown at *A* (Fig. 2284). The grain descends from a hopper and is shifted over from side to side by the alternate inclines, which are perforated plates in a flue occupied by an upward current of heated air.

Fig. 2283.



Grain-Dryer (*Rotary-Cup System*).

4. The *annular drum system B* (Fig. 2284) consists of a vertical double cylindrical chamber with conical ends. The space between the inner and outer casing is the one traversed by the grain, which enters at the apex of the upper cone and departs at the apex of the lower one. The inner and outer casings are all perforated with holes, about 2,300 to the square foot, and the punching being from without, inward, the slight roughness has a tendency to turn the grain which rubs against the protuberances, giving a sort of stirring action to the grain, and aiding the exposure of its whole surface to the stream of heated air. The heat is generated by a stove in the interior of the chamber, and the heated air passes through both casings and through the body of grain contained between them. The apparatus stands upon legs so as to elevate the discharge opening that the falling grain may be received into sacks or grain-barrows for shipping or binning.

A damper or valve at the discharge opening regulates the area of the exit orifice, and thus governs the speed of the passage, determining thereby the time which the grain shall occupy in its transit, according to its condition and the necessities of the case.

5. The *spiral-flue* system *C*, which consists of a long spiral tube traversed by a flue from a stove. The sides of the tube are full of fine perforations, and the draft is upward between the two surfaces and outward through the perforations, carrying the moisture from the grain, which descends in a shower between the flue-pipe and the perforated casing.

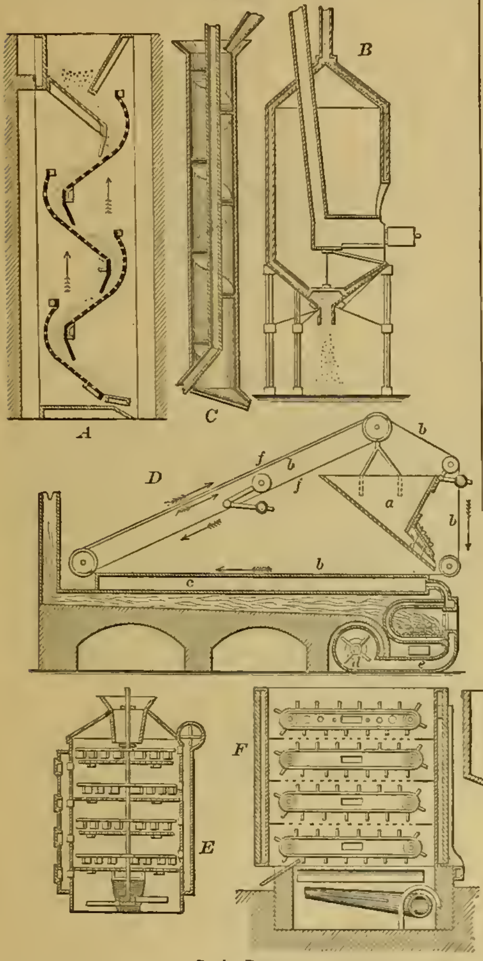
6. The *traveling-belt* system *D* consists of a furnace air-box and traveling-belt which receives its grain from a hopper. Grain from hopper *a* falls on to belt *b*, which travels over the grated top of the box *c*, which is heated by air from fan *d* and tubes *e* which form the box and basket grate of the furnace. After passing the length of the box the grain is caught between the belts *b* and *f* and returned to the hopper for a repetition of the operation, or as it descends is intercepted by a spout.

7. The *rotary-drum* system, in which an inclined cylinder of wire contains the grain which tumbles over and over, and eventually is discharged at the lower end of the cylinder, which rotates in a chamber heated by a furnace.

8. The *floor-and-scraper* system, in which grain passes from floor to floor, scrapers distributing and discharging it on and from the respective floors in the series.

E F (Fig. 2284) show two forms of this. In *E* the upright cylindrical chamber has a series of circular perforated floors, with alternate central and marginal discharge apertures. Rotary conveyors, alternately centrifugal and centripetal, convey to the apertures the grain which falls from floor to floor.

Fig. 2284.



Grain-Dryers.

In the other example *F* the grain is moved alternately to the right and left, over finely perforated plates, by the slats or endless chains which pass over the plates. Hot air from a blast or other means passes upward through the plates and grain. The grain drops from the end of each plate to the one immediately beneath.

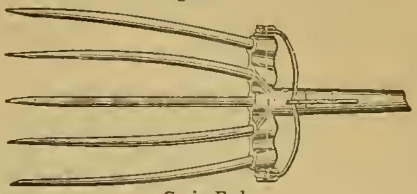
Grain'er. 1. The brush used in *graining* or imitating woods.

2. An infusion of pigeon's dung for giving flexibility to skins in the process of tanning. Also called *bate.*

3. A knife used by tanners.

Grain-fork. A light fork with long and curved tines, used for pitching gavels of cut grain on to a wagon when the straw is too short for convenient binding. A *barley*-fork.

Fig. 2285.



Grain-Fork.

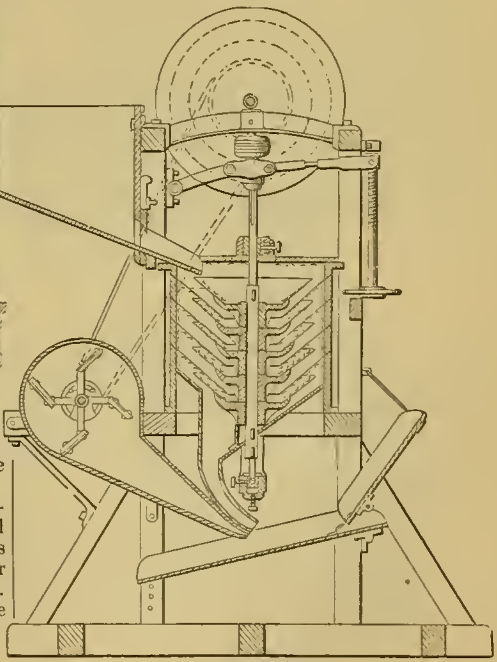
Grain-gage. A device for weighing grain. It has a measure of given capacity, and a scale beam which is graduated to give the weight in pounds and fractions of a measured bushel.

Grain-har'vest-er. A machine for cutting standing grain. There are many varieties, and the idea is as old as the time of Pliny, A. D. 79. In his time the plains of Gaul were reaped by a machine driven by one ox harnessed between shafts. The head of the grain was cut from the straw and fell into a large box which formed a part of the machine. See REAPER; CLOVER-SEED HARVESTER.

Grain-hull'er. A machine for taking the cortex or skin from grain, making hulled wheat, pearl barley, hominy, as the case may be. Known also as a *decorticator, debranning-machine, hominy-machine,* etc.

Wheat is slightly scalded with steam and then fed

Fig. 2286.



Grain-Huller.

between roughened surfaces in motion, or it is rubbed between stones or disks which are set at such a distance apart as not to grind it. In the example, inclined serrated plates are attached to the case of the machine and intervene between similar plates attached to the vertical revolving shaft. The grain is alternately ejected from the latter and returned by the former, and is thus subjected to the succession of rasping devices, and is eventually discharged at the bottom of the case and cleaned by a blast of air. See Cotton-seed Huller; Hominy-mill, etc.

Grain′ing. 1. (*Leather Manufacture.*) *a.* The process of rubbing leather with a board to *raise* the *grain*. The leather having been shaved to a thickness at the beam, and daubed, is hung up to dry, and is then folded, grain side in, and rubbed on the flesh side with a *pommel* or *crippler* to give the leather a granular appearance and render it supple. See Crippler.

The hide is then extended and rubbed on the grain side. This is termed *bruising*.

b. A process for giving markings to a surface of leather to imitate the wrinkled appearance of morocco, hog-skin, and some other leathers.

2. (*Painting.*) The imitation of the natural grain of wood by means of tools. Combs, brushes, and the corner of a folded rag, are used in making the various patterns.

3. (*Lithography.*) A mode of giving a certain texture to the face of a stone. One stone is laid upon another with a quantity of sifted sand of a given fineness, and, by a peculiar oscillation and gradual progression, the surface is cut into a set of fine prominences more or less deep and distant, according to the character of the work to be placed upon the stone.

Grain′ing-board. (*Leather Manufacture.*) *a.* A board on which leather is spread while being grained by the *crippler*.

b. A board with a surface impressed or engraved with a pattern, in imitation of the natural grain of some kind of leather, and used to confer the same appearance upon other leather by pressure.

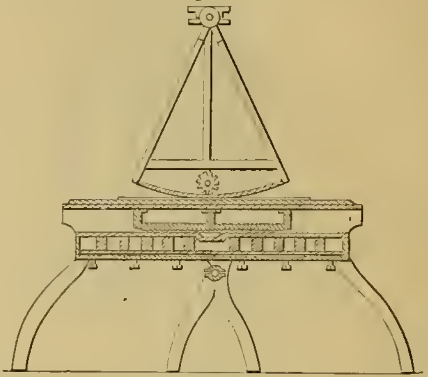
Grain′ing-ma-chine. 1. A roller with a pattern surface representing the grain of wood, and used to transfer the pattern in paint to wood. In the example (Fig. 2287), the roller is an elastic air-bag, which receives its paint from an endless graining-belt.

In the graining-machine for buckets the pail is placed on a block rotated by a winch, and the pattern roller is brought alternately in contact with the pail and inking-roller by the action of a treadle and weighted cord. The surface of the pattern roller is made in removable segments, so that the pattern may be varied in imitation of staves of different woods.

2. (*Leather Manufacture.*) A machine having rollers with raised, parallel, straight, or diagonal threads, which indent the goat or sheep skins and confer the wrinkled appearance to morocco leather.

In the example, the horizontal table vibrates beneath the swinging sector, whose surface has the grained pattern which is to be impressed upon the leather which is between the sector and the table. The graining is sometimes given by hand, by boards or rollers pressed upon the grain side of the leather.

Fig. 2288.



Graining-Machine.

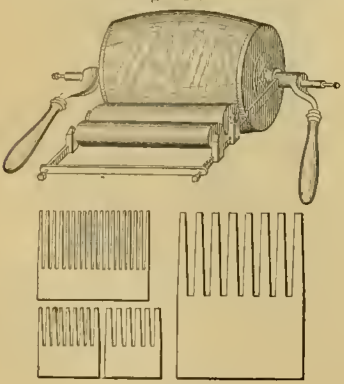
Grain′ing-tool. Hand-tools resembling combs (Fig. 2287), for imitating in painting the lines which represent the growths of timber. A light-colored coat of paint is allowed to dry and a darker coat laid over it. While this is yet damp, it is marked by the graining-tool, which removes some of the darker paint and leaves white stripes behind it. The graining-tools are of steel, horn, wood, or leather, are of different grades of fineness, and have varying numbers of teeth.

Grain-leath′er. 1. Dressed horse-hides.

2. Goat, seal, and other skins blacked on the *grain* side for women's shoes, etc.

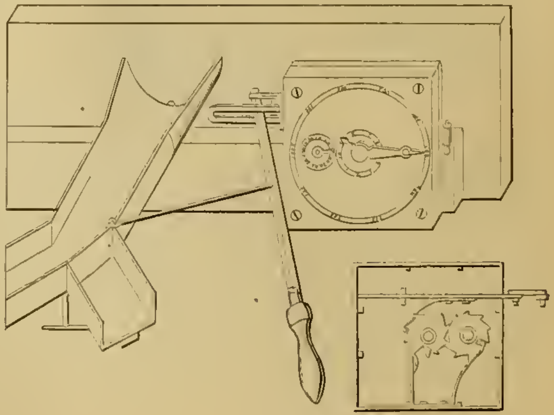
Grain-me′ter. A means for measuring grain,

Fig. 2287.



Graining-Tools.

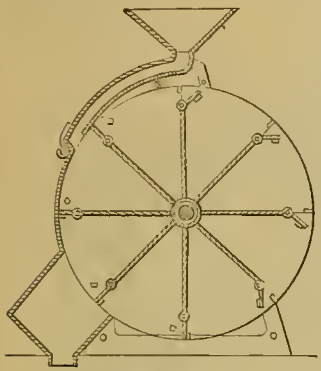
Fig. 2289.



Grain-Register.

sometimes by bulk, but more usually in the great grain markets of the United States by weight, as the bushel of grain of a given grade of quality has a legal weight. In the example, a measure is placed under each branch of the chute, and as the gate is moved to direct the grain into either branch the act is denoted by the register, which simply keeps count of the number of motions of the handle. This may be used on thrashing-machines and in filling measures from granaries, but is not so well adapted for the larger needs of the warehouse and elevator. (See ELEVATOR.) In these, a hopper is poised at the end of a graduated beam, weighted for a given number of bushels, say fifty. As the beam rises, the valve at the bottom of the hopper is pulled, the grain discharged, and the process repeated. Automatic registering devices may be used.

Fig. 2290.

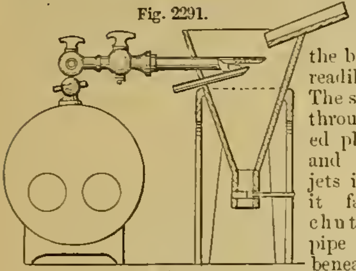


Grain-Meter.

In another form (Fig. 2290) the space between the disks is partitioned by radial divisions into receptacles for grain as it falls from the hopper; the spaces are successively presented for filling and discharging by the revolution of the shaft. The rotations of the wheel are registered by a system of wheels, like the gas-meter.

Grain-moist'en-er. A device for damping the cuticle of grain, in order to enable the bran to be more readily removed. The steam is forced through a perforated plate or shield, and is thrown in jets into wheat as it falls from a chute. A drip-pipe is placed just beneath the perforated shield and carries off the condensed steam.

Fig. 2291.



Grain-Moistener.

Grain-rake. 1. A rake used in raking grain in the swath into gavels for binding.

2. A rake used by one who rides on the reaper in raking gavels from the platform of the machine.

Grains. 1. A residuum of fiber and insoluble matters after infusion or decoction; as the *grains* of malt after the wort is decanted.

2. A harpoon with several barbs. A five-pronged fish-spear.

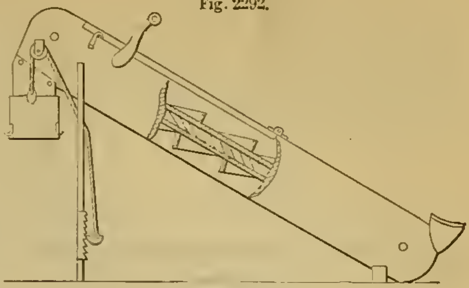
3. Prongs, as of a fish-spear or fork.

4. A *bating* solution of birds' dung, used in destroying the effect of lime, and in improving the flexibility of leather.

5. Pieces of sheet-metal, cast-iron, or tinned iron inserted into a mold for the purpose of supporting an accessory portion, such as a *core*, in position.

Grain-sack'er. A device for sacking grain. In the example, the grain is raised by an endless apron and buckets, and is discharged through an adjustable tube, to which bag hooks are attached. See BAG-HOLDER.

Fig. 2292.

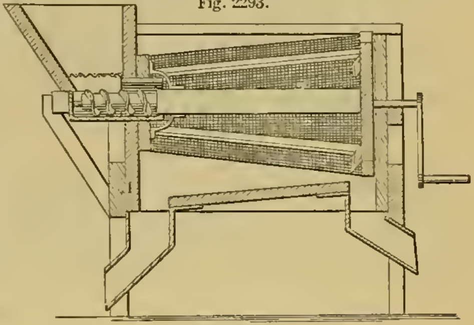


Grain-Sacker.

Grain-scour'er. A machine for cleaning grain. A *smut*-mill. A machine in which grain is rubbed and chafed, and eventually sorted into qualities by gravity and blast.

Grain-screen. A shaking sieve, or a rotating cylindrical reel of wire-cloth in which grain is sorted by quality, according to its ability to pass through the meshes of the sieve. The grain-screen is a part of every fanning-mill: it is also used in the *separator*, which is a thrasher and cleaner. It is also used as a means of cleaning grain from cockle, cheat, grass-seeds, and dust; especially wheat for seed.

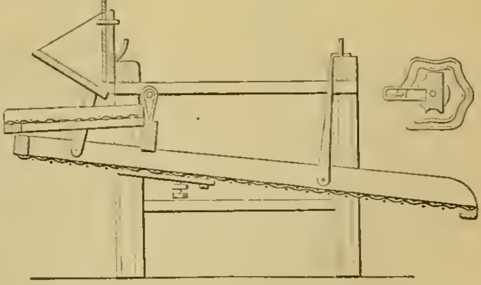
Fig. 2293.



Grain-Screen.

Fig. 2294 shows a reciprocating form of the device; the riddle and screen are suspended upon adjustable straps and have a very rapid motion communicated by means of a cam-wheel and lever. The riddle is agitated in the opposite direction to the screen.

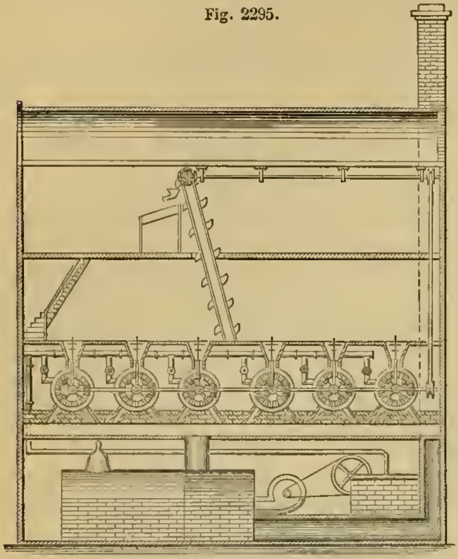
Fig. 2294.



Grain-Screen.

Grains-dry′er. An apparatus for drying the spent malt, known as brewer's *grains*, or other similarly sodden material. The illustration shows a regular plant for this purpose, consisting of a series of six cylindrical casings, with rotating paddle-shafts driven by bevel-gearing from a single shaft rotated by power from the engine. The casings are heated by steam-pipes, and the grains pass into one end of the cylinder and out at the other, being then elevated to the upper floor, where they are sacked. Grains are dried for feed, spent hops for manure, sprouted grains for malt. A fan drives furnace-heated air through the grains, the hot vapor passing out at the upper part of the cylinder.

Fig. 2295.

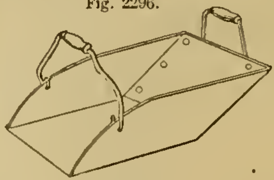


Grains-Dryer.

Grain-sep′a-ra′tor. A thrashing-machine. See Separator; Thrashing-machine; Grain-screen; Fanning-mill.

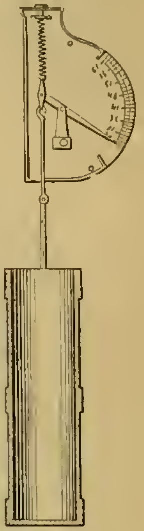
Grain-shov′el. One for handling grain in bagging, on the floor of a kiln, granary, or warehouse, or in the hold of a vessel where it is in bulk. In the example, the swinging handles are attached in positions to bring the weight of grain evenly on both hands to facilitate the shoveling of the same.

Fig. 2296.



Grain-Shovel.

Fig 2297.



Grain-Tester.

In the more usual form it is a scoop-shaped shovel.

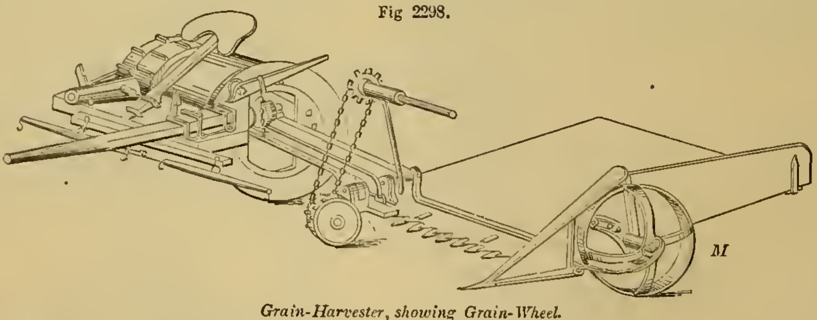
Grain-test′er. A means for weighing small quantities, as samples of grain. The cup has a known capacity, as a certain aliquot part of a bushel, and the divisions on the scale indicate the pounds which a bushel of the grain tested would weigh.

Grain-thrash′er. A machine for operating on grain in the sheaf to remove it from the straw. See Thrashing-machine.

Grain-tin. Crystalline tin ore. Metallic tin smelted with charcoal. Tin reduced from the loose grains of tin stone.

Grain-wheel. (*Husbandry.*) The wheel *M* of a harvesting-machine which supports the outer end of the finger-bar.

Fig 2298.



Grain-Harvester, showing Grain-Wheel.

Graip. A manure or potato fork.

Gran′a-ry. A bin or house for storing thrashed grain.

In the cradle of civilization, Egypt, the granaries were on a costly and unsurpassed scale. They consisted of buildings in which the bins were arranged in a double row of brick structures, like ovens.

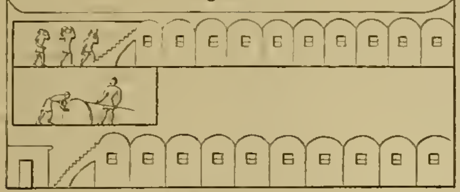
These were probably of adobe, and had two doors; an upper one through which they were filled, and a lower one through which the grain was removed. They were ascended by steps, as shown in the illustration, which is from a painting in the tomb of Rotei at Beni Hassan. The grain is measured and noted by attendant clerks, as shown in another painting.

Demosthenes tells us that, of the whole foreign importation of grain into Attica, one half came from the Scythians of the Euxine, and estimates its amount in ordinary years at 400,000 medimni = 600,000 bushels. The fertility of the soil and the habits of the people remain nearly the same, and the trade of England with Odessa, at the present time, is a counterpart of that which twenty-three centuries ago was carried on between Athens and the Scyths of the Pontus.

"The Greeks in former times [Strabo, A. D. 16] imported from the Chersonesus corn and the cured fish of Palus Mæotus. Leucon is said to have sent to the Athenians 2,100,000 medimni of grain from Theodosia (a town)." A medimnus was about 1½ bushels, English.

A Sicilian bushel of wheat in the time of Polybius (150 B. C.) was worth, in Cisalpine Gaul, Lombardy, and Piedmont, 4 oboli per bushel, barley 2 oboli. The obolus was about 3 cents.

Fig. 2299.



Egyptian Granaries.

The tavern price there for a good meal was ¼ obolus.

The granaries of the Romans were of several kinds, and were enumerated at 327. One kind was a building with heavy brick walls, and a hole in the roof through which it was filled. Another was a structure raised on wooden columns.

In Thrace, Cappadocia, Spain, and Africa, grain was laid up in pits lined with chaff. Caverns and cisterns were used in Palestine. A similar practice yet prevails in Tuscany.

Grand-ac'tion. A piano-forte action, in which three features are combined: 1, a *hammer* to strike the string; 2, a *hopper* to elevate the hammer, and then escaping therefrom leave the latter instantly to fall away from the string, independently of the position of the key; and 3, a *check* to catch the hammer and prevent rebounding.

Grande. (*Sugar Manufacture.*) The largest evaporating-pan of a battery.

Grand-pi-a'no. A harp-shaped piano, whose form is suggested by the varying lengths of the strings, the mechanism being introduced in the most effective manner regardless of the dimensions of the instrument, as in the square or cottage, where the motions are incommoded to bring the instrument within certain limits or proportions. See PIANO-FORTE.

Certain piano-forte movements are invented for and known as grand-actions.

The grand-piano has three strings to each note.

The *bi-chord* or *semi-grand* has but two strings to a note, but has the *grand* movement. The *cottage* or *boudoir* grand has shorter strings, and is less bulky.

The *grand square* has the movement of the grand in a square case.

The *upright* grand was set on end, and, being unwieldy, was superseded by the *cabinet*, in which the frame came down to the floor, long vertical rods transmitting the movement of the keys to the upper ends of the wires.

Gran'ite. A hard and durable silicious stone composed of quartz, feldspar, and mica conglomerated.

Gneiss has similar components, but is stratified.

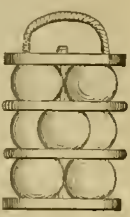
Gran'ite-axe. (*Quarrying.*) A stone axe for spalling granite.

Gran'ny's Knot. (*Nautical.*) A knot in which the second tie is across, differing from a reef-knot, in which the end and outer part are in line. See KNOT.

Gran'u-la'ted-steel. (*Metallurgy.*) Melted pig-iron is scattered by a wheel into a cistern of water, and thus reduced to fragments. These are imbedded in powdered hematite or sparry iron ore, and subjected to furnace heat. The exterior of the fragments become decarbonized, and thus reduced to the condition of malleable iron. The metal is made homogeneous by melting, and steel is produced.

Grape-shot. Spherical iron shot rather less than half the diameter of the bore of the piece for which they are intended, and put up in *stands* consisting of three tiers of three shot each; the stand has a circular cast-iron plate at top and bottom connected by a bolt and nut; two rings bind the tires together and keep them in place. Grape-shot are now little used, except with guns of the larger calibers, from 24-pounders upwards.

Fig. 2300.



Grape-Shot.

Quilted grape are formed by sewing the shot up in a sort of canvas bag, which is afterwards wrapped around with twine or cord, so as to form meshes; musket bullets put up in this way were formerly employed for blunderbusses, wall-pieces, and small artillery.

Grape-trel'lis. A structure on which grape-vines are trained. See TRELLIS.

Previous to 1547 (time of Edward VI.) grapes were brought from Flanders to England. The vine was introduced into England in 1552. The statements of the growth of the vine in Britain (time of Julius Cæsar) seem to lack confirmation. One of the largest vines in Europe is that of Hampton Court Palace, near London, the famous palace built by Cardinal Wolsey and given to Henry VIII. It is stated to have been planted in 1769, and to have produced 2,272 bunches of grapes in a season, weighing over 2,000 pounds; its stem being thirteen inches in girth.

Graph. Names ending in "graph" are as follows. The list is given for the convenience of those in search of a word: —

Actinograph.
Anaglyptograph.
Anemograph.
Areograph.
Auto-chronograph.
Auto-typograph.
Barograph.
Barometrograph.
Catagraph.
Cecograph.
Cerograph.
Chalcograph.
Chorograph.
Chromo-lithograph.
Chronograph.
Crytograph.
Curvograph.
Cyclograph.
Ectotypograph.
Eidograph.
Electro-chronograph.
Ellipsograph.
Embossed typograph.
Galvanograph.
Glyphograph.
Glyptograph.
Helicograph.
Heliograph.
Hyalograph.
Hydro-metrograph.
Hyetograph.
Hygrograph.
Ichnograph.
Kinograph.
Lithograph.
Magnetograph.
Marigraph.
Mechanograph.
Metallograph.
Metrograph.
Micrograph.
Noctograph.
Odontograph.
Omnigraph.
Optigraph.
Orthograph.
Paneiconograph.
Pantelegraph.
Pantograph.
Perspectograph.
Phonautograph.
Photogalvanograph.
Photograph.
Photo-lithograph.
Photo-metallograph.
Photo-zincograph.
Pianograph.
Polygraph.
Scenograph.
Sciograph.
Scotograph.
Seismograph.
Solograph.
Sphereograph.

Sphygmograph.
Stereograph.
Teleiconograph.
Thermetrograph.
Thermograph.
Vitreograph.
Xylograph.
Xylopyrograph.
Zincograph.
See also METER; SCOPE; TYPE.

Graph'ic-mi'cro-scope. A microscope provided with a reflector, which casts down the image upon a sheet of paper. The instrument has two reflectors, the second one of which is a prism, across the edge of which the eye observes the image, which may be traced by a pencil.

Graph'ite. A form of carbon occurring in nodules or foliated six-sided prisms, and used for pencils, for blacking stoves, for crucibles, and for lubricating. Graphite was supposed by the early chemists to be a carburet of iron, but it is now universally acknowledged that iron is only mechanically mixed with it, there being no chemical combination between them. It may have a trace of iron, but this is not essential. Its name, *graphite*, is derived from its use in writing and drawing. It is well known in the mechanic arts as *plumbago* and as *black-lead*, but the names have no relevance, as *plumbum*, lead, is not found in it.

It is a unique mineral, useful for many and widely different purposes in the mechanic arts. It was utilized as a lubricator in the immediate neighborhood of its natural deposits two hundred years ago, but was not widely used till within the past few years. It can hardly be exceeded as a lubricator, when finely pulverized, perfectly pure, and free from grit, — conditions which are absolutely necessary for this use. It has been mixed with clay for crucibles since the tenth century, but was not generally adopted till the foliated variety was utilized, in 1827, by an American, — the late Mr. Joseph Dixon of Jersey City. It was early adopted for crayons, and was found in use by the Aztecs when Cortez landed in Mexico. It is indispensable in the graphic arts, in the form of what are commonly called *lead-pencils*, the finest of which were formerly made in England from the granulated, pure graphite, taken from the celebrated Borrowdale Mine in Cumberland; but after that mine became exhausted the world was supplied with pencils made from the impure graphite found in Bavaria and Bohemia, purified for the purpose. Bavaria is well represented by the Messrs. Faber, whose pencils of all qualities are so well known. But recently the fine graphite found at Ticonderoga, in the State of New York, has been utilized for this purpose by the Dixon Crucible Company of Jersey City, and a fine quality of pencils produced, — the company having been awarded the Medal of Progress for them by the Vienna Universal Exposition, 1873.

Graphite is polymorphous, has a bright metallic luster, of a steel-gray color, something like that of molybdena, but darker, and the two are sometimes confounded by inexpert persons, both being sometimes formed in flexible laminæ; but the molybdena has none of the physical characteristics even of foliated graphite, except the similarity of color and form.

Molybdena has a sp. gr. of about 4, which is about double that of graphite. Nitric acid attacks molybdena, reducing it to a yellow powder, but does not affect graphite. Molybdena gives a yellowish green flame with the blow-pipe; graphite does not. Graphite in the blow-pipe flame burns away to carbonic acid, leaving but little ash, and, if pure, develops no odor. Molybdena deflagrates with niter much more violently than graphite. The formation of graphite most common in the pure state is that of laminated crystals, elongated at right angles with the sides of the vein, if not more than from four to six inches wide; but when the vein widens, the crystallization often radiates from numerous centers, and the whole formation is very beautiful; the foliated variety is equally valuable and more brilliant, but rare in any quantity; the acicular form of crystal is not apt to be as pure in the lump, but is useful for most purposes; the granulated variety, the purest of all, is of little use for crucibles, but, with suitable manipulation, produces the finest grades for electrotyping and fine lead-pencils, and is unequaled for lubricating. Pure graphite is absolutely free from grit, when pulverized and rubbed between the fingers, and the polish produced in the same way is instantaneous and very bright, being like a darker shade of polished silver. It is also found mixed with iron, rhombspar, and other forms of lime, the rock and earth in which the vein is carried, and many other foreign substances injurious for all the purposes for which pure graphite is needed. Lime, for instance, is fatal to graphite for crucible making.

It is very refractory in closed vessels, but combustible in air or oxygen at a high heat. It is infusible. The laminated and foliated varieties are difficult to pulverize, reducing to scales instead of grains, and if it is wanted very finely divided must be ground in water.

It is found in these varieties mainly in Ceylon, where it occurs in veins, carried in rock and kaolin; the lumps are removed and sent to market as they are, not being entirely pure, but sufficiently so for most purposes. It is found in many of our own States and in Canada, in veins and disseminated in quartz and other rock, from which it is separated by stamping in water and floating off the scales; but while this process, with care in the manipulation, produces the purest graphite for use in the arts, it has not so far been successful except at Ticonderoga, by the American Graphite Company. A large deposit of the granulated graphite was supposed to have been found in California, and a favorable report was made upon it by one of the European savants, but there is no real graphite in the mixture; it is a sort of carboniferous clay, deceptive in its physical characteristics. A good, compact, granulated graphite is found in Sonora, Mexico, and a specimen brought to us from Japan is of the same character; but the granulated graphite best and longest known to commerce is found in vast quantities in Bohemia and Bavaria. It is divided in water and floated, to separate it into grades, not being pure enough as it comes from the mines. It is cheap in price, but poor in quality for use in the arts, except for pencils after extensive purification. It is not very refractory, and is of but little use for crucibles, although long employed for want of better. It is useless for polishing, or for preservative paint, or for lubricating, and, having a very low conducting power, cannot be used to advantage for galvano-plastics. It resembles a weak, black clay in appearance, and has but two of the physical characteristics of true, natural graphite, these being the marking and the greasy feel when highly purified. There are large deposits of compact granulated graphite in Siberia, but they are so far from any means of transportation that only the deposit discovered by Mr. Alberti has as yet been made use of, and that is under contract to the Messrs. Faber of Stein, Bavaria, for pencils.

Natural graphite has a sp. gr. of 2.089 – 2.245. Artificial graphite forms on the inside of furnaces and retorts where coal is used for making gas; but it is so hard and harsh that it is not adapted to many uses, and has been utilized only for carbons for galvanic batteries by sawing it into the required shape. Graphite occurs in the primitive and frequently in the transition rocks, in granite, gneiss, quartz, feldspar, kaolin, mica-slate, schist, crystalline limestone, and occasionally in the coal formations. It is generally in veins, but in the quartz it is often in disseminated scales. In Ceylon it is in well-defined veins. In the United States and Canada it occurs in irregular veins and in nests, patches, and pockets, the only reliable veins known being those of the American Graphite Company at Ticonderoga, New York.

Graphite is the purest carbon next to the diamond, but requiring a higher heat to burn it, and leaving a reddish ash if the specimen contains a trace of iron, aś most of it does. It is not affected by acids or alkalies. If the well-known process of washing is not sufficient to purify the graphite to the required degree, then either of the following methods may be adopted.

Method of Professor Kerl of the Royal School of Mines, Berlin. Heating to a red heat in a retort will change the iron oxide into metallic iron, and sulphate salts into sulphides of metals, for the extraction of which employ hydrochloric acid.

Professor Loewe heats the graphite to a red heat, with double the quantity of carbonate of potash, soda, or hydrate of potash; he extracts the formed potash salts, especially the silicate of potash, with boiling water, heats the residue gently with dilute nitric or strong hydrochloric acid, filters, and washes out with water and dries. Repeating this process three times yielded an entirely pure graphite.

Professor Brodie obtains a graphite almost pure, 99.96 carbon, by boiling graphite with acid, and heating with hydrate of potash. If the graphite is pulverized, mix it with $\frac{1}{4}$ of its weight of chlorate of potash, and double the weight of the graphite of concentrated sulphuric acid; heat the mixture in a water-bath; a little fluoride of sodium is added to remove silica, and the whole carefully washed, dried, and heated to a red heat.

Graphite may also be purified sufficiently for most uses by treating it with 4 parts sulphuric and 1 part nitric acid, washing and drying. See CRUCIBLE; PENCIL.

These points are taken from the manuscript of a work on graphite, now in course of preparation, by Orestes Cleveland, President of the Dixon Crucible Company, of Jersey City.

Graph-om'e-ter. A surveying instrument for taking angles. A *demicircle.*

Graph'o-type. A process invented by Hitchcock, in which a zinc plate is covered with a thick coating of oxide of zinc, placed under an hydraulic press to made a perfectly plain and hard surface, the design drawn upon the oxide with an ink consisting of a chloride of zinc and a menstruum. This produces as to the parts where the ink touches a very hard material, the oxychloride of zinc. The remaining surface is rubbed away by brushes, velvet, and the fingers, leaving the lines in relief to be printed from.

The process is more used in England than in this country, though it is an American invention. The English illustrated paper, the "Graphic," is understood to be largely illustrated by this means.

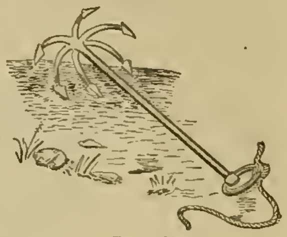
In one form of the process the adhering material is solidified by immersing it in a solution of silicate of soda.

Grap'nalls. A heavy tongs used for dragging logs, chunks, stones, etc. See GRAPPLE.

Grap'nel. 1. A small anchor having five or six hooks arranged in a circular manner on the end of the shank, which terminates in a ring to which the cable is attached. It is used by small vessels and boats, and sometimes as a kedge in warping or hauling.

2. An implement for recovering tools, etc., dropped into a bored shaft; or for breaking and raising the axial stem left by the annular borer. See GRAB; GRAPPLE.

Fig. 2301.



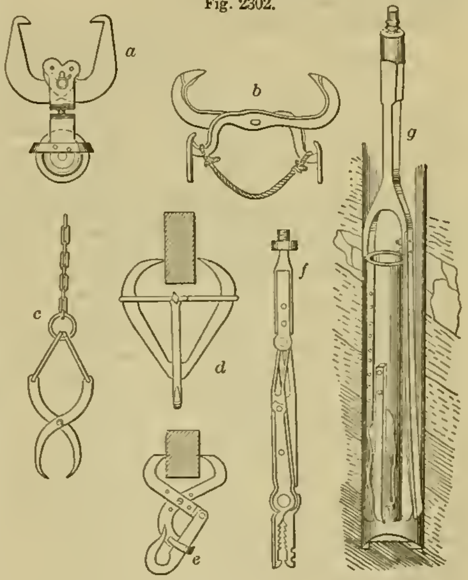
Grapnel.

Grap'ple. 1. A hook for securing one vessel to another or one object to another. Used in holding vessels in engagement while boarding, or in a more peaceable way to hold them associated while loading, unloading, or transferring cargo. A *grappling-iron.*

2. A grasping tongs, used in various shapes and for many purposes.

a is a form used to grasp on each side of a rafter or beam to form a means of suspending hay-hoisting tackle. The claws form a toggle which is clasped against the wood by the weight suspended from the sheave.

Fig. 2302.



Grapples.

b is somewhat similar, the claws being moved in by the weight suspended from the bight of the cord.

e is for ice-tongs or clutching other objects to be lifted.

d has a pair of toggle-bars jointed to the claws.

e is a toggle-clutch.

f has claw-ended levers for reaching tools dropped into or broken in bored wells.

g is a *grab* for recovering well-tubes from bored wells or shafts.

Grass-cloth. A light fabric resembling linen, exported from the Malay Islands. It is made from the fiber of the "poa," a species of nettle.

A similar cloth is made from the Chinese *ma*, a species of *cannabis* (hemp). It is perennial, and sends up numerous stems of from 7 to 10 feet in hight.

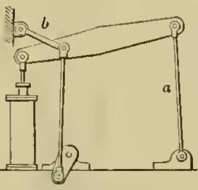
The plant yields three crops every year. The first cutting takes place in June. On being cut, the leaves are carefully taken off with a bamboo knife by women and children, generally on the spot. It is then taken to the house and soaked in water for an hour. In cold weather the water should be tepid. After this the plant is broken in the middle, by which the fibrous portion is loosened and raised from the stalk; into the interstice thus made, the operator, generally a woman or child, thrusts the finger-nails and separates the fibers from the center to one extremity and then to the other. A partial bleaching is effected on the fibers before they undergo farther division, sometimes by boiling and at other times by pounding on a plank with a mallet. After being dried in the sun, a tedious process of splitting the fibers by the finger-nail ensues, then hatcheling, followed by rolling in balls, soaking, washing, and steeping in lye. The fibers are then spliced for the weaver.

Grass-edg'ing Shears. A form of large scissors with a bent shank, and used for cutting the straggling leaves of grass at the edges of grass-plots and of grass-bordered beds.

Grass-har'vest-er. See Mower.

Grass'hop-per-beam. One form of working-beam used in steam-engines. Instead of oscillating in fixed bearings, one end is attached to a rocking pillar *a*, and the point of attachment of the pitman to the beam bears such relation to that of the piston-rod as will correspond to the relation between the stroke of the piston and the throw of the crank. *b* is the radius-bar of the parallel motion which secures verticality to the piston-rod.

Fig. 2303.



Grasshopper-Beam.

Grass'ing. The exposure of *steeped* flax-straw on the grass, where it is spread evenly and frequently turned to wash out the mucilage and loosen the *shives* and *boon*. Then follows *breaking*.

Grass-seed Sep'a-ra'tor. A form of sifter by which grass-seed is rid of larger and smaller matters, either grains or weed seeds, as the case may be. It may have several sieves, with wire-cloth of varying fineness, the more open to allow the grass-seed to pass and remove larger matters, and sieves with closer meshes to hold the grass-seed and allow certain small weed-seeds and dust to pass.

Grate. 1. A grated box or basket, or a box with a series of bars for a floor, in which fuel is burned.

The oldest form of grate may have been a row of bars laid upon bearers or stones so as to admit air beneath the fuel in the intervals of the bars. A *cresset* or *fire-cage* is also an old form of grate. See Cresset.

In an inventory, dated 1606, of the goods of Sir Thomas Kytson, at Hengrave Hall, Suffolk, England, mention is made of "a cradell of iron for the chimnye to burn sea-coal with," and also "j fier sholve made like a grate to seft the sea-coal with." The "cradell" was probably a standing basket-grate. This is an early mention of the use of sea-coal, but the basket form was common in cressets.

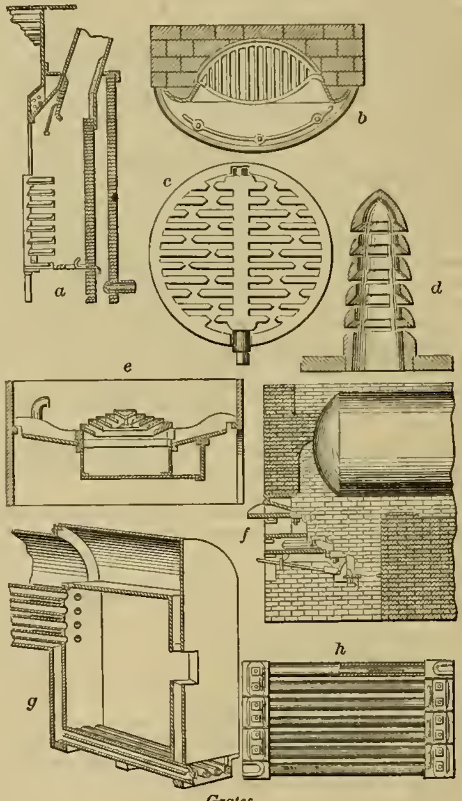
James Watt, in 1785, patented an arrangement for consuming the smoke in furnaces, by supplying the fire from above downward by means of a reservoir of fuel in contact with the ignited mass, the fuel descending by its own weight to supply the consumption.

Combustion was supported by a strong lateral current of air passing through the fire to a flue on the other side, near the entrance of which was a supplementary fire which consumed the smoke of the first.

Cutler patented a smoke-consuming contrivance for open fires in 1816, and in 1817 Deakin attached a metallic box, holding fuel for one day's consumption, to the back of the fireplace; the fuel was drawn forward horizontally by a screw, as required, and in this way the smoke was nearly all consumed.

In the same year Hawkins patented a shovel for supplying coal to the fire at bottom. The shovel had a cover, and the contained coal was pushed forward into the fire by a piston.

Fig. 2304.



Grates.

The revolving grate was introduced by Steel and Brunton, English patents, about 1819.

Grate-bars of hollow tubes, connecting water-boxes at front and rear, were introduced by Chapman in 1824. See Smoke-consuming furnace.

In 1825, Atkins attached a fuel-chamber to the back grates, the bottom of the chamber being made to slope at a considerable angle.

Jeakes, in 1854, formed a movable grate, which was lowered into the fuel-box, gradually consuming the fuel and admitting a supply of air from above to support the combustion.

Kowe, in 1854, introduced coal into the bottom of the grate by a pipe leading from a side reservoir of fuel.

In 1854, Bachhoffner consumed the smoke of one fire by passing it through an upper fire.

Leighton, in 1856, surrounded the sides and back of a fire-grate with a fuel-chamber, the fuel being brought forward by a poker, as required. The outer coal is thus coked. See also FIREPLACE.

Grates are known by many names indicative of position, as *low-down;* purpose, as *steam-furnace* grate; construction, as *revolving, shaking,* etc. Fig. 2304 shows some forms, in which —

a is the ordinary basket-grate of the parlor fireplace.

b is the low-down grate as viewed from above, the wall in section.

c is a stove-grate, in which the central oscillating portion has alternately long and short bars, which act in conjunction with others projecting inward from the ring, the ends of each being deeper as more exposed to wear.

d is a cone-shaped or pyramidal grate opened at its bottom, intended to be placed in the center of a fire-pot in a stove. The bars of these grates are inclined downwards from the center to the outside, so as to prevent the fire-coal, sawdust, tan, etc., which it is intended to burn, from choking up the apertures in the grate.

e is Eaton's locomotive furnace-grate. The congeries of grate-bars are in steps, and afford more uniform access of air to the fuel. The ash-pan has back and front dampers, and a perforated guard-plate in front to govern the draft.

f is composed of three or more tiers, in combination with a fire-box and trap-grate. When in use, a continuous inclined plane of incandescent coals is formed from the upper tier to the lowest grate.

g is a steam-boiler furnace. The grates are tubular, and have longitudinal horizontal diaphragms extending nearly throughout their length, forming an extension of the boiler-surface in which the water circulates.

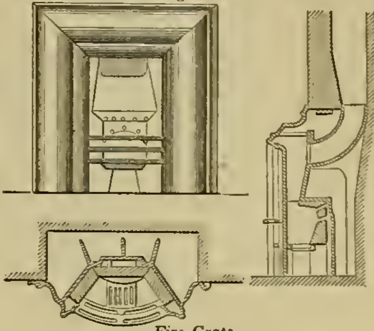
In *h* the tubes are combined into a continuous passage for the water, the alternate ends being connected by caps which admit of expansion.

The commission appointed by the House of Commons in 1856 to examine into the best mode of heating buildings reported a fire-grate for heating barracks, hospitals, etc., which embodies many of the best features of previously existing inventions.

Fig. 2305 illustrates a grate of this kind set in an ordinary fireplace. The grate is placed as much forward in the room as possible; the part in which the fire is contained is of fire-brick; the bottom, being partly solid, checks the consumption of fuel. A supply of air is admitted from behind the grate, and is thrown on the top of the fire to assist in consuming the smoke; the sides are splayed so as to throw the heat by radiation as much as possible into the room; the opening into the chimney has no register; there is a chamber behind the grate into which air is brought from the outside and warmed by the large heating surface of the back of the grate, increased by flanges, and after being heated to from 56° to 70° F., the air passes into the room by a shaft cut out of the wall which terminates in a louvered opening placed out of reach, or a shaft of sheet-iron may be fixed to the wall to serve the same purpose. In the accompanying plan and section, the fire-brick lining of the grate is shown by the shaded portion; the back lining has grooves in it terminating in holes just at the bottom of the splay, which form air-channels for admitting air at the back over the fire. The hearth is made of a plate of cast-iron.

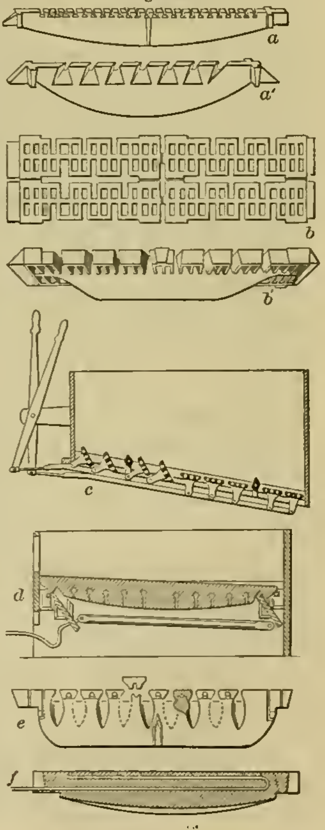
The contrivance for admitting air into the air-chamber depends on circumstances. If the fireplace be built in an external wall, the openings for fresh air may be made in the back; but if in an internal wall, the channel from the outside may be either between the flooring of the room and the ceiling joists of the room below, or in the spaces between the joists, or by a tube or hollow beam carried below the ceiling of the room below.

Fig. 2305.



Fire-Grate.

Fig. 2306.



The subject may be pursued under a variety of heads, where allusion may be found to heating and ventilating devices. See FURNACE; VENTILATOR, etc. Also specific indexes under AIR-APPLIANCES; STOVES AND HEATING-APPLIANCES, etc.

2. (*Mining.*) A metallic perforated plate on which ores are stamped.

Grate-bar. The iron bar in a furnace which supports the fuel. A part of a grid in a furnace.

Among the numerous forms may be cited: —

a a′, the *paragon*-bar, which has passages for air formed by notches in the upper surface expanded downwardly, so as not to fill with ashes.

b b′ are two views of a grate-bar. The upper view is a top view of two bars; the lower one shows a side and bottom view, with a strengthening belly flange.

c is an inclined shaking grate composed of a number of bars, with lozenge-shaped openings, cast in one piece, and so arranged as to be operated in pairs or all at once, by levers. The bars are placed at right angles with the length of the grate; the air supplied to them from beneath flows through their perforated tops, which rise above the surface of the grate, and among the burning coals.

In *d* each alternate bar is supported by the imposition of its inclined edge upon the oblique surface of the cross-bars at either end. When the rock bars are moved, they strike against the notches and cause one end of the grate-bar to climb upon the supporting bar, while the other end slides down the incline of the supporting bar at that end.

e has spaces between the fuel points which admit air to the incandescent fuel, and afford an escape for dust and ashes from the fire-bed. Provision is made for economically renewing the fuel points, and the construction is such as to afford a proper grate surface, with a copious supply of air.

f has a steam-pipe passing longitudinally through the grate-bar and throwing jets of steam from its upper surface.

These are but a few of the numerous kinds.

The grate surface should be equal to one square foot for each horse-power.

Grat′er. 1. A plate roughened by punching holes which raise protuberances forming a rasping surface. Used for grating ginger, nutmeg, horseradish, lemons, crackers, etc.

2. (*Bookbinding.*) An iron instrument used by the forwarder in rubbing the backs of sewed books after pasting.

Grate-sur′face. (*Steam-engine.*) The area of surface of grate by which air has access to the fuel.

In an average boiler this is 1 square foot per horse-power, and is expected to evaporate 1 cubic foot of water per hour.

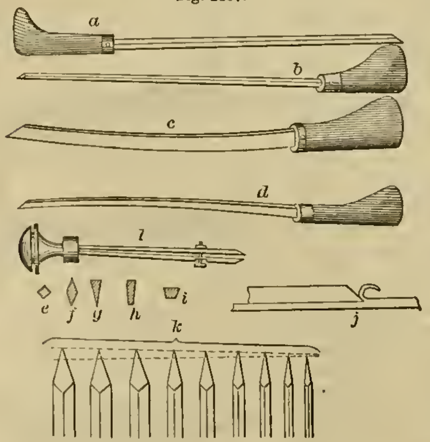
With the Cornish boiler double this amount of grate-surface is allowed. With the locomotive, 1 square foot evaporates 8 cubic feet of water.

Grat′ing. (*Nautical.*) An open wood-work of cross slats to cover hatchways and yet admit light and air.

Grav′el-car. A railway ballast-wagon.

Grav′er. Gravers are used for engraving or chasing metals or other materials, such as fine hard woods, in certain descriptions of ornamental work. They are made of fine steel, which, for cutting steel, is tempered to a "pale straw" color, the first color that appears in "drawing the temper."

Fig. 2307.



Gravers.

Gravers are made of different shapes. Those for "line" engraving are square or rhomboidal in their cross section, and the end is sharpened by grinding it off obliquely, as seen in the figures *a b c.* The lower edge of the graver is termed the *belly*, and is angular for line-engraving. For engraving lettering it is frequently rounded or flat, and for heavy work is destitute of a handle, and is driven by a hammer.

d shows the shape of the graver used in *stipple* or *chalk* engraving, so called from its consisting of dots which resemble the appearance of chalk-drawing upon rough paper. See STIPPLE-ENGRAVING.

e is a section of a square graver.

f is a lozenge graver.

g h i are tint tools, used principally by wood engravers.

j shows the work of a tint tool.

k shows a set of tint tools.

l is an adjustable double graver.

Grave′stone. A monumental stone for erection or erected at a grave. The advertisement by the Quartermaster-General, U. S. A., for bids for furnishing 300,000 gravestones for soldiers' graves at different national cemeteries throughout the country, brought forward specimens of all materials, — white and black marble, polished and plain, sandstone of various colors, white and red clay, vitrified and unvitrified, porcelain, cryolite porcelain, béton-coignet, and all sorts of composite stone; painted iron, malleable iron, compositions of tin and spelter, copper and spelter, brass, bronze, and wood.

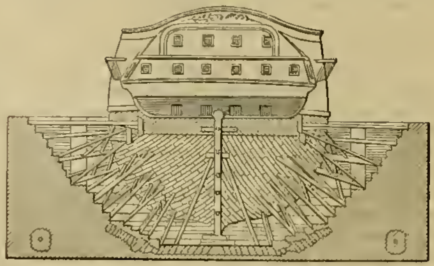
One stone from Philadelphia has letters cut by a *sand-blast* system in seven minutes.

Grav-im′e-ter. An instrument for determining the specific gravities of bodies. Nicholson's instrument consists of a hollow ball of brass or copper, having a stem rising from its top which supports a cup or dish. Another dish is suspended from the lower part of the ball by means of a stirrup; this dish is made heavy enough to keep the instrument vertical when placed in a liquid; and the weight of the instrument is such that 1,000 grains placed in the upper dish sinks it in distilled water, so that a mark about the middle of the stem is on a level with the surface of the liquid. See AREOMETER.

Grav′ing. (*Nautical.*) Cleaning a ship's bottom by burning off the sea-weed and then paying the planks with pitch. Ships were formerly beached for this purpose, and the work was done during the recess of the tide. It is also called *breaming.* See GRAVING-DOCK.

Grav′ing-dock. A dock into which vessels are floated to have their bottoms examined and cleaned. A *dry-dock.*

Fig. 2308.



Graving-Dock

The vessel is floated in and the gates at the entrance closed when the tide is at ebb. The remaining water is then pumped out.

The graving-dock of the Navy Yard at Brooklyn measures 350 feet in length within the caisson-groove, and the main chamber is 98 feet in breadth at the top. The width of entrance is 68 feet, and the depth of water 26 feet. It was commenced in 1841, and completed in 1851. Great difficulty was experienced in its execution, occasioned mainly by the softness of the foundations; upwards of 8,000 piles, varying from 25 to 40 feet in length, having been employed in the work, which is stated to have cost $2,000,000. It is built of granite, and is furnished with iron gates and an iron caisson or floating gate.

Other larger ones are now constructed at South Brooklyn.

Many of the Liverpool docks have graving-docks, and some of the dock-entrances are arranged to be used as graving-docks. Two of the latter have the following dimensions: —

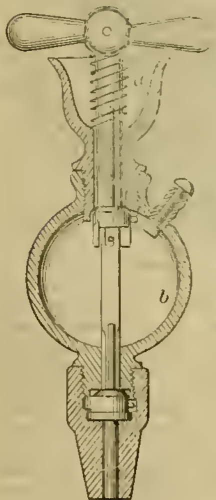
	Length.	Width.	Depth of Water at Sill. Feet.
Canada dock-lock .	500	100	26
Huskisson dock-lock	396	80	24.75
Birkenhead dock-lock	500	85	30.25
16 graving-docks of Liverpool . .	300 – 700	40 – 70	18 – 21
3 Birkenhead graving-docks . .	750	50 – 70	25.75
10 private graving-docks, Birkenhead	380 – 440	80 – 87	19.25 – 24

Grav′i-ty-bat′ter-y. Invented by Callaud or by C. F. Varley, London; English patent, December 5, 1854, no. 2555. A form of double-fluid battery, in which the fluids range themselves at different hights in a single jar by virtue of their different specific gravities. The copper or – element is in the bottom, and the zinc or + in the upper part of the cell. See CALLAUD BATTERY.

In the ordinary forms of "gravity" or "Callaud" battery, if the sulphate of copper dissolves faster than its solution is used up, the copper solution rises, finally touching the zinc, rendering the battery useless.

R. M. Lockwood, patent April 8, 1873, shows an arrangement for avoiding this. The copper element or a portion thereof is placed at the point where it is desired to maintain the separation of the liquids; so long as the circuit is closed the copper solution will not rise above such element.

Fig. 2309



Grease-Cup.

Grease-box. (*Railroad Engine.*) The receptacle over an axle arm, which contains the lubricating material.

Grease-cock. (*Machinery.*) A faucet by which oil is admitted to a journal-box, or other part requiring lubrication. It is used on the cylinder cover for lubricating the piston without permitting the escape of steam or the entrance of air.

Grease-cup. (*Machinery.*) A cup attached to a part requiring lubrication, and from which it is supplied with oil. In the example, the two valves are on the same stem a little more distant apart than are their seats; the revolution of the stem by bringing one or the other of the valves to its seat establishes communication between the supply cup *a* and the globe *b*, or between the latter and the valve-chest. See OIL-CUP.

Grease-pot. An iron pot, the third in the series in which iron plates are tinned. It contains clear melted tallow or lard, and is situated between the *wash-pot* and the *pan*. The series is: *tin-pot*, *wash-pot*, *grease-pot*, *pan*, and *list-pot*. See TIN-PLATE.

Great-or′gan. (*Music.*) One (and the most important) of the three organs which are associated in large combined organs. They are the *great*-organ, the *choir*-organ, and the *swell*; to which may be added the *pedal*-organ or *foot-keys* for acting on the larger pipes. The key-board of the *great*-organ contains the principal keys, and has the middle position, the *swell* having the highest bank and the *choir* the lowest. See ORGAN.

Great Prim′er. (*Printing.*) A type four sizes larger than *Long Primer.*

Long Primer, 89 ems to a foot.
Small Pica, 83 ems to a foot.
Pica, 71 ems to a foot.
English, 64 ems to a foot.
Great Primer, 51 ems to a foot.

Greek-fire. An incendiary composition used in early times by the Tartars, and afterwards by the Greeks.

The invention is ascribed to Collinicus, an architect of Heliopolis, the "city of the sun," afterwards called Baalbec. He is reported to have deserted the service of the Caliph and entered that of the Emperor Constantine Pogonatus, A. D. 673. The Emperor Leo described its use, 911; the Princess Anna Comnena described its properties, 1106; so did Joinville, 1249.

In two sieges, writes Gibbon, the deliverance of Constantinople may be chiefly ascribed to the novelty, the terrors, and the real efficacy of the Greek-fire. It was poured from large boilers on the ramparts, or launched in hollow balls of metal, or darted with arrows and javelins, twisted round with flax and tow which had imbibed the inflammable oil. In naval battles, fire-ships filled with these combustibles were carried by the wind, that fanned their flames against the sides of the enemy's vessels. It was usually blown through long copper tubes, planted in the prow of a galley, and fancifully shaped into the mouths of savage monsters that seemed to vomit a stream of liquid fire. The art of compounding it was preserved at Constantinople as the palladium of the state. Its galleys and artillery might occasionally be lent to the allies of Rome, but the secret of the Greek-fire was concealed with the most jealous scruple for above four hundred years. The Princess Anna Comnena, in mentioning resin, sulphur, and oil as its components, only intended, it is probable, to baffle curiosity by telling just so much as everybody knew already.

In 1098, the fleet of Alexis Comnenus used Greek-fire against the Pisans. His ships had "siphos" fore and aft, in form of syringes, which squirted the inflamed matters.

It is believed that the ancient Byzantium was marked by the present walls of the Seraglio. Constantine enlarged it A. D. 328, gave it its name, and made it the rival of Rome. It was taken from the Greeks, in 1204, by the Venetians under Dandolo; retaken by the Greeks, in 1261, under the Emperor Michael Palæologus; captured by the Turks in 1453.

An old recipe for Greek-fire is thus given: —

> "Aspaltum, nepta, dragantum, pix quoque Græca,
> Sulphur, vernicis, de perolio quoque vitro.
> Mercurii, sal gemmæ Græci dicitur ignis."

Another reads as follows: "Take of pulverized resin, sulphur, and pitch equal parts; one fourth of oppopanax and of pigeons' dung well dried, dissolved in turpentine water or oil of sulphur; these put into a strong, close, glass vessel and heat for 15 days in an oven; after which distill the whole in the manner of spirits of wine and keep for use."

The contact of water would increase the violence of this villainous compound.

The savans of the Middle Ages were well acquainted with a number of explosive mixtures, some of which were especially effective by the liberation of poisonous gases which asphyxiated the enemy. In effect like our modern stink-balls, but not thrown, like the latter, from a gun or mortar, but projected by squirts or in bottles, after the manner of a hand-grenade. Prester John, who seems to have combined regal and sacerdotal powers somewhere in Tartary about the eleventh century (some say the thirteenth), is cited as particularly skilful in blowing up his enemies. He stuffed — so says the legend — copper figures with explosive and combustible materials which were emitted at the mouths and nostrils of the effigies, making great havoc.

The Danish historian, Saxo Grammaticus, A. D. 1200, gives an account of a similar contrivance, used by a Gothic king. The devices of Archimedes, who defended Syracuse from the Romans, 212 B. C., were mechanical or optical, and do not seem to have involved chemical compounds.

Green-house. 1. (*Pottery.*) A house moderately warmed, where some kinds of *green-ware* are placed to become partially dried before taking to the *hot-house*, where the drying is completed by strong heat.

The ware is then arranged in seggars and *fired* in the kiln.

2. (*Horticulture.*) A plant-house, with glass roof and sides, with facilities for maintaining an artificial temperature and the necessary ventilation.

Gre′go-ri-an Tel′e-scope. The first and most ordinary form of reflecting telescope, invented by Professor James Gregory of Scotland, and described by him 1663.

Its object mirror or speculum is perforated in its axis, and reflects the image to a smaller concave speculum placed in the axis of the tube at a distance from the larger speculum. The image is viewed through an eye-piece in the aperture of the object-speculum. See TELESCOPE.

Gre-nade′. (Italian *grenado.*) A small shell weighing about two pounds, and thrown by hand. It is said to have been first used at the siege of Wacklindonck, near Gueldres. The right company of each battalion was formerly composed of the taller men armed with hand-grenades. Hence the term *grenadiers*. Various forms of grenades have been invented, some containing combustibles, missiles of various sorts, Greek-fire, or other incendiary compounds. 6-pounders, and even larger shells, have been used as rampart grenades, being rolled over parapets against assailants.

The Orsini grenades, with which an attempt was made to assassinate Louis Napoleon, were spherical shells containing powder and missiles, and having a large number of cones or nipples, each capped with a gun-cap. They were made in London.

Gren′a-dine. (*Fabric.*) A gauzy dress goods, silk or wool, plain, colored, or embroidered.

Grid. 1. A gridiron.

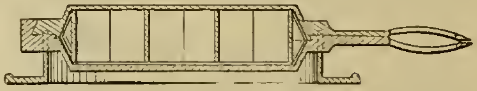
2. A grating of parallel bars, for a furnace, stove, window, vault-cover, or sewer opening.

3. A grating. Used as a concave, partially enclosing the toothed cylinder of a thrashing-machine, or the scutching beater of a cotton-batting machine. *Grids* have other uses; their essential feature of construction consists in having alternating bars and spaces, the latter afford space for the escape of matter or the passage of air.

Grid′dle. 1. A miner's sieve for separating the ore from the *halvans*.

2. A flat plate of iron long known as the *gurdel*, and used from remote antiquity for cooking flat cakes of dough upon a fire on the hearth. We find mention of the use of this implement in all histories, in the Bible, and among the classic writers, and in the Egyptian paintings. A bag of oatmeal and a *gurdel* was the ordinary furnishing of a Scottish soldier in the time of Edward III. The equipment of the Goths was substantially the same.

Fig. 2310.



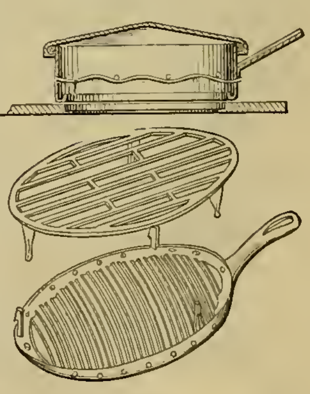
Reversible Griddle.

In the example, two dish-shaped cast-iron plates have projecting ears, and when placed together form a hollow dish to contain nests for cakes, etc. The griddle is supported by its projecting ears, which form journals whereby it is turned over upon a rim placed upon the pot-hole of a stove or range.

Grid′i-ron. 1. (*Hydraulic Engineering.*) A grated frame on which ships are hauled out of the water for examination, cleaning, and repairs. Or a framing of cross-timbers which receives a ship with the falling tide.

2. (*Domestic.*) A grated iron utensil on which fish, flesh, and fowl are exposed for broiling. The illustrations show a gridiron with a wire grating and a sheet-metal rim and cover; one with legs, and another griddle-shaped. See also BROILER.

Fig. 2311.



Gridirons.

Grid′i-ron-pend′u-lum. A compensation pendulum invented by Harrison. The bob is supported by parallel bars of two metals which are unequally expanded by heat. These are so disposed that, while one tends to lengthen it, the other tends to shorten it. The ratio of lengths is determined by the relative expansibility. See PENDULUM.

Grid′i-ron-valve. (*Steam-engine.*) A valve whose opening is divided into a number of narrow parts by which the travel may be abridged.

Griff. (*Weaving.*) A series of horizontal parallel-edged bars, also known as *knives* or *blades*, arranged in a reciprocating frame to raise and lower the vertical hooked rods connected to the *shedding* mechanism, when the hooked ends of said rods are brought by a pattern device within the path of said knives.

Gril′lage. (*Hydraulic Engineering.*) A structure of sleepers and cross-beams forming a foundation in marshy soil for a pier or wharf.

Grind′ing and Pol′ish-ing. See under the following heads: —

Ayr-stone.
Bob.
Border.
Bowldering-stone.
Brayer.
Bristol-brick.
Brush-wheel.
Buffing-machine.
Buff-stick.
Burnisher.
Burnishing-machine.
Cadrans.
Cane-polishing machine.
Card-grinding machine.
Charcoal.
Clearing-stone.
Coffee-polishing machine.
Colcothar.
Corundum.
Crocus.
Cylinder grinding, etc.
Dial.
Diamond-cutting, etc.
Dop.
Drill-grinding machine.
Dry-grinding.
Dutch rush.
Emery.
Emery-paper.
Emery vulcanite-wheel.
Emery-wheel.
File-grinding machine.
Fish-skin.
French-polish.
Gem-cutting, etc.
Glass-cutting.
Glass-paper.
Glass-polishing.
Glazer.
Glazing-wheel.
Gouge-slip.
Grinding and polishing materials.
Grinding-machine.
Grinding-clamp.
Grinding-mill.
Grinding-slip.
Grinding-wheel.
Grindstone.
Grindstone. Artificial
Grindstone-dresser.
Holystone.
Hone.
Lap.
Lapidary's mill.
Lead-mill.
Lens. Grinding, etc.
Liner.
Lustering.
Marble-polishing.
Martin.
Mill (varieties, see MILL).
Mortar.
Muller.
Oil-stone.
Palette.
Paper-polishing machine.
Plate-powder.
Polishing materials.
Polishing-mill.
Polishing-needles.
Polishing-powder.
Polishing-slate.
Polishing-snake.
Polishing-tin.
Porphyrization.
Porte-polish.
Pumice-stone.
Putty-powder.
Rabat.
Rabot.
Ragging.
Razor-strop.
Reaper-bar grinder.
Reaper-knife sharpener.
Red-stuff.
Rifle.
Rouge.
Rottenstone.
Roughing-mill.
Rubber.
Rub-stone.
Rumble.
Sand-blast.
Sand-jet.
Sand-paper.
Sand-papering machine.
Saw-grinding.
Saw-sharpening machine.
Scorching.
Scratch-brush.
Scythe-stone.
Shaking-machine.
Shave-grass.
Sheet-metal polisher.
Skate-grinder.
Skive.
Slate-making machine.
Slicer.
Slitting-mill.
Smoothing-mill.
Spade.
Spring-polisher.
Steel.
Stone-grinding machine.
Stone-polishing machine.
Straggling.
Strickle.
Tanite.
Tape-carrier.
Tool-holder for grinding.
Tripoli.
Tumbler.
Varnish.
Whetstone.
Whetter.
Whiting.
Wood-polishing machine.

Grind′ing and Pol′ish-ing Ma-te′ri-als. Abrasive substances used in the solid form: —

Grindstone.
Hone.
Oil-stone.
Charcoal.
Emery-cake.
Fish-skin.

Abrasive substances used in powder; materials stated in about the order of their hardness: —

Diamond.
Sapphire.
Ruby.
Corundum.
Emery.
Sand.
Flint.
Glass.
Tripoli.
Turkey-stone dust.
Rottenstone.
Slate.
Pumice.
Chalk.
Oxide of iron, colcothar.
Crocus or rouge.
Oxide of tin or putty-powder.

The abrasive powders are applied by thin circular disks, which cause them to act as *saws*.

On the periphery of wheels which act as *grindstones*, *glazers*, or *buffs*, according to the quality of the material and the terms of the trades.

On plane surface of disks which form *laps*.

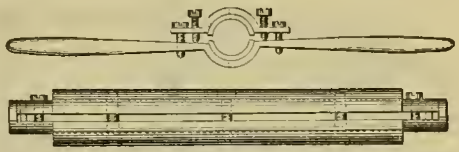
On the ends of rods which act as *drills*.

On slips of wood which act as *files*.

Spread upon cloth, paper, or leather, forming a grinding or polishing paper or pad, as the case may be. See EMERY-PAPER; SAND-PAPER; etc.

Grind′ing-clamp. A grinding-clamp for cylindrical work has two semi-cylindrical leaden blocks enclosed between the two halves of the clamp, which are adjusted by binding-screws. The halves of the clamp are adjusted to the desired distance, slips of wood being placed in the jaws while the melted lead is run in to form the cheeks.

Fig. 2312.



Grinding-Clamp and Rod.

For internal work the grinder consists of two semi-cylindrical rods of iron, fitted to each other by dowel-pins and set screws, so as to be expanded to the required distance. The leaden cheeks are cast upon the rods, which are placed in a mold for that purpose.

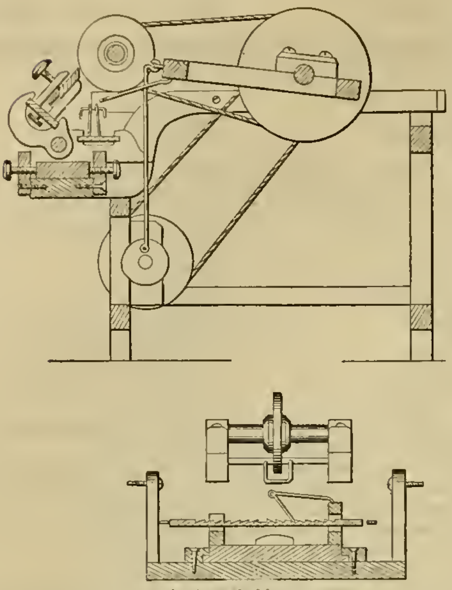
Grind′ing-frame. An English term for a cotton-spinning machine.

Grind′ing-ma-chine′. Fig. 2314 shows a machine in which the article to be ground is moved past the face of the grindstone, which is stocked in a swinging frame for the purpose of giving to the bezel of the tool or implement a concave form, having a greater radius than that of the stone.

Fig. 2314 shows Whitelaw's machine for grinding pulleys. *a* is the grindstone, which is caused to revolve at about 180 turns a minute in one direction, while the pulley *b* rotates at about 130 revolutions per minute in the other.

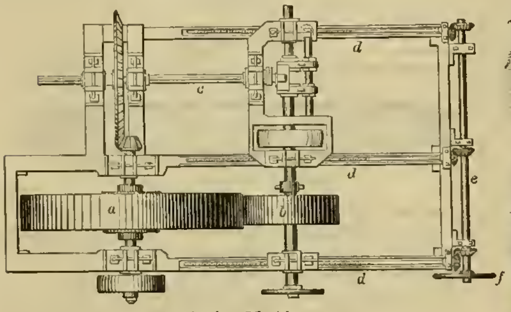
The pulley is caused to traverse back and forth across the face of the stone by bevel-gearing connected with the crank-shaft *e*, and is kept up to the stone by similar gearing from the shaft *e*, operating the screws *d d d*, through the hand-wheel *f*.

Fig. 2313.



Grinding-Machine.

Fig. 2314.



Grinding-Machine.

Grind'ing-mill. 1. The original grinding-mill was a mortar; a hollowed stone in whose depression the parched grain was pounded by a bowlder. Such stones are found amongst most nations possessing food requiring such treatment. The North American Indians, who had maize, pounded it in this manner to make a coarse meal or hominy; large stones in their villages formed permanent mortars. Their pestles were sometimes fortuitous bowlders of convenient shape, sometimes they were fashioned into a shape like a painter's muller, or even approximating the form of dumb-bells. Collections of curiosities abound with specimens of this rudimentary grinding-mill. The Smithsonian Institution has many such from North America and the South Seas.

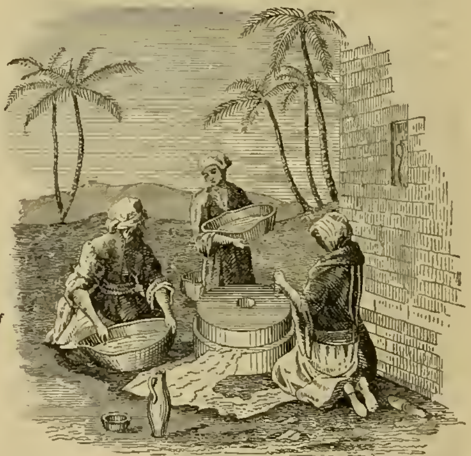
The *mortarium*, or *mola trusatilis*, was a modification of this form, and Pliny states the bread made of the broken grain to be superior, in the estimation of some, to that more closely ground in the mills of more perfect construction, and leaves us to infer that throughout the greater part of Italy the grain for bread is pounded in a mortar by an iron-shod pestle. The Romans had great variety of bread, the best and most fashionable the *alica;* also *ostrearius* (oyster-bread), *artolagonus* (cake-bread), and many others. (See BREAD.) A passage in Pliny suggests that in course of time the mortar was ridged and the pestle notched, forming a machine which had a grating action upon the grain. See MORTAR.

When the upper stone or *runner* was enlarged and furnished with a handle, by which it was rotated upon the nether or bed-stone, the device may be said to have crossed the line between the *mortar* and the *mill.* The grain was fed in at an eye in the axis of the runner, and the meal escaped at the space between the stones at the outer margin of their effective faces, as shown at Fig. 2315. Such a mill was the *quern*, common in Italy and Britain in Roman times and since.

The ancient Egyptian mills, says Wilkinson, were of simple and rude construction. They consisted of two circular, horizontal stones, nearly flat; the lower one fixed, while the upper one, called the *rekkab*, or rider, in Arabic and Hebrew, turned on a pivot or shaft rising from the center of the lower one. It was turned by two women, seated, each holding the perpendicular handle, and operating by a concerted push and pull motion. The modern Egyptian hand-mill is substantially similar. Their larger mills were turned by oxen or asses, like those of the Romans. The millstones were of hard grit or granite, and are occasionally met with in the ruins.

The grinding of grain for a family was performed by women or slaves, and, the grist being usually sufficient for a single meal only, the work was a daily occurring one. Samson ground in the prison-house. Job spoke of his wife grinding for a stranger. The Master spoke of the days of tribulation surprising two women grinding at the mill. Moses forbade the taking of the millstone to pledge, as it was a man's life, — a daily necessity, a grist for a meal being ground at a time. The last of the Egyptian plagues was the death of the first-born, from that "of Pharoah that sitteth upon his throne, even unto the first-born of the maid-servant that is behind the mill." The citation seems to include the extremes of the social scale.

Fig. 2315.



Oriental Mill.

When the labor of cattle was substituted for that of mankind, the upper millstone was called *meta* and the lower *catillus*, such mills being known as *molæ jumentariæ*. The sweep to which the cattle were yoked was fastened to the runner which rotated upon the bed-stone. Since a time that the memory of man runneth not to the contrary, the Phœnicians have had mills for bruising olives, constructed on the plan of the Chilian mill, one stone rolling on its edge in a circular track around a post planted vertically in the center of the track. (See OIL-MILL.) Such was probably a common form of the Syrian cattle-driven grain-mill.

The cattle-driven grain-mills in Rome, about the time of Constantine, numbered three hundred.

Strabo informs us that mills were driven by water in the period of Mithridates of Pontus, the contemporary of Cæsar and Cicero. Such mills were driven by the current of the Tiber a little before the time of Augustus. It is not certain that these were grain-mills.

Windmills were introduced from Greece by one Paulo, and were used for grinding grain, if we may credit Pomponius Sabinus.

Antipater, time of Cicero, refers distinctly to the use of water-mills in an epigram: —

"Cease now your work, ye maids, ye who labored in the mill; sleep now, and let the birds sing to the ruddy morning, for Ceres has commanded the water-nymphs to perform your task; these, obedient to her call, throw themselves on the wheel, force round the axle-tree, and by these means the heavy mill."

Palladius advises the erection of water-mills on estates where streams afford the opportunity of saving manual labor in grinding grain.

Public mills were established in Rome A. D. 398, and were driven by the surplus of water brought to Rome by her splendid aqueducts. They were principally at the foot of Mount Janiculum.

In the sixth century (A. D. 536), when Vitiges, king of the Goths, harassed Rome, and stopped the water of the fourteen aqueducts which entered the city, the mills were stopped thereby, and great distress was the consequence. The grand old soldier Belisarius moored boats in the current, and provided them with paddle-wheels, by which the mills were driven and the people supplied with meal. The Goths tried to destroy them by throwing logs into the stream, but the Romans intercepted these by booms.

Water-mills soon became common in Gaul and Germany, and we read of some on a tributary of the Moselle A. D. 379, and a mention of them by Fortunatus in the next century.

It is needless to particularize farther, as the notices of water-mills in France, Bulgaria, Italy, and elsewhere, are numerous in the writers from the fifth century down.

The moving stone, known as the *runner*, is usually the upper stone, as shown at Fig. *G* in the plate on the page opposite. Variations from this practice are shown at *K*, where the *runners* are beneath, and at *F*, where both stones are driven, but in contrary directions.

The following terms apply to grinding-mills and to parts many of which are represented in figures *G H* of the plate. *L* is an enlarged view of the parts around the spindle and eye.

Bed-stone (*a*); a stationary millstone, usually the lower one.

Runner (*b*); a revolving millstone, usually the upper one.

Run of stones; a pair of millstones in working order.

Spindle (*d*); a shaft which supports and drives the runner.

Step or *ink* (*c*); the socket which holds the *toe* of a vertical shaft or spindle.

Bridge-tree (*f*); the beam which supports the *ink*.

Bush (*g*); wooden chocks called *followers* surrounding the spindle within the eye of the bed-stone. The upper bearing of a millstone-spindle.

Keys (*h*); wedges by means of which the bush is fastened in the bed-stone.

Driver (*i*): a cross-bar by which the motion of the spindle is conveyed to the runner.

Coffins; sockets in the eye of the runner for the ends of the driver.

Balance-rynd (*j*); an iron bar stretching across the eye of the runner, and by which it is poised on the spindle.

Cock-eye (*k*); a cavity on the under side of the balance-rynd to receive the point of the spindle.

Cock-head; the upper point of a millstone-spindle.

Horns; the points of the driver.

Eye (*n*); the central aperture of a millstone.

Hoop (*o*); the enclosing case of a run of stones.

Hopper (*p*); a conveying trough or funnel for feeding a mill.

Shoe (*q*); a conducting spout or trough from the hopper to the eye of the stone.

Spout (*r*); the issuing nozzle for the ground meal. A projecting ventage.

Damsel (*s*); a projection on a millstone-spindle for shaking the shoe.

Dress; a system of land and furrows. A mode of preparing the grinding-surface.

Face; the grinding-surface of a millstone.

Rynd; the bar by which the runner is poised on the cock-head.

Skirt; the outer margin or edge of a millstone.

Furrows; grooves in the face of a millstone to expedite the grinding action.

Land (*x*); level surface between millstone furrows.

Leader (*t*); a furrow extending from the eye to the skirt of a millstone.

Second furrow (*u*); the branch-furrow nearest the eye of a millstone.

Skirt-furrow (*v*); the branch-furrow nearest the skirt of a millstone.

Gouge-furrow; one concave at bottom.

Track-edge; the abrupt edge of a millstone furrow.

Feather-edge (*w*); the shallow edge of a millstone furrow.

Quarter (*y*); a section of millstone dress consisting of a leader and its branches.

Bosom (*z*); a sunk area in the face of a millstone around the eye.

Tram-staff; an instrument to test the squareness of the spindle with the face of the bed-stone.

Red-staff; a straight-edge employed to detect irregularities in the face of a millstone.

Proof-staff; a metallic straight-edge by which the red-staff is corrected.

Wing (1); a strip (commonly of leather) attached to the skirt of the runner to sweep the ground meal into the spout.

Lighter-screw (2); a screw for adjusting the relative distance of the grinding-surfaces.

Husk (3); the supporting frame of a run of millstones.

Grit; a kind of sandstone.

Grits; hulled and coarsely ground grain.

Food; the substance being ground.

Cutlins; half-ground fragments of grain.

Dressing; preparing the face of a millstone for grinding.

Face-cracking; roughening the land-face of a stone by means of numerous blows with a pick-hammer.

Tramming; adjusting the spindle so as to be exactly at right angles with the bed-stone face.

Raking; an action in which, the runner being out of balance, one edge rakes or presses unduly.

Chuckle; the runner is said to chuckle when it rocks upon its center while rotating.

Facing; preparing the working-surface or *face* of a millstone.

Wreathe; the food is said to wreathe when its particles hug the eye so closely as to retard or prevent their descent.

Sling; to swing from side to side (applied to a millstone).

In tram; the spindle being perpendicular with the face of the bed-stone.

Out of tram; the spindle being oblique with the face of the bed-stone.

Gummed; having an indurated coating of vegetable matter.

Killed; meal over-heated in the act of grinding.

Round; not unduly pulverized; meal rather granulated than powdered.

Bush loose; loose in its upper bearings (applied to the spindle).

Draft; the degree of deflection of millstone furrows from a radial direction; thus, in a *seven-inch draft*, the track-edges are tangential to a seven-inch circle.

Fourteen quarter dress; a system of fourteen sets of furrows.

Grit; degree of hardness or texture, — as hard grit, soft grit, coarse grit.

The term *hopper*, although now usually applied to a stationary conductor or funnel, was formerly applied to a shaking one, and hence the name.

The *killing* of the meal usually takes place between grinding surfaces, which, having been worn smooth and somewhat glazed, are set too closely together, and the flour, sliding between instead of rolling over the surfaces, becomes parched, so as to impair its vitality and capacity for panary fermentation. A perfect dress will *slide* the bran and *roll* the flour.

A of the plate is a form of portable mill, adapted to be worked by manual labor, or, by substitution of a band wheel for the crank, by horse-power. The shaft has a bevel-wheel gearing into a pinion on the spindle of the runner.

B is an English form of hand-mill made for the colonies and foreign market. It has a fly-wheel, bevel-wheel, and pinion, which drive the upper stone. Both stones are of buhr. The grain is fed from the hopper in the usual manner, and conducted by the shoe to the eye of the runner, a damsel on the millstone-spindle shaking the shoe.

In some mills and in many forms of corn-crackers metallic plates have been substituted for stones. Among the first of these was the French military mill, the invention of Francis Devreux, to whom a patent was granted for it in 1824. The principle is that of metallic groove plates turning in a vertical plane; the grooves cut radiating from the center of the plate. One of the plates is fixed to the end of the frame of the mill; the other revolves upon an axis fixed in the center of the fixed plate at one end, and in the side of the frame in the other. The grain is fed through an aperture in the fixed plate. See millstone-plate.

E is an emigrant mill, attached to the tongue of a wagon, and designed to be worked by two cranks.

The Shakers of New York reduce their roots to powder by means of a crushing-mill *C*, succeeded by a powdering-mill *D*. The first is on the principle of the Chilian mill, and reduces the dried roots to the size of samp or fine hominy. The stones are of Esopus granite, 4 feet diameter, 1 foot thick, and weight 2,000 pounds each. They turn on their axle, which is at right angles to the vertical axis by whose rotation they are caused to revolve around a common center, and also rotate on their own axes. The principle of the Chilian mill is well understood, and its effect is very powerful. As the outer periphery or face of the stone describes a larger circle than the inner, the face of the stone has a constant rubbing action on the bed-plate, and the material subjected to the action of the stones is much more forcibly grated than it would be by the mere crushing weight of a traversing stone.

The roots, cracked and reduced to a certain fineness in the crushing-mill, are next placed in the powdering-mill *D*, which has a rounded bed-stone of granite and two runners in the shape of truncated cones, which have a rotation on their own axes, and also a revolution around the vertical axle by which the power is transmitted. This mill is very effective. In this form of grinding-mill is illustrated the crushing action just referred to. The outer portion of the face of the upper stones — or that portion of each which for the time being is nearest to the rim of the bed-stone — is subjected to the greatest amount of attrition, being farthest from the common, vertical axis of revolution; it thus causes the other portion of the face, or that nearest the center of the bed-stone, to advance in the general direction of motion, the outer portion being detained by the greater friction, and the result being a rotation resulting from the revolution. Rotary harrows are constructed on the same principle, a rotation being imparted to the individual harrows by power exerted in the direct line of draft.

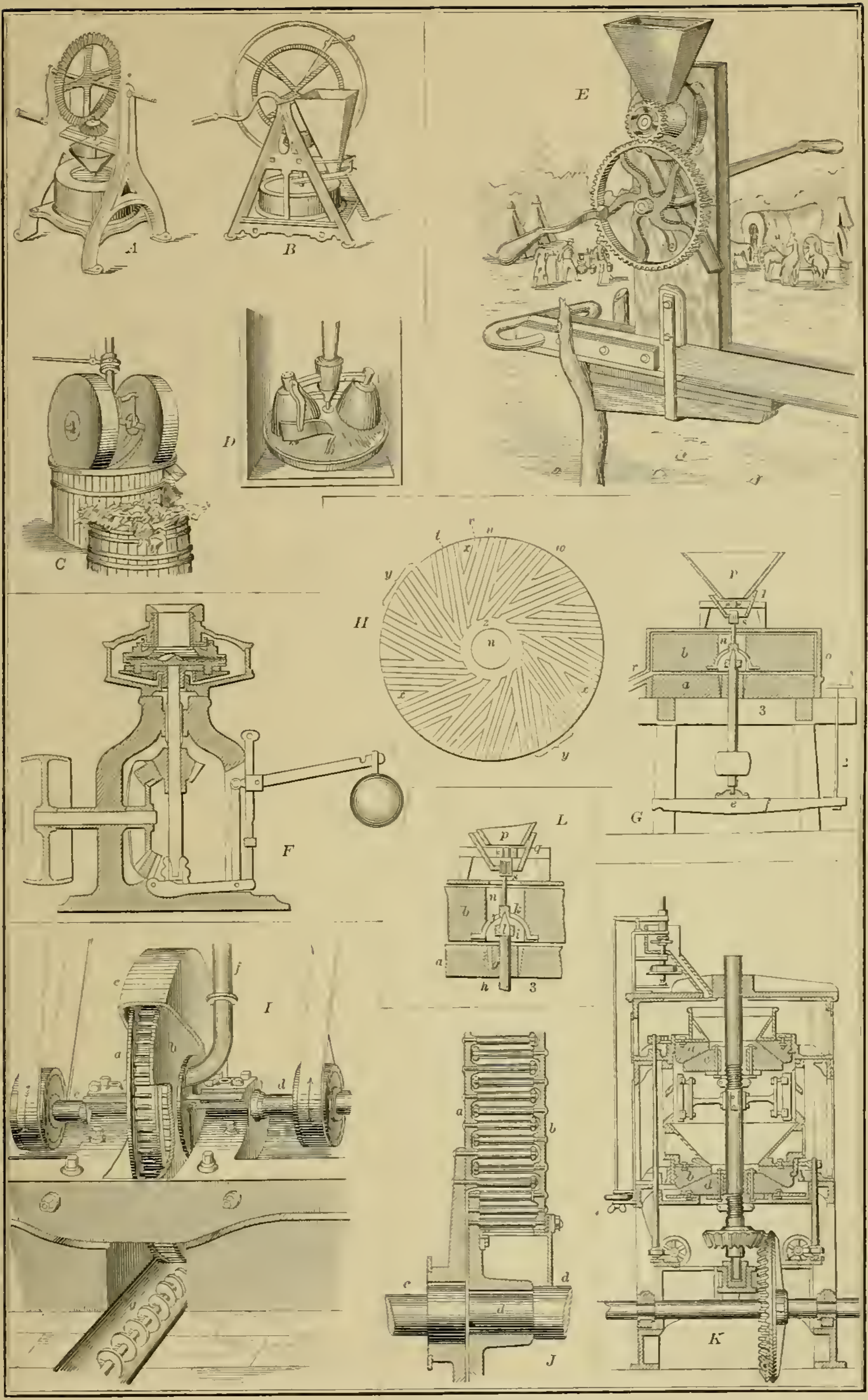
In one form of the English farm-mill *F* the upper and lower plates rotate in the same direction and at nearly equal velocities, but not on the same center. Their eccentric setting gives their grooved surfaces a shearing cut upon each other.

Carr's disintegrating flour-mill (English) is shown by a general view at *I* and by a partial sectional view at *J*.

a and *b* are circular metallic disks, which rotate in contrary directions upon the shafts *c* and *d*, which are situated in the same line. On the inner surfaces of these disks are concentric rings of projections, called *beaters*, the rings on one disk intervening alternately with those on the opposite disk, and moving in a contrary direction. Several concentric rings of beaters may be thus made to operate conjointly.

The revolving beaters are inclosed in a casing *e*. The grain is delivered down the fixed shoot *f* through the orifice in the outer casing, into the innermost cage, from which it is instantly projected by centrifugal action through the machine and delivered, in a shower radiating from every portion of the circumference, into the outer casing, in the form of a meal similar to that thrown out by the ordinary millstones; to this state the grain is reduced by being dashed to the right and left alternately by the bars of each of the successive cages revolving in opposite directions at a very high rate of speed. As it falls to the bottom of the casing, the meal is continually removed by the screw *g*; it is then passed through the usual bolting-machines to separate the bran, and subsequently through silk dressing-machines to separate the fine flour.

The machine is driven at a speed of about 400 revolutions per minute; and the outermost ring being 6 feet 10 inches diameter, the last beaters have a velocity of 140 feet per second, or about 100 miles per hour.



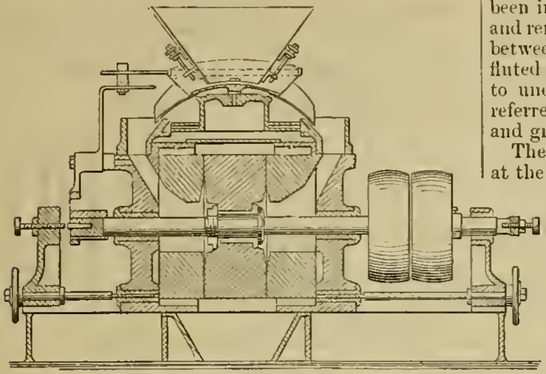
GRINDING-MILLS.

Plate XXII.

See page 1020.

K represents Westrup's conical buhr-stone flour-mill. In, this the upper stone is fixed while the lower revolves, and weighs but about $1\frac{1}{2}$ cwt. instead of 14 cwt., as the ordinary stones do. *a* is the upper, *b* the lower fixed stone; *c* the upper and *d* the lower runner, both fixed on the same spindle.

Fig. 2316.

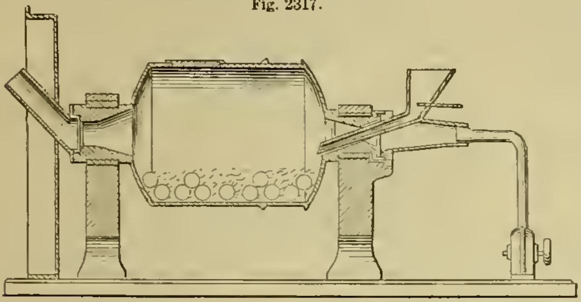


Horizontal-Shaft Grinding-Mill.

This arrangement diminishes the power required, and is said to deliver a much larger quantity of flour in the same time.

Fig. 2316 is a form of mill in which the runner rotates with a horizontal shaft passing through boxes in the adjustable standards, by whose movement the other stones are adjusted. The grain passes from the hopper through two spouts, and passes through ways in the standards and the side stones.

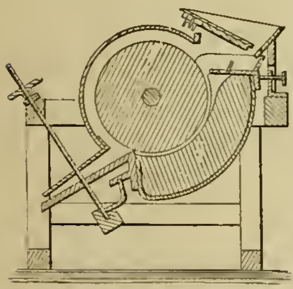
Fig. 2317.



Rolling-Balls Grinding-Mill.

In Fig. 2317 the material is fed into the cylinder through one of the tubular journals, and is subjected to the action of metallic balls running loosely in the rotating cylinder. A blast enters through the inwardly flaring aperture of the journal at the feed end and carries the powdered particles through the other journal to the receiving chamber.

Fig. 2318.



Concave-Bed Mill.

In Fig. 2318 the bed-stone is a concave, which may yield to any hard substance and preserve it from injury.

Many of the new processes for putting wheat into a convenient shape for cooking are but revivals of old modes. We have spoken in this article, and under **Bread**, of the Roman preference for decorticated grain, rasped in a mortar and then simply broken. The Hungarian plan, which may have been in use for centuries, is to decorticate the grain and remove the bran, and then rasp the hulled kernels between a complicated series of differently speeded fluted rolls. Other devices for this purpose are referred to under **Decorticator**; and allied machines are referred to under **Huller**. Pearl barley, hominy, and grits are hulled grains.

The ventilating of millstones, by a blast of air in at the eye and out at the skirt, is old as Gendebein and Houyet's patent, January 5, 1847. They proposed to use plenum or vacuum.

Oliver Evans's *hopper-boy* patent, a means of feeding grain to the millstone, was pronounced by Thomas Jefferson so important that the inventor ought not to be allowed a patent on it, it being an absolute necessity to a miller when once discovered.

The regrinding of roughly ground or coarse meal was practiced by the Romans, and has been revived in latter times by the Germans and French; by the latter under the name *mouture économique*. The grain is coarsely ground, bolted; the coarse portions and bran reground again and again. The various grades and kinds of flour or meal thus obtained were called by Pliny *similago*, *simila*, *flos*, *pollen*, *cibarium*.

Two other plans may be noticed; one which produces what is called *entire wheat flour*, the bran being ground to an impalpable powder and mixed with the flour. Also a French plan, in which grinding is dispensed with; the wheat being decorticated, macerated, and crushed by rollers into a dough fit for baking.

The first steam flouring-mill in England, perhaps in the world, was the "Albion," erected at the Southwark end of Blackfriars' Bridge, London, in 1783.

The best-appointed *grinding-mill* in England is said to be the City Flour-Mill of London. Its capacity and arrangement are thus described by Mr. Tomlinson: —

"The mill, which is fire-proof, is 260 feet in length and 60 in width. There are thirty-two pairs of stones all furnished with the blowing-apparatus, the runner of each pair being worked by a strap. A long horizontal trunk placed above the millstones is supplied with condensed air by means of a powerful fan. From this trunk proceeds a smaller trunk obliquely into the casing of each pair of millstones, and when the blast has served its purpose it escapes up another oblique trunk, into a second long horizontal shaft, in which the air is rarefied by means of a fan. This fan conveys the air into a chamber lined with woolen cloth which arrests the flour carried off by the blast.

"The wheat is hoisted to the top floor, where, after undergoing certain cleansing operations, it is let down to the stones. The meal is conveyed along horizontal trunks, by means of archimedean screws working in them, to a series of bucket-elevators attached to an endless band working in a vertical plane over and under rollers at the top and bottom. These elevators distribute the meal among sixteen silk dressing-machines, each of which is 36 feet long, 3½ feet in diameter, and inclosed within a wooden casing. The silk-machine consists of an octagonal wooden framework attached by radial bars to a central axis. The frame is covered with a fine silk cloth, hard in texture and tightly stretched. The axis is inclined ⅜ inch to each foot of its length; the two ends are open, and the meal, being poured in at the upper end, is sifted through the bolting-cloth which covers the eight sides, as the frame revolves.

"As a means of jarring the frame to prevent the clogging of the meshes of the bolting-cloth, the radial rods of the frame have wooden balls threaded loosely upon them, so that as the frame revolves they fall from the axis upon the circumferential bars, and then back again upon the axis as the position of the radial bars changes. The fine flour which passes through the cloth is conducted to a bin; the pollard and bran are conducted to a dressing-machine.

"The average quantity of wheat ground per week is 20,000 bushels. Wheat can be ground and dressed in fifteen minutes, during which time it passes three times from the top to the bottom of the mill by means of screws and elevators. But few hands are employed, the work of the mill being mostly performed by steam-driven machinery. The steam-engine in this establishment is on the marine principle, and was formerly one of the stationary engines of the Blackwall Railway, when the carriages on that line were moved by means of a rope.

"The nominal power of the engine is 220-horse-power. There are seven boilers for generating steam, and they are made to consume the smoke by causing one fire as soon as it is supplied with coals to discharge its smoke into the adjoining furnace."

2. A lapidary's wheel of lead, the disk surface of which is touched with emery and water. It follows the *sifting* or *roughing* mill, and like them is mounted to rotate on a vertical axis. See LAPIDARY'S MILL.

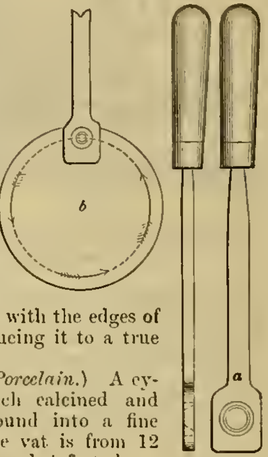
See under the following heads for mills and parts of mills: —

Bag-clasp.
Bag-holder.
Balance-rynd.
Barley-mill.
Bed-stone.
Bolt.
Bolt-feeder.
Bolting-mill.
Bosom.
Bran-duster.
Bridge-tree.
Bruiser.
Bruising-mill.
Brush-wheel.
Buckwheat-huller.
Buhr.
Clack.
Cider-mill.
Clay-mill.
Cock-eye.
Cock-head.
Corn-mill.
Cotton-seed mill.
Damsel.
Debranning-machine.
Decorticator.
Dress.
Feed-regulator.
Flax-seed mill.
Flour-bolt.
Flour-cooler.
Flour-dressing machine.
Flour-packer.
Foot-stalk.
Furrow.
Furrowing-hammer.
Grain-conveyor.
Grain-dryer.
Grain-elevator.
Grain-gage.
Grain-huller.
Hand-mill.
Hominy-machine.
Hoop.
Hopper.
Hopper-boy.
Huller.
Hulling-machine.
Husk.
Kern.
Kibbling-mill.
Lighter-screw.
Mill (varieties, see MILL).
Mill-hopper.
Mill-pick.
Millstone.
Millstone-balance.
Millstone-bridge.
Millstone-dress.
Millstone-dresser.
Millstone-feed.
Millstone-furrower.
Millstone-hammer.
Millstone-pick.
Millstone-regulator.
Millstone-ventilator.
Pane.
Proof-staff.
Red-staff.
Runner.
Rynd.
Shoe.
Sifting-machine.
Smut-machine.
Tram-staff.
Ventilating-millstones.

Grind'ing-slip. A thin slab of oil-stone or hone to reach edges of tools which cannot be conveniently applied to the usual stone.

Grind'ing-spheres. Fig. 2319 illustrates Guy's device for grinding balls to a true surface. The ball, previously turned as nearly spherical as may be, is placed in the conical aperture of the holder *a*, and two rings *b* set from each other a distance equal to the diameter of the ball and pressing tightly against it, are made to rotate at right angles to each other, carrying the ball with them and bringing its protuberant portions in contact with the edges of the aperture, thus reducing it to a true spherical surface.

Fig. 2319



Grinding-Spheres.

Grind'ing-vat. (*Porcelain.*) A cylindrical tank in which calcined and stamped flints are ground into a fine paste with water. The vat is from 12 to 14 feet in diameter, and 4 feet deep, paved with chert-stone. It acts on the principle of the ARRASTRA (which see), large blocks of chert being attached by chains to revolving arms and dragged upon the pavement of the vat. Chert-stone is used because of its chemical affinity to the liquid, in order that no deleterious ingredients may be introduced by the mutual attrition of the *muller* and pavement in this operation, which is equivalent to porphyrization.

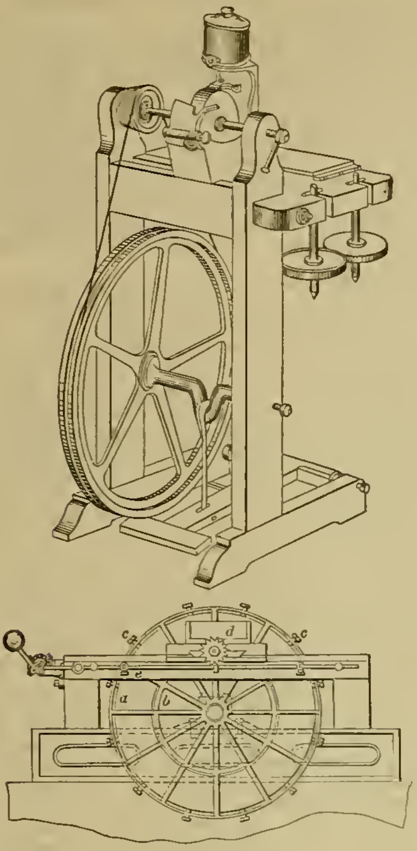
Grind'ing-wheel. Fig. 2320 is a small grinding and polishing machine, adapted for receiving various interchangeable spindles carrying grindstones, emery-wheels, or a circular brush. It is operated by a treadle, has a stand for a water-can, and slots at the sides in which the spare wheels with their spindles may be placed.

The lower machine in the same figure is adapted for grinding large flat surfaces. It consists of an inner and an outer circle *a b*, between the radial divisions of which segmental pieces of grindstone are inserted and fixed by set screws *c c*. The work is placed on the carrier *d*, which traverses on the table *e*.

a b c (Fig. 2321) represent guides for giving a uniform bevel to the cutting-edges of tools. In *a* this is effected by blocks of wood having the proper slope, to which the tool is fastened and the block clamped to the table. *b* is provided with a quadrant which allows of a vertical adjustment. The grinding-wheels *d e* are horizontal. *c* is adapted for affixing to a block, which is applied alongside of a vertical wheel. The tool is clamped to a holder, which has horizontal and vertical graduated arcs, admitting of adjustment to any required angle, so as to form a double bevel.

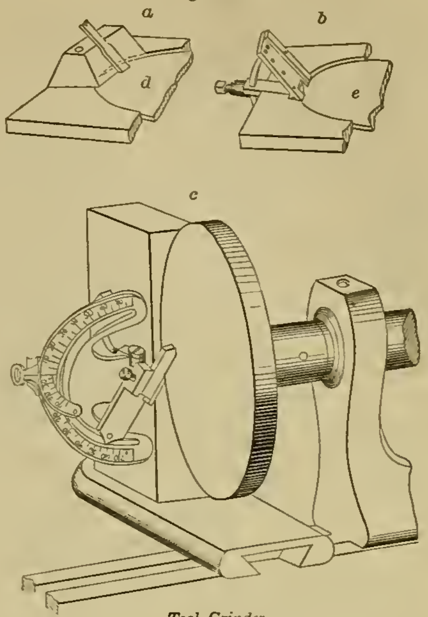
Grind'stone. Grindstones are made from the more compact sandstones, varying in texture and compactness according to the work required. Those

Fig. 2320.



Grinding-Wheels.

Fig. 2321



Tool-Grinder.

of England are highly esteemed. Different localities of that country afford such as are required for almost every purpose. Among these the "Newcastle" stones, from the coal measures of Northumberland and the adjacent counties, have a pre-eminence in England for general purposes; others are used for grinding, while many varieties are employed as plane surfaces for whetstones. Other qualities are used for hones. A German variety is famous for this purpose. The very finest qualities, composed of an almost impalpable agglutinated powder, are used as oil-stones. Such are the "Water of Ayr," and "Blue" stones, and the "Turkey" oil-stone. The old "Royal Exchange" of London was paved with this stone, and when it was burned, about 1834, the pavement yielded a handsome amount towards the re-erection.

The Nova Scotia and Berea, Ohio, grindstones are largely employed in this country; these may be obtained of very large size and uniform quality. The Washita, Arkansas, stone is of the very finest quality, being sharp and clean, and is made into a great variety of forms; grindstones, whetstones, hones, and slips of various sizes and forms.

In dressing rough grindstones, the process of hacking is employed. *Hacking* consists in notching the projecting parts with a short-handled hammer resembling an adze. *Laps* used in polishing stones, etc., are *jarred* by holding an old knife against their edges, so as to vibrate or *chatter*, making a slight indentation at each jump; these serve to retain the finely powdered emery or rottenstone mixed with adhesive material with which the lap is covered.

For clearing the surfaces of stones, in which particles of iron or steel have become imbedded, a square bar of ½ to ¾ inch iron is held and wabbled against the edge while in motion. This is called *straggling* or *ragging*.

Turning or *roving* is effected by reversing the motion of the stone and holding a hooked flat tool against its edge, which is afterwards farther smoothed by the roving plate.

The series of operations in making grindstones is about as follows.

The layer or ledge of rock being uncovered, channels are cut at each end of the slab to be removed, and then a row of holes is drilled on the line where the fracture is to be made. Steel wedges are driven into these holes, driving them consecutively a little at a time, keeping all on a strain, until the mass cleaves from the ledge forming a large parallelopiped. This block is similarly divided into squares, and these, if too thick, are split or cleft in the plane of the stratum to thickness required.

The square stone is now chipped into an octagonal shape, when it is ready to have the eye made. This is done by a pick-hammer.

It is then mounted on a mandrel driven at the rate of 125 rotations a minute. The turning-tools are five feet long, one and a half inches wide, and five eighths of an inch thick, tapered to a point by the blacksmith and afterward hammered to a hooked point by the workmen, who turn from 100 to 200 per day, according to size. An exhaust-fan withdraws the stone-dust, and a conductor leads it to the outside of the building.

The stones are placed in a row, an iron rod and wooden axis through them, a wooden head at each end being jammed against the stones by nuts. Slats nailed to the wooden heads and hoops over the slats complete the package. The works at Berea, Ohio, are the largest in the United States.

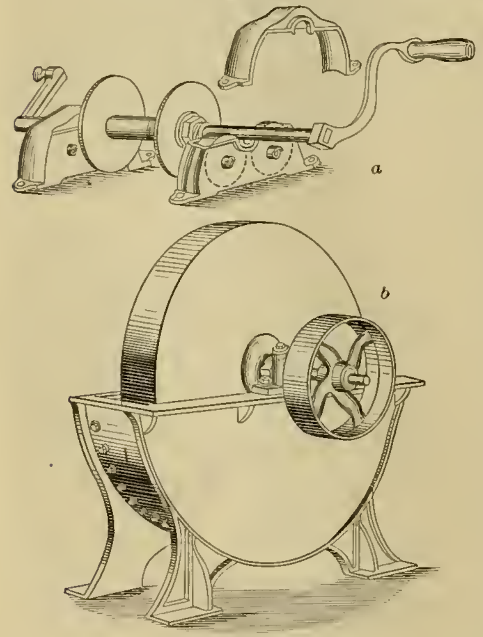
The large grindstones employed in grinding gun-barrels are 8 feet in diameter, and are used until they are reduced to a diameter of about 2 feet, when they are rejected. They are placed in a case with holes for the introduction of the barrel, which is temporarily slipped upon a rod, a crank at one end of the latter enabling the barrel to be turned while the stone is rapidly revolved. The case keeps the water from splashing upon the workman, and may afford some protection against pieces when the stone bursts, as it sometimes will, owing to the rapid rate at which it is driven. The danger of fracture cannot be entirely obviated, but may be much lessened by clamping the stone on its axis by disks instead of wedges inserted between the sides of the eye and the square arbor on which it it suspended. It would seem possible to avoid the eye altogether, and depend upon cheek-pieces with studs or projections which penetrate into depressions in the sides of the stone. The stones are so very heavy that their fracture when in rapid motion is apt to do great damage to life, limb, and property.

Artificial stones are largely employed, especially in dry-grinding and polishing.

The *corundum stone* used by the Hindoos and Chinese is composed of corundum powdered, 2 parts; lac-resin, 1 part. The two are intimately mixed in an earthen vessel, kneaded, flattened, shaped, and polished. A hole for the axis is made by a heated copper rod.

The grain is more or less fine, according to the grade of the powdered corundum. The wheel is mounted horizontally, and revolved by a bow in the right hand of the workman, while the left applies the work to the stone.

Fig. 2322.



Grindstone and Hangings.

The following recipe may also be employed: —

Sand of the required fineness, 3 or 4 parts; shellac, 1 part; melted, incorporated, and molded under pressure.

Ransome's artificial stone, sand agglomerated by silicate of lime, has been used for grindstones with excellent effect.

In a test trial between Ransome's (English) artificial grindstones and some Newcastle grit to ascertain which had the greatest abrasive effect, it was found that the Ransome stone ground away ¼ ounce from a steel bar ¾ inch diameter in sixteen minutes, while a Newcastle stone (natural grit) driven at twenty per cent greater speed required eleven hours to effect the same work. (London "Engineer.")

a, Fig. 2322, illustrates an arrangement for hanging grindstones in which the stone is held between adjustable disks and journaled between anti-friction rollers.

b, Fig. 2322, is an improved form of grindstone stand, having a pulley for turning, a lubricating oil-cup, and side-disks for holding the stone.

Stones for grinding cutlery vary in diameter from 4 inches to 2 feet. The faces of some, as of those for grinding razors, are convex. Those for dry grinding, an operation very injurious to health, have a flue above through which the small particles of stone and metal are driven by an air-blast.

Magnets have also been placed near that portion of the periphery of the wheel where the work is applied, in order to attract the filings, which would otherwise be inhaled by the workmen.

The angles formed by the faces of cutting-tools increase in proportion to the hardness of the material to be operated upon. Thus, the razor has an angle of from 17° to 20°, wood-cutting tools 25° to 45°, and tools for iron and steel 60° to 70°. For reaming-tools the angles are greater; for the hexagonal broach, 120°; octagonal, 135°.

Great care should be taken, where tools requiring an accurate edge are to be ground, to keep the face of the stone true. This may be effected by hanging a pair of grindstones so that their faces shall touch. Their rotation thus causes each to wear away the inequalities of the other.

The teeth of circular saws may be sharpened by a small grindstone having on the edge a ridge suited to the form of the teeth, and a slide fitted with an adjustable stop to regulate the abrasion.

Gripe. 1. (*Nautical.*) *a.* The *fore-foot* of a ship, on to which the *stem* is planted. The forward end of the *keel*. It is scarfed to the stem-piece and false-keel, and is secured by a horseshoe or ring to the stem. See STEM.

b. A broad plait of rope or bars of iron with lanyard rings and claws, passing over a large boat and by which it is secured to the ring-bolts of the deck.

c. One of a pair of bands passing round a boat near the stem and stern when suspended from the davits to prevent the boat from swinging about.

2. A brake applied to the wheel of a crane or derrick. It generally consists of an iron hoop under the control of a lever, and is drawn closely around the wheel to check its motion.

3. (*Weapons.*) Of a sword-hilt. The part which is grasped by the hand.

Grip′pers. (*Printing.*) The fingers on an impression cylinder which seize the paper by one edge and carry it to, and sometimes through, the press. In some cases tapes conduct it after it has been fed in by the grippers.

Grist. 1. (*Rope-making.*) A given size of rope. *Common* grist is a rope 3 inches in circumference, with twenty yarns in each of the three strands.

2. (*Milling.*) A batch of grain to be ground in a custom mill, or the result of the grinding less the toll.

Grist-mill. A grain-grinding mill. See GRINDING-MILL.

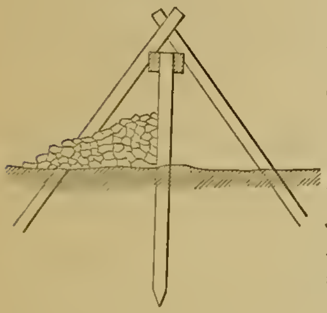
Grit. A sandstone used for grinding. The term *millstone-grit* shows that it was the material used in grinding-mills, but its use now is principally for *grindstones* and *whetstones, buhr* being used for *millstones*. *Buhr* is a foraminous quartz.

Gro′gram. (*Fabric.*) A coarse stuff of silk, or silk and mohair. The name is French (*gros-grain*, coarse texture).

Admiral Vernon, 1750, introduced rum and water as a ration on board ship, and wore a *grogram* coat. The soubriquet *Old Grog* referred to the coat, but was afterwards applied to the beverage.

Groin; Groyne. 1. A timber structure on a beach to accumulate shingle and sand, so as to form an advance protection from the energy of the waves to the land situate in its rear. It is formed of piles driven into the beach and projecting above it, to which are fastened land ties and planking. The illustration shows an open framing of timber placed parallel to the shore on the line of low water, and common in Holland. To avoid the washing out of the sand by the reflux of the wave, an apron of stone is placed at the foot.

Fig. 2323.



Groin.

On the Sussex coast, south of England, the groins are from 150 to 250 feet long. The piles 4 feet apart, 12 to 25 feet in length. Planking 2½ inches thick; land ties 25 feet in length. Every 16 feet in length contains 4 piles, 1 land tie, tail piles and keys, tie bar, blocks, and bolts, 180 superficial feet of planking, 140 6-inch spikes, and costs $150. See SEA-WALL; BREAKWATER.

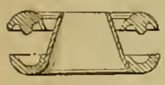
2. (*Architecture.*) The line of junction of two intersecting arches. A *Welsh* groin is one crossing transversely, but having a lesser pitch or hight.

Groined Arch. (*Architecture.*) An arch intersected by another cutting across it transversely. The line of junction is the *groin*.

Groin-rib. (*Architecture.*) A rib or projecting member following the line of junction of the two arches forming a groin.

Grom′met. 1. (*Nautical.*) A ring formed of a strand of rope laid round and spliced. Used as a *hank*, a *thimble*, or with large oars, in connection with a pin, as a substitute for a row-lock. Metallic grommets, forming eyelets, are sometimes substituted. In the example, an iron flange is cast to the wrought-metal thimble; after insertion the edge is spun over upon the other cast-metal ring.

Fig 2324.



Grommet.

2. (*Ordnance.*) A wad made of rope, rammed down between the ball and the charge. Made of oakum and bound with spun-yarn, it is called a *junk-wad*.

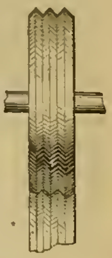
Groove. 1. (*Joinery.*) A channel in the edge of a board. In *matched* boards it receives the *tongue*.

2. (*Guns.*) A spiral channel between the lands in rifling.

Grooved Bit. A wood-boring tool adapted to be used in a brace, and having a cylindrical stem with a spiral groove. See BIT.

Grooved Wheel. 1. One having circumferential indentations, as a mode of increasing the traction or effective frictional surface contact. The edges of corresponding wheels have counterpart channels and ridges, so as to increase the area of the contacting surface and allow them when driven against each other to attain a mutual *bind* or *grip*. A *friction-wheel*. The two constitute a *friction-gearing*.

Fig. 2325.



Grooved Wheels.

2. A band-wheel or pulley having peripheral depressions for a round band, as in some lathes.

Groove-ram. (*Needle-making.*) A stamp for making the groove in which the eyes of needles are formed.

Groov′ing-planes. Carpenters' and joiners' planes which are adapted for cutting grooves, such as the *plow*, *fillister*, *router-plane*, *banding-plane*, etc. (which see). Planes are made in sizes to suit, in pairs known as *hollows* and *rounds*.

Gros. (*Fabric.*) A heavy silk with a dull finish.

Gros-de-Na′ples. (*Fabric.*) A plain, heavy, woven fabric, made of organzine silk.

Ground. 1. (*Navigation.*) To touch bottom.

2. (*Fabric.*) The prevailing color.

3. Sediment.

4. (*Plastering.*) Flush strips in plastering for the attachment of moldings and other finishing.

5. The surface of the ground, level or otherwise, or a representation thereof; as, —

Ground plan.
Ground plane.

6. The parts of a foundation or of a structure near the base; as, —

Ground-joist.
Ground-plate.
Ground-plot.
Ground-sill.
Ground-work.

7. (*Painting.*) The color first laid on.

8. (*Japanning.*) The pigment mixed with hard varnish which forms the basis for the japan or polished varnish surface.

9. (*Engraving.*) An acid-resisting composition of, asphaltum, 4; Burgundy pitch, 2; white wax, 1. This is melted and mixed, and then tied up in a silk rag.

In using, the plate is heated over an alcohol lamp or brazier, and the composition smeared on. It is then spread by a silk dabber, and blacked by the smoke of a candle or an oil-lamp. When cool it is ready for the *etching-point*. See ETCHING.

Where the point removes the ground, the plate is exposed to the subsequent action of the acid, and a line or a dot, as the case may be, is made in the plate.

Soft-ground is made by adding 1 part of lard to 3 parts of common etching ground. It is used for a certain kind of etching called *etching on soft ground*. See ETCHING.

In mezzotint engraving, the *ground* is said to be *laid* when the whole face of the plate to be occupied by engraving is raised by the *cradle* so as to have a *burr* which would print a uniform black. This is scraped away for the lights. See MEZZOTINT ENGRAVING.

10. (*Telegraphy.*) *a.* Accidental connection between the line wire and the earth.

b. The earth in its capacity as the return-circuit carrying body. The wire is carried to earth and connected to a *ground-plate*, or in cities to a water or gas main, which forms an admirable and extensive conductor.

Ground-au'ger. An earth-boring auger. See AUGER. Figs. 441-443.

Ground-glass. Glass whose surface is *ground*, so as to break up the pencils of light passing through it, preventing the passage of a distinct image. Lamp globes are ground in order to mellow and disperse the light passing through them. The process is done mechanically or chemically; the wheel, sand-blast, by rotating with pebbles inside, or by fluoric acid.

Ground'ing-in. The application of the secondary and subsequent colors to a cotton cloth, after it has received the color of the first block. It is a term used in the hand-block printing, and the *grounding-in* or *re-entering* may be of a *mordant*, a *topical-color*, or a *resist*. The correspondence of position of the color in the pattern is secured by points on the block; equivalent to the *register-point* of the chromatic process of type-printing or lithography.

Ground'ing-tool. (*Engraving.*) The rocker by which the mezzotint steel plate is roughened.

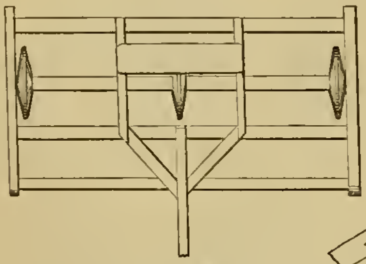
Ground-joint. A joint made by grinding together two pieces of metal with emery and oil; or pieces of glass with fine sand and water: the glass stopper is a specimen of the latter.

Ground-joist. (*Carpentry.*) A joist of the basement or ground floor. Often termed a *sleeper*.

Ground-lay'ing. (*Porcelain.*) A coating of boiled oil to the surface of porcelain, in course of manufacture, to receive the color. *Bossing.*

Ground-mark'er. An implement for laying off corn-rows. It is frequently attached to a corn-planter to make a mark for planting on the next bout. In the example, it is a frame with three sharp-rimmed wheels set at the desired distance apart, say 3 feet 8 inches to 4 feet, according to the size of corn and the practice of the country. The "King Philip" corn of New England may do with 36 inches, but the larger Southern varieties need 48 inches apart in the rows and between the rows.

Fig 2326.



Ground-Marker.

Ground-mold. (*Civil Engineering.*) A templet or frame by which the surface of the ground is brought to the required form, as in terracing or embanking.

Ground-plan. A representation on a horizontal plane of the foundation, or of the arrangement of the lower tier of rooms of a building.

Ground-plate. 1. (*Building.*) The lower horizontal timber of a building on which the frame is erected. A *sill*.

2. (*Railway Engineering.*) A bed-plate for sleepers or ties in some kinds of ground.

3. (*Telegraphy.*) A metallic plate buried in the earth to conduct the electric current thereto. It should bear a certain proportion to the size of the conductor which is attached to it; it should have a surface as many times larger than the surface of the conductor as the difference in the conductivity of the conductor and the earth. Connection to the pipes of a gas or water main is usual in cities.

Ground-plot. A representation on a horizontal plane of the ground to be occupied by a structure or other engineering works.

Grounds. (*Carpentry.*) *a.* Pieces of wood nailed on as guides for the plastering which comes flush with the face of the *grounds*. To them the molding and other finishings are nailed.

b. Framing or pieces forming a basis for other structure, as *ground-sills*.

c. Sheathing upon *quarters* or *studding* to form a basis for cornice work or moldings.

Ground-seat. (*Saddlery.*) A ply of canvas or linsey drawn over the *straining* which supports the padding and seat of a saddle.

Ground-sill. (*Carpentry.*) A *sleeper*; or a lower timber, which supports the remainder of the frame.

Ground-table. (*Building.*) The foundation course of stones.

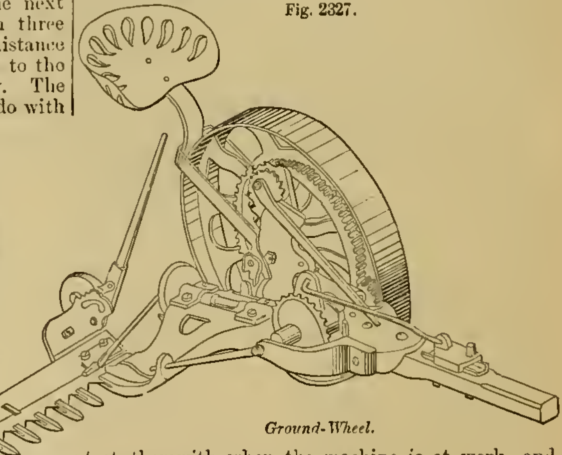
Ground-tack'le. (*Nautical.*) The ropes and tackle connected with the anchors and mooring apparatus.

Ground-tim'bers. (*Shipbuilding.*) Those which lie on the keel and are bolted to the keelson. *Floor-timbers.*

Ground-ways. (*Shipbuilding.*) The large blocks and planks which support the cradle on which a ship is launched.

Ground-wheel. That wheel of a harvester which, resting on the ground, is revolved by contact therewith when the machine is at work, and which drives the cutter.

Fig. 2327.



Ground-Wheel.

Similar wheels in other agricultural wheeled implements actuate subsidiary parts, such as the feed-wheels of drills, the thrashing cylinders and shoes of traveling harvesters, the rakes of hay-loaders, the reels of tedders and reapers, etc.

Ground-work. 1. (*Civil Engineering.*) *a.* The preparation of ground for the foundation of a structure, or giving it the required contour for any other purpose.

b. The basis or structural foundation of an erection.

2. (*Painting.*) The base color on which the painting is performed.

Grout. *a.* A thin coarse mortar used to run into crevices between the stones or bricks of a structure. "The Norman walls were of great thickness, and were filled up with small stones, amongst which mortar was poured in hot. This was called *grouting*; and in time the whole mass so hardened together as to acquire the consistence and strength of a solid rock." — Weale.

b. A finishing or setting coat of fine stuff for ceilings.

Grove Bat'ter-y. A form of double-fluid galvanic battery, invented in 1839 by William Robert Grove, F. R. S. It has a glass jar or cell in which is placed a plate of zinc bent into cylindrical form, and thoroughly amalgamated. Within the zinc is a porous cup, in which is placed a strip of platinum.

In the outer cup is dilute sulphuric acid (1 of acid to 20 of water by measure), and in the inner or porous cup is strong nitric acid. See Galvanic Battery.

Grow'ing-slide. A cell formed between two glasses, adapted as a *slide* for a microscope, and supplied with water by the capillary action of a few filaments of cotton extending thence to a little reservoir of water. It is designed for preserving algæ or infusoria in a growing condition.

Groyne. (*Hydraulic Engineering.*) A projecting defence extending out from the sea-shore or bank of a river, to prevent the land from being washed away. A shingle-trap. See Groin.

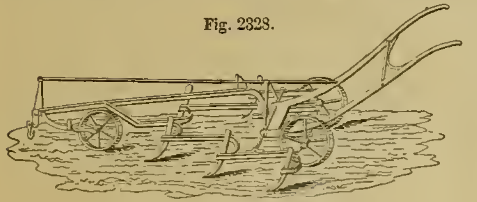
Groz'ing-i-ron. 1. An instrument with an angular steel projection, used for cutting glass before the general application of the diamond to that object.

2. (*Plumbing.*) A tool used in smoothing the solder joints of lead pipe.

Grub'ber. (*Agriculture.*) *a.* An agricultural implement used in Scotland for stirring and loosening the soil to plow depth. It is a heavy cultivator drawn by four horses, and supported on wheels. One form has an inner frame attached to the wheel-frame, and has two ranks of teeth, 5 in the front and 6 in the rear, cutting the balks between the preceding and outside of them. The teeth consist of colters armed with shares.

The form represented in Fig. 2328 is a heavy implement, not designed for tending crops, but to bring the land to a state of fine tilth, acting as substitute for the plow in some cases. It is more the practice in Britain than in the United States to give several successive plowings to ground in the course of one season, before sowing the seed. The grubber and some others of the heavier forms of cultivators are thus used. We apply the tool to the crop principally; they to that purpose, and also to the land, stirring it to bring it into good order and tilth before sowing.

Fig. 2328.

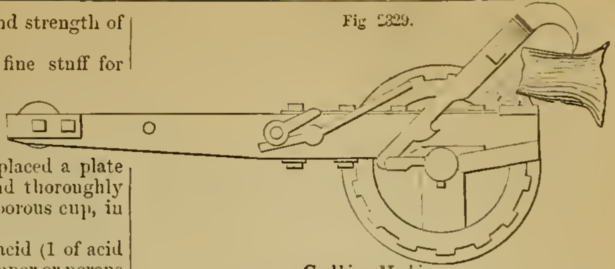


Kirkwood's Grubber (Scotch).

The grubber represented has a frame of a general triangular shape, having teeth set in divergent rows. It has a caster-wheel in front and two wheels behind. The machine is adjusted vertically, by means of depressing the handles, which oscillate upon the hind axle and raise the share frame, being attached to a transverse bar across the frame near the rear and to the lever in front, which forms the carriage of the caster-wheel. This is a highly respectable implement.

The term "grubber" is somewhat local, and other implements of similar construction and purposes are described under Cultivator (which see).

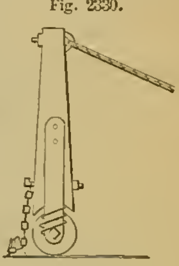
Fig 2329.



Grubbing-Machine.

b. A machine or tool to pull *grubs;* that is, stumps and roots of bushes, saplings, and small trees. Some heavy plows are made to tear through ground occupied by the stubs and roots of bushes and brush. The English *turn-wrest plow* is adapted for tearing through and routing up the roots of bushes. The grubber shown at Fig. 2329 has a lever supported upon an axle and wheels. When in vertical position it is attached by a grab hook and biting tooth to the stump, the lever is then pulled over by a rope or tackle, as seen in the smaller figure (Fig. 2230), where a post, roller, and chain constitute the apparatus. The pole is attached by the hounds to the axis of the rollers when being transported, but presses directly on the periphery of the roller when in action.

Fig. 2330.



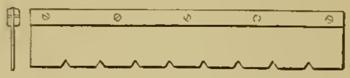
Grubber.

Grub'bing-axe. An implement having a curved bit presented at right angles to the helve, like an adze; and another bit presented in the line of the helve, like an axe. A *mattock.*

Grub'bing-hoe. A heavy hoe for digging around stumps or stones. A mattock.

Grub-saw. A hand-saw used for sawing up marble slabs into strips, such as shelves, mantel-pieces, etc. The kerf is started by a narrow chisel while lying upon the rubbing-bed. It has an iron blade notched at the edge, and stiffened by a backing of wood like the metallic back of a tenon-saw.

Fig. 2331.



Grub-Saw.

Grunt'er. (*Brass-founding.*) An iron rod, with a hook at the end, by which an assistant aids in supporting the crucible, by catching hold of the shoulder of the crucible-tongs.

Gua'no-sow'er. Guano is the excrement of sea-birds collected in thick beds on some islands on the coast of Peru, and in some other places. Its use is no new thing. The Peruvians before the conquest used guano in the cultivation of the potato, tobacco, corn, and other plants for which Europe is indebted to this side of the Atlantic. An English cruiser in 1720 mentions having captured a small vessel laden with it.

The guano-sower is sometimes an attachment to a wheat-drill, and does not differ very materially from a seed-sower, except in devices to keep the stuff stirred up and prevent its becoming aggregated in lumps.

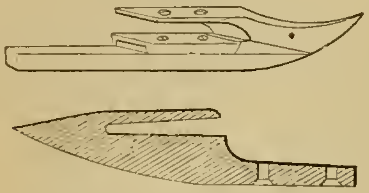
Guard. 1. An upright piece of wood in a narrow passage to prevent the lock of a canal or the corner of a street from being injured by passing boats or vehicles. A *fender*, *guard-pile*, or post, as the case may be.

2. (*Navigation.*) An extension laterally of the deck of a river steamboat, beyond the lines of the hull, making it overhang the water. It frequently comes flush with the outside of the paddle-box.

3. (*Machinery.*) A light frame in which the nuts of bolts fit to prevent their unscrewing by the vibration of the engine.

4. (*Husbandry.*) One of the teeth projecting forward from the cutter-bar of a harvester. The knife plays through the guards, and the knife sections make a shear cut against the soles *B* of the guard-slots. In the upper figure the sole-piece is removable to enable its edge to be sharpened.

Fig. 2332.



Harvester-Guards.

5. The bow or basket of a sword-hilt to protect the hand.

6. (*Fire-arms.*) *a.* A bow beneath a gun-stock protecting the trigger.

b. A safety-lock of a fowling-piece to prevent the accidental dropping of the hammer.

c. A nipple-shield to protect the little tube which receives the percussion-cap.

7. A bow or wire around a lantern to protect the glass.

8. (*Bookbinding.*) One of the slips of paper bound in with a blank-book to thicken it at the back, when the leaves are intended to contain mounted slips, or drawings.

Guard-fin′ger. One of the teeth projecting forward from the cutter-bar of a harvester, and through which the knife plays. See GUARD.

Guard-lock. (*Hydraulic Engineering.*) A *tide-lock*, forming a communication between a basin and tide-water.

Guard-pile. (*Maritime Construction.*) A pile of the nature of a *fender*, driven in front of a quay or wharf to protect the structure from the blows of, or abrasion by, a vessel alongside.

Guard-plate. The plate which closes the opening in front of a cupola-furnace, to whose iron casing it is attached by staples. In the center of the plate is the *tapping-hole*, through which the melted metal flows when the *stopping* is withdrawn.

Guard-rail. (*Railroading.*) 1. A short rail placed on the inside of a main rail, so as to keep a wheel on the track by pressing against the inside of the flange of the wheel. It is used when there is a short break in the continuity of the other rail, as in switches and crossings. A *safety*, *side*, or *wing* rail.

2. (*Nautical.*) *a.* A hand-rail on the paddle-box bridge of a steam-vessel.

b. A breast-rail on the break of the poop.

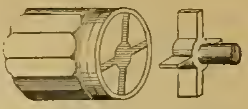
3. A safety-rail around a hatchway.

Gud′geon. *a.* The metallic journal piece let into the end of a wooden shaft.

b. The bearing portion of a shaft.

c. The metallic eye bolted to the stern-post to hang the rudder upon.

Fig. 2333.



Gudgeon.

The rule for finding the size of the gudgeon of a timber water-wheel is as follows: — Multiply the diameter of the wheel in feet by the width of the wheel in feet, add to this the square of half the diameter of the wheel in feet. The cube root of the sum thus obtained will give the required diameter in inches.

Guest-rope. The rope by which a boat is kept steady while in tow.

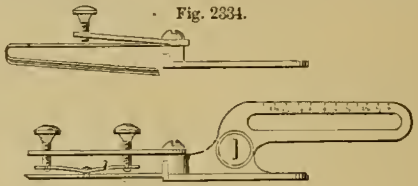
Guide. 1. A tool or instrument director, as the staff or director of a surgeon's probe or bistoury.

2. A pile driven to mark a site.

3. A pulley to direct a band in a new direction.

4. (*Sewing-machines.*) A means of directing cloth to the edge or face-plate of a gage, in making a hem or tuck.

Fig. 2334.



Clemons's Cloth-Guide.

In the example, the elastic plate is attached to the gage-plate and rests upon the goods, an adjustable pressure being brought upon the elastic plate by a screw or screws in a rigid plate above, and in such a manner that it presses more upon the cloth outside of the seam than inside, and so directs the cloth against the face of the gage-plate.

5. (*Railway Engineering.*) An additional rail to keep a locomotive or car on the track in curves, crossings, or steep grades. See GUIDE-RAIL; GUARD-RAIL.

6. (*Steam-engine.*) One of the bars which keep in line the blocks on the cross-head of the piston-rod. See GUIDE-BLOCK.

7. (*Printing.*) A printer's copy-holder, which marks the line.

8. (*Water-wheels.*) A plate in the curb of a water-wheel to direct the water upon the buckets of the wheel.

Guide-blocks. (*Steam-engine.*) Metallic pieces with parallel sides fitted on the ends of the cross-head and sliding as guides on the side frames to keep the motion of the piston-rod direct.

Guide-pile. (*Hydraulic Engineering.*) A pile driven to mark out or limit the field of operation or a site.

Guide-pul′ley. (*Machinery.*) A pulley for directing or changing the line of motion of a belt, but not otherwise concerned in the transmission of motion.

Guide-rail. An additional rail, usually placed midway between the two ordinary rails of a railway track, and employed in connection with devices on the engine, carriages, or both, in preventing the rolling-stock from running off the track.

The *center-rail* gripped by horizontally rotating wheels acts as a guide-rail.

Blenkinsop's rack-rail (English patent, 1811) was used as a means of progression in connection with a spur-wheel on the engine, and not as a guide.

Following him was Snowden's middle-rack and mechanical horse. See CENTER-RAIL.

Easton's center-rail (English patent, 1825) fulfilled two purposes; its upper edge formed a rack and served, in connection with a spur-wheel on the locomotive, as a means of progression; its sides formed a guide-rail in connection with pairs of horizontally rotating rollers underneath the carriages of the train.

Kollman's English patent of 1836 has a similar guide-rail.

Prosser's guide-wheels (English patent, 1844) are set an angle of 45° beneath the truck, and have sunken rectangular faces which bear upon the inner angles of the square rails. The guide-wheel enables the flanges of the bearing-wheels to be dispensed with.

No extra rail is introduced.

The *guide-rail* gripped by horizontally rotating wheels, driven by the engine, the combination of wheels and center-rail forming the means of ascending gradients, is first found in the English patent of Vignolles and Ericsson, 1830.

Sellers's United States patent, 1835, has a similar device, and it is also used by Fell on the White Mountain Railroad in New Hampshire and the Mt. Cenis Railway, which climbs the Alpine pass, connecting St. Michel on the French side with Susa on the Italian.

A correspondent of the Hartford "Courant" thus describes it: —

"The carriages are about half the length of ours at home, with seats on each side, so that the passengers face each other as in an omnibus, and with windows at the sides, from which it is difficult to see out when one is squeezed in tight on the seat, with his back to them. The cars are also very narrow, the track being only three feet six or seven inches gage, so that they are not much more comfortable than an omnibus. The fare, first class, was twenty-five, second class, twenty-two francs, from Susa to St. Michel, the time occupied in the passage being from four to five hours.

"The locomotives of these trains are small, compact, and powerful; their trucks, as well as those of the carriages, set well in the middle, so that they can turn very short curves. The track has three rails, one elevated in the center. Besides its ordinary driving-wheels, the locomotive has two horizontal wheels which press this third rail on either side, and it is by this strong traction that the train is pulled up. The carriages have corresponding wheels for the center rail, but their only use is to keep the train on the track. Both cars and locomotive have double sets of brakes, one for the ordinary and one for the central rail, so that they can screw the cars to the track with the grip of a vise, and render it almost impossible for the carriages to run away. There is every precaution against accident; and I should only fear the snow-storms of winter, and perhaps an avalanche in some places high up, which are not roofed in.

"Our train seemed to be a huge live reptile with legs and claws, that crawled up by its own power; it literally dug right up hill, and we felt ourselves mounting, and, looking back, could see the deep incline. On the curves, where the wheels got a good grip of the rail, we moved with ease and more rapidly than on a straight pull, where the locomotive evidently labored more, and we rose more slowly. The steepest grade on the road is one foot in nine feet, but this is only for short distances. The rise of one in twelve is more common; and the least (of which any note is taken) is one in twenty-five. The curves are so short as to be startling. We seemed to turn in a space as small as an ordinary wagon could. The shortest curves are on a radius of only one hundred and twenty feet; that is, our train would run round a circle only two hundred and forty feet in diameter. Our track was all the time in sight, behind and before, running along the steep hillsides, and constantly doubling, like a compressed letter S."

Gui′don. A swallow-tailed company flag in a cavalry regiment, half red and half white, dividing at the fork. The red above has "U. S." in white. The white is below, and has the letter of the company in red. The *fly* is 3 feet 5 inches to the end of the tail; the *head* is 27 inches. The lance is 9 feet long, including spear and ferrule.

The regimental cavalry flag in the United States service has 29 inches *fly* and 27 inches *head*. The edge has a yellow silk fringe. The field is of silk, and has the arms of the United States embroidered in silk on a blue ground, with the number and name of the regiment in a scroll under the eagle.

Guil-loche′. (*Architecture.*) An ornament of intertwisted bands or interlaced cords, which is made continuous as a fascia.

Guil′lo-tine. A machine for beheading persons, named after Joseph Ignace Guillotin, a French physician (1738 – 1814), its supposed inventor. He did not invent it, but seeing that his Revolutionary friends had a large job of killing on hand, he suggested its use as a certain and complete mode of decapitation.

Dr. Antoine Louis, of Paris, had the credit of its invention for a while, and it appears under the hands of the facile French to have attained a completeness in construction and execution which left nothing to be desired — except, perhaps, mercy.

A beheading machine, called the *maiden*, and sometimes the *widow*, by the *lively* Scotch, was imported from Halifax, England, into Scotland, about 1550, by the Regent Morton, who seems to have been enamored of the maiden's business capacity. He was beheaded thereby in 1581, — though he was not the first victim, as has been sometimes stated. The murderers of Rizzio were beheaded by it in 1566; and among its last victims was the Earl of Argyle, 1681.

It is laid up as a memorial in the Museum of the Scotch Society of Antiquaries, Edinburgh.

Of the Halifax machine we know but little except that Morton imported the maiden thence.

Pursuing the back track, we find that the Duc de Montmorenci (blue blood) was executed by a falling axe at Toulouse, 1632; that the Dutch used it in executing slaves in their colonies, and that its use was comparatively common in Germany during the Middle Ages.

The *Mannaia* of Italy, by which Conradin of Swabia was executed, 1268, at Naples, and Beatrice Cenci at Rome, in 1605, was of the same construction substantially.

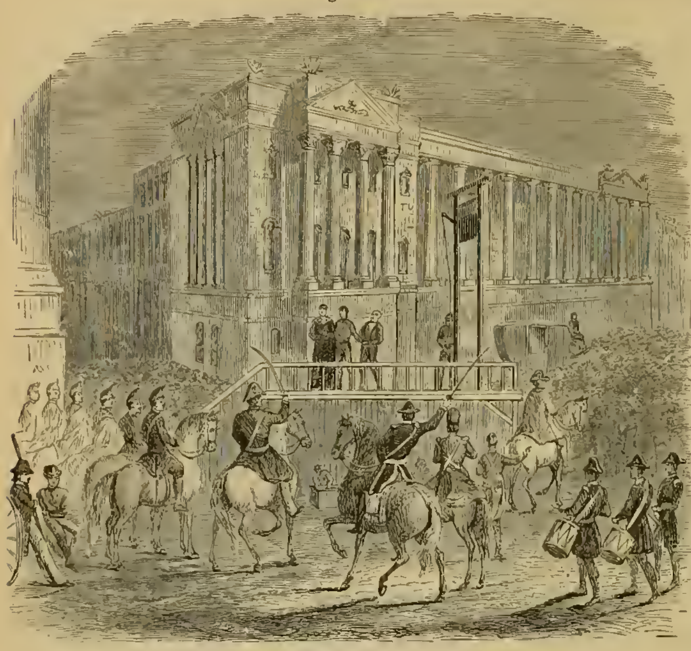
The guillotine is mentioned in German books of 1534, 1551, and 1570. It is called the Roman falling-axe, and the decollation of St. Matthew thereby was a favorite subject with illuminators of manuscripts 250 years before the French Revolution.

In the London "Monthly Magazine," April 1, 1800, p. 247, is an enumeration of ten cuts and engravings of the sixteenth century in which a guillotine is employed. The representations are principally martyrdoms of saints.

During the war of the Spanish Succession, 1702 – 13, Count Bozelli was decapitated by the guillotine, which is thus described by a traveler who witnessed the act: —

"In the great square was erected a scaffold, covered with black. In the middle of it was placed a

Fig. 2335.



Guillotine.

great block of wood, exactly of such hight that the criminal, on his knees, could lay his head upon it, between the pillars of a sort of gallows, which supported an axe of a foot in hight and a foot and a half in breadth, sliding in a groove. The axe had a mass of above a hundred weight of lead attached to its upper side, and was suspended by a cord fastened to the gallows. The executioner cut the cord that supported the axe. The deadly instrument in its fall severed the head from the body, and penetrated about two inches into the block."

The original instrument was probably Persian.

The French *guillotine* has a heavy knife, sliding in vertical grooves in a frame.

It is a grim subject, but, involving mechanical construction, is within our scope.

An observer in Paris thus records the appearance of the machine and the mode of using it: —

"On a platform about 12 feet square, and 7 feet above the ground, are erected the two upright posts between which is suspended the axe. They somewhat resemble a narrow gallows with not more than a foot between the posts. The axe, which is not unlike a hay-knife, though much heavier and broader, is drawn up to the top of the posts, between which it runs in grooves, and is held suspended by a loop in the halyards, passed over a button at the bottom. The edge of the axe is diagonal, so as to make a *draw* cut, giving it a fearful power and certainty in severing a human neck.

"On the center of the platform stands a frame or large inverted box, much resembling a soldier's arms-chest, about 6 feet long and 2½ feet wide and high. One end of this abuts upon the upright posts; at the other end is a small truck having a strap and buckle by which the culprit is secured to it.

"The victim was advanced with his breast against the truck, to which his body was rapidly strapped. He was then tilted down, truck and all, upon his face; the truck, moving upon small wheels in grooves on the top of the chest, was run rapidly forward until the neck came under the knife. The rope was unhooked from the button, the axe fell with a *thud*, the head fell into a basket, and the body was unstrapped and rolled into a large basket alongside."

There is an air of ferocity about the punishment by beheading, and of absolute brutality in the mode of execution by hanging. The Japanese are skillful decapitators. The Spanish garotte is a horror. Poisoning is ancient but disreputable. Shooting is martial, and has one merit; it enables a man to stand up and face the executioner, and has less of humiliation than the cutting and choking processes.

It is a vulgar error that Dr. Guillotin perished by the machine of his suggestion. He died in 1814, after founding the Academy of Medicine.

The myth seems to have been derived from the Regent Morton's having been beheaded by his imported pet. This kind of poetic justice is commoner in tradition and romance than in fact. It seems to round up and complete the history when —

> "This even-handed justice
> Commends the ingredients of our poisoned chalice
> To our own lips."
> "Where the offence is let the great axe fall."

Guil′lo-tine′-cut′ter. A machine which cuts by a knife descending in guides. Cutters for paper and straw are thus made, and the descent is usually oblique, so as to give a *draw* cut.

Gui-pure′. A kind of lace in imitation of the antique. Patterns are cut out of cambric to form the flowers and heavy parts; the open parts are made of stitches.

Gui-tar′. The ancient Egyptian guitar (*a*, Fig. 2336) had a hollow, oval body, and its upper surface was perforated for the escape of the sound. It had three strings of catgut, fastened at the lower end to a triangular piece of wood or ivory which raised them to a sufficient hight without a bridge. The guitar was played as an accompaniment to the voice and in concert with other instruments. Also in concert with dancing motions and posturing, which is about as near as the Egyptians came to theatrical performances. These were invented by the Greeks, the originators of tragedy and comedy. The Romans added the pantomime.

On the Guglia Rotta at Rome is a large obelisk, which was brought from Egypt by Augustus and thrown down and broken at the sacking of the city by the Constable of Bourbon, in 1527.

On it is represented a guitar (*b*) which had evidently two strings. The length of the finger-board would allow a considerable scale of notes.

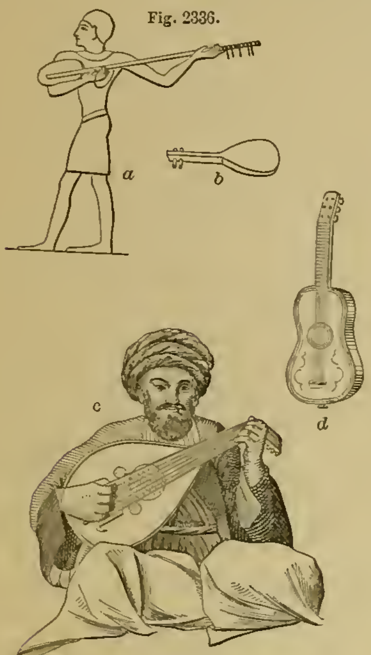
In the sculptures of Nimroud is represented a musician playing on a guitar.

The present name is derived intermediately from the ancient Greek, where it indicated a musical instrument resembling a harp (*cithara*).

The Europeans, ancient and modern, derived it from Egypt. Like some other things, it was imported directly into Greece from Egypt in ancient times; and again through the intervention of the Saracens into Europe, after the lull of the dark ages; following the track through Spain.

The modern Arabs have an instrument called the 'ood (c, Fig. 2336), which may be considered the Syrian guitar. The head is bent over as in the European guitar; the neck appears to be destitute of frets. The strings are seven, and are made of catgut.

Fig. 2336.



Guitars.

The Peruvians had a guitar with five or six strings, called a *tinya*. They also possessed the *syrinx*, *flute*, *tambourine*, and *trumpet*.

The guitar was introduced into England by Francis Corbeta, about 1660, and was a novelty to the writers of the day.

"I heard a Frenchman play upon the guitar most extreme well, though at best methinks it is but a bawble." — PEPYS's *Diary*, 1661.

"My Lord Sandwich playing upon the gittarr, which he now commends above all musique in the world" — PEPYS's *Diary*, 1665.

The guitar is the principal musical instrument of the Japanese. Their *syamsic* has three strings, two in the octave, the middle one giving the fifth. It is played with a plectrum, consisting of a flat piece of horn, held between the thumb and third finger. The Japanese have no idea of harmony, and play all their instruments in unison. Their dancing is of the Oriental style, like the Almehs of Egypt, — motions of the arms, head, and body, rather than of the feet. It is not so exclusively professional as in Egypt and India, and consequently not so systematically lascivious.

The Spanish guitar *d* has a hollow body with a round opening in the sounding-board. The neck has seventeen frets. The strings are six, are tuned E, A, D, G, B, E, and are stretched between a bar attached to the sounding-board and the pegs, which are journaled in the *head*.

An English guitar has been constructed to be touched by keys, and one of a large size has been made in Germany, and is adapted to be held with the bow between the knees. Neither have proved valuable accessions to the list of musical instruments.

Gui'tar-ban'jo. An instrument combining the characteristics of the guitar and the banjo, having the strings and fretted neck of the former, and the sheepskin head and metallic hoop of the latter.

Gul'let. 1. (*Civil Engineering.*) A narrow working cutting made in the formation of an excavation, and used as a means of laying down a pair of rails to bring the dirt-cars to the bank.

2. (*Harness.*) The lower end of a horse-collar, around which passes the *choke-strap*, and the *breast-strap* which supports the pole of a carriage.

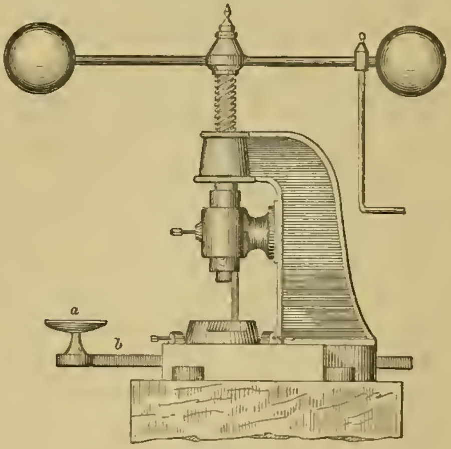
3. (*Saws.*) A hollow cut away in front of each saw-tooth, in continuation of the face, on alternate sides of the blade. Such saws are known as *gullet-saws* or *brier-tooth saws*.

The gullet is adapted to allow the saw to be sharpened by a round or half-round file, by which the face of the tooth becomes concave when viewed edgeways, and acquires a thin cutting edge. The increased curvilinear space also allows more room for the sawdust. See GULLET-SAW.

Gul'let-ing. (*Railroad Engineering.*) In excavating for railroads, a system of carrying the work forward in a series of steps upon which different gangs of men are at work with pick, shovel, and wheelbarrow, assisted by temporary lines of rail and dumping-wagons if the work be sufficiently extensive. Also called *notching*.

Gul'let-ing-press. A press for punching or gulleting saw-blades, gumming worn saws, or paring down or retoothing broken saws. The punch is socketed in the end of a plunger whose upper portion is a double-threaded screw crowned by a fly-handle. The table *a* is adjustable by means of its rod *b*, and affords an axis for the eyes of circular saws or saw-blades under treatment.

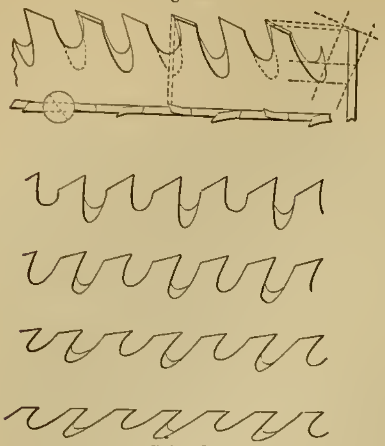
Fig. 2337.



Gulleting-Press.

Gul'let-saw. A saw having a hollow cut away in front of each tooth in continuation of the face and on alternate sides of the blade. Called also a *brier-tooth saw*.

Fig. 2338.



Gullet-Saw.

Gul′let-tooth. A form of saw-tooth. See Gullet-saw.

Gul′ley. The tram-plates or rails laid for the use of tram-wagons.

Gum. 1. An instrument for shaping saw-teeth. See Saw-gummer.

2. A hive made of a section of a hollow log; a *bee*-gum.

3. A hollow log inserted vertically into the ground as a curb for a spring.

4. A vegetable secretion which hardens as it exudes, but is soluble in water; distinguished from resins, which are soluble in alcohol, but not in water. There are a few resins which by careless custom are named as gums, such as *copal*, often called *gum-copal.*

Gum′mer. A tool or machine for deepening and enlarging the interdental spaces of worn saws. See Saw-gummer; Gulleting-machine.

Gum′ming. (*Lithography.*) The treatment of a lithographic stone with a solution of gum-arabic, after, or simultaneously with, the etching process, whereby the clean parts of the stone devoid of work are protected from receiving fatty matter, and thus reject the greasy ink when the roller passes over the stone. The clean surface of the stone is damped between each impression, but, without the gumming, it would not permanently resist the ink.

Gum-pot. A copper boiler used by varnish-makers for melting the gum and mixing the ingredients. It is about 33 inches deep, and 9½ inches in diameter. An upper section is riveted to it to keep in the ingredients when they foam. It is supported by a circumferential flange which rests on the top of the furnace, and is adapted to be readily removed and replaced.

Gun. A weapon having a barrel adapted to receive and discharge a missile which is projected by a charge of powder, gun-cotton, or air, as the case may be. See under the following heads: —

Air-gun.
Arquebus.
Battery-gun.
Blunderbuss.
Cannon.
Carbine.
Carronade.
Columbiad.
Field-gun.
Fire-arm.
Fowling-piece.
Gatling-gun.
Howitzer.
Machine-gun.
Magazine-gun.
Mitrailleur.
Musket.
Pistol.
Pivot-gun.
Revolver.
Rifle.
Shot-gun.
Siege-gun.
Swivel-gun.
Steam-gun.

Allied are another class not usually termed guns.

Mortar.
Coehorn.

The projectiles are numerous. Lists may be found under Weapons; Projectiles; Fire-arms; Artillery (which see).

Gun-bar′rel. Gun-barrels of superior quality are known as *stub, stub-twist, wire-twist, Damascus-twist, stub-Damascus.*

Stub-iron consists of horseshoe nails, cleaned in a tumbling-box, mixed with from 12 to 50 per cent of steel pieces of the same size; puddled, hammered, heated, tilted, and rolled. From this material a *skelp* is made.

Twist barrels are made of a ribbon of iron wound spirally around a mandrel and welded.

Stub-twist is stub-iron coiled on a mandrel, as described.

Wire-twist is made by welding laminæ of iron and steel together, or two qualities of iron, and drawing the compound bar into a ribbon, which is coiled as described.

Damascus-iron is made of several bars of steel and iron laid parallel in a *fagot* and drawn out into a bar. A piece of the bar is heated to redness, one end placed in a vise and the other end grasped by tongs, by which the bar is twisted till it assumes a cylindrical shape, and is shortened to, say, three feet. Several such bars, twisted in diverse directions, are laid together, welded, and drawn into ribbons, which are severally wound on mandrels as before.

Stub-Damascus is formed from a single bar or twisted rod, forged, drawn into a ribbon, and wound on a mandrel.

Damascus and wire twist is ribbon of the said varieties combined.

The ribbon for the twisted barrel is several yards long, about ½ inch broad, and is thicker at one end than the other, in order to give the strength at the breech. It is heated to redness, coiled around a mandrel, the coil removed, heated to welding heat, dropped on to a cylindrical rod which is then struck vertically on the ground to jar the edges of the spiral together and cause them to adhere. This is called *jumping*, and the operation of welding is completed by a hammer on an anvil, the central rod being maintained in position.

The iron plate, technically termed a *skelp*, is usually about a foot in length, and when heated to a welding temperature is rolled around a mandrel and passed through sets of rollers, which, in turn, elongate the skelp, reducing its diameter and giving the proper size and taper to the barrel.

Formerly the edges of the heated blank were welded upon the mandrel by the successive blows of a trip-hammer, or a "drop," dies intervening between the iron tube and the drop and anvil respectively. A portion only of the seam is closed at a time by this means, and the operation is more tedious and expensive than the rollers just described. The rolling process was introduced from England.

(*Boring.*) For boring, the barrels are placed in a heavy iron frame called "boring banks," where they are reamed out by the boring-tool, which consists of a square broach of steel, with sharp edges. The tool is rotated and advanced while the barrel is firmly held, and the operation is repeated with successively larger tools until the required size is obtained, — something short of the eventual caliber, as other operations are to follow, and will farther increase the size of the bore.

The outer surface of the barrel is then turned in a lathe, the barrel being sustained by mandrels at each end. The tool may be fixed in a slide-rest which moves it longitudinally of the barrel, and also in or out to give the required taper from the breech to the muzzle, or the latter or transverse motion may be imparted to the tool-rest while the barrel has a longitudinal in addition to its rotary motion.

The barrel is then ground by being held parallel to and against the face of a rapidly revolving stone. For this purpose the barrel is slipped upon an iron rod and revolved by means of a crank on the end of the rod. The stones are cased in for safety, and also to keep the water from splashing upon the workmen, holes in the ends of the casing permitting the introduction and withdrawal of the barrel.

After grinding, the barrels are polished by hard-wood rubbers, supplied with lard-oil and emery. The barrels are placed in upright frames, several in each frame. The grooved ends of the rubbers are then pressed by springs against the barrels as they move up and down with a regular and rapid motion, the barrel, the while, revolving slowly. After remaining in the first polishing-machine for fifteen minutes or thereabouts, they are transferred to another and similar apparatus where the emery is dispensed with.

Much ingenuity has been expended in devices for detecting deflection or faults in gun-barrels, and for straightening them when unevenness is detected. The correction is made by placing the barrel on a small anvil and giving it a gentle blow with the hammer. The workman obtains artificial aid in detecting faults, by a transparent slate marked with two parallel lines and placed in a window. The barrel being pointed towards the window, the lines are reflected upon the polished interior surface of the barrel, and any unevenness throws the reflected lines out of parallelism; which is readily detected by the experienced workman. In former times, a hair or some other very slender line was passed through the barrel and drawn successively across each portion of the inner surface, concavities being revealed by the distance between the line and its reflected image in the metal.

For proving, the barrels are loaded with a heavy charge and then laid in a rank in the parallel grooves of a massive table in the proving-room, the charge in each piece being connected to a train of powder on the back of the stand, and passing to the outside of the building, so as to fire the charges from a place of security. The balls are received in a bank of earth, and those barrels which appear to have withstood the first charge are subjected to a second, smaller proving charge, to open any rent which may have been made by the former. Those which stand both tests are stamped with the mark of approval.

A still more severe test is filling the barrel with water, and driving in an air-tight bullet by heavy and repeated blows. If any chink or crack is to be found, the water will ooze from it.

The barrel having been welded, rolled, bored, turned, ground, polished, and proved, is now to be rifled by having twisting grooves cut in its interior. This is more fully referred to in this work under RIFLING-MACHINE, and is a very old device, specimens of rifled cannon and small-arms of the seventeenth century being preserved in European collections. In general features most of the machines agree; the barrel is firmly secured in the frame of the machine, and the grooves on its inner surface are cut by narrow bars of steel, which are placed within three apertures near the end of an iron tube which passes through the barrel by a slow compound motion, rotary and progressive.

The sight and cone seat are attached to the barrel at the proper stage of its progress, the former by brazing and the latter by welding.

Steel barrels are drawn from short bars, which are bored, heated, and drawn upon a mandrel between rolls, which successively lengthen and reduce the diameter of the barrel.

After boring and rifling, the grain or mottled appearance is produced by steeping in acids or by heating in boxes with charcoal, and then plunging in solution of ammonia. See BROWNING.

The principal imperfections to which gun-barrels are liable are the *chink*, the *crack*, and the *flaw*.

The *chink* is a small rent in the direction of the length of the barrel.

The *crack* is an imperfection across the barrel.

The *flaw* is a scale, or small plate, adhering to the barrel by a narrow base, from which it spreads out like the head of a nail from its shank, and when separated leaves a little pit in the metal which collects moisture and foulness, corroding the metal.

Gun-bar'rel Gage. The gage of large guns is the weight of the ball they carry, as 6-pounder, 8-pounder, 12-pounder, etc.

Or it is expressed in inches, and the fraction, if such there be, in decimals, as 8-inch, 10-inch.

The bore of the barrels of fire-arms is also denominated by the decimals of an inch, as .44, .45, .50, .55; all of which are somewhat common sizes.

The usual mode of denominating the barrels of sporting-rifles and fowling-pieces is by the number of bullets, of the diameter of the bore, that are contained in one pound of lead.

Gage-Table for Barrels of Fire-Arms.

No.	Diameter of Bore in 100ths of 1 Inch.	Weight of Leaden Bullet in Grains.	No.	Diameter of Bore in 100ths of 1 Inch.	Weight of Leaden Bullet in Grains.
5	.98	1,400	19	.65 +	$368\frac{8}{19}$
6	.93 –	$1,666\frac{2}{3}$	20	.63 +	355
7	.89	1,000	21	.63	$333\frac{1}{3}$
8	.85 –	875	22	.62 +	$318\frac{2}{11}$
9	.81 –	$777\frac{7}{9}$	23	.61 +	$304\frac{8}{23}$
10	.79	700	24	.61	$291\frac{2}{3}$
11	.77 –	$636\frac{4}{11}$	25	.60 +	280
12	.75 +	$583\frac{1}{3}$	26	.59 +	$269\frac{3}{13}$
13	.74 –	$538\frac{6}{13}$	27	.59	$259\frac{7}{27}$
14	.72 –	500	28	.58 +	250
15	.70 +	$466\frac{2}{3}$	29	.58 –	$241\frac{11}{29}$
16	.69 –	$437\frac{1}{2}$	30	.57	$233\frac{1}{3}$
17	.67 +	$411\frac{13}{17}$	31	.56 +	$225\frac{25}{31}$
18	.66	$388\frac{8}{9}$	32	.56 –	$218\frac{3}{4}$

Gun-bat'ter-y. 1. (*Fortification.*) The emplacement of two or more pieces of artillery, destined to act on the offensive or defensive. It may be, —

Open; merely field-guns in position.

Covered; protected by a parapet.

Masked; disguised by a screen of branches, or other obstructions to the view.

Enfilading; sweeping the face of the body of troops or the works, by a fire in the line of the length of the object.

En echarpe; having a line of fire oblique with the face of the object.

En revers; playing upon the rear of the enemy.

Cross-fire; several batteries having a converging fire upon an object.

Siege; of a large description, for breaching.

a. *Elevated*; on the natural level of the ground.

b. *Half-sunken*; when the *parapet* is partly made of earth from the *terre-plein* or gun-platform.

c. *Full-sunken*; when the *terre-plein* is farther lowered by taking all the earth therefrom to form the *parapet*.

Casemate; when protected by a bomb-proof chamber and firing from *embrasures*.

Barbette; firing over a parapet.

Breaching; devoted to making an opening in the wall of a fortification.

Ricochet; when the balls, with a low charge, traverse the inner face of the enemy's works and rebound and roll along the same.

Mountain; light pieces adapted to be dismounted, and, with their dislocated carriages, carried on mules.

2. (*Field-artillery.*) The tactical unit of field-artillery. A certain number of field-guns under one command, together with the officers, men, horses, wagons, and stores.

An English field-battery has six 12-pounder, Armstrong, breech-loading, rifled guns. Each gun has its limber, and the battery has 22 other carriages and 210 horses. It is officered and manned by two captains, three lieutenants, and 236 non-commissioned officers and men.

Three field-guns to 1,000 men is the usual proportion in European armies.

Gun′boat. A small vessel of war, carrying from one to four guns if sea-going. Gunboats in the United States Service are usually fourth-rates. See IRON-CLAD.

The gunboats employed for river service by the United States government during the late civil war were generally flat-bottomed, side-wheeled craft, of light draft, and partially iron-plated above the water-line with from two to four inches of iron, backed by eighteen to thirty inches of oak, set at an incline of 55° or thereabouts. The strongest plating was forward, and when these vessels could fight "bow on" they were considered invulnerable to 64-pound shot. They carried from four to sixteen guns, which were fired through portholes. (See illustration on opposite page.)

Auxiliary to the gunboats was a fleet of steam-rams, built especially for speed, and calculated to run down and sink an enemy. They generally carried one gun.

Gun–car′riage. The apparatus upon which a cannon is mounted for service. It may or may not be adapted for the transportation of the piece.

The first consisted merely of a timber-block, or frame, to which the cannon was secured by straps or bolts. Uprights, with holes for pegs, were sometimes employed to give elevation to the muzzle. Afterwards a species of trough, having a butt-piece and mounted on wheels, was introduced (*A*, Fig. 2339). Subsequent improvements brought them nearly to the form *B*, which represents a carriage of the Gribeauval pattern. Gribeauval, a French artillery officer, made great improvements, 1765, in gun-carriages and the organization of artillery, reducing the size of the parts, and making the similar parts, for those of the same class, interchangeable; he also added a tongue, so that two horses could draw abreast, and made the limbers so that one sort would answer for several different kinds of carriages.

Land gun-carriages comprise field, siege, casemate, and barbette carriages. The two former are adapted for the transportation as well as service of the piece, while the latter are intended to be kept in one position in a fortification. A smaller kind of field-carriage may be readily taken to pieces and put together, so as to be carried on mules' backs in a rugged and mountainous country.

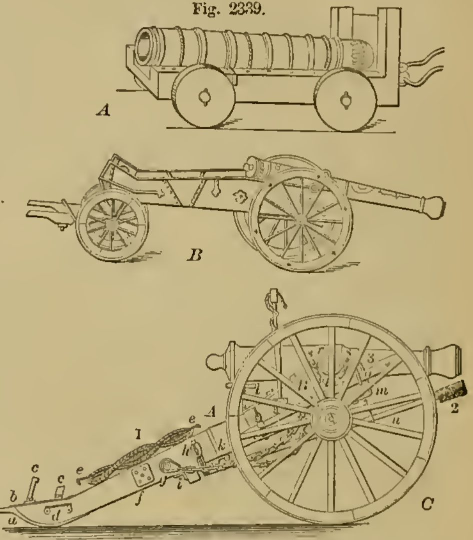
Field-carriages include those which are adapted to accompany the movements of troops during an engagement, and carrying a class of guns weighing from 800 to 1200 pounds, as the 12-pounder smooth-bore and lighter rifled cannon.

These carriages are known as "stocktrail" pattern, from having a single piece, which serves as the trail, inserted between the two cheeks on which the trunnions rest.

The Gribeauval and older patterns of carriage had no stock, the ends of the cheeks resting immediately on the ground; the fore-wheels were also smaller than the hinder.

C is an elevation of a field-gun carriage without its limber. The various parts are, —

Fig. 2339.



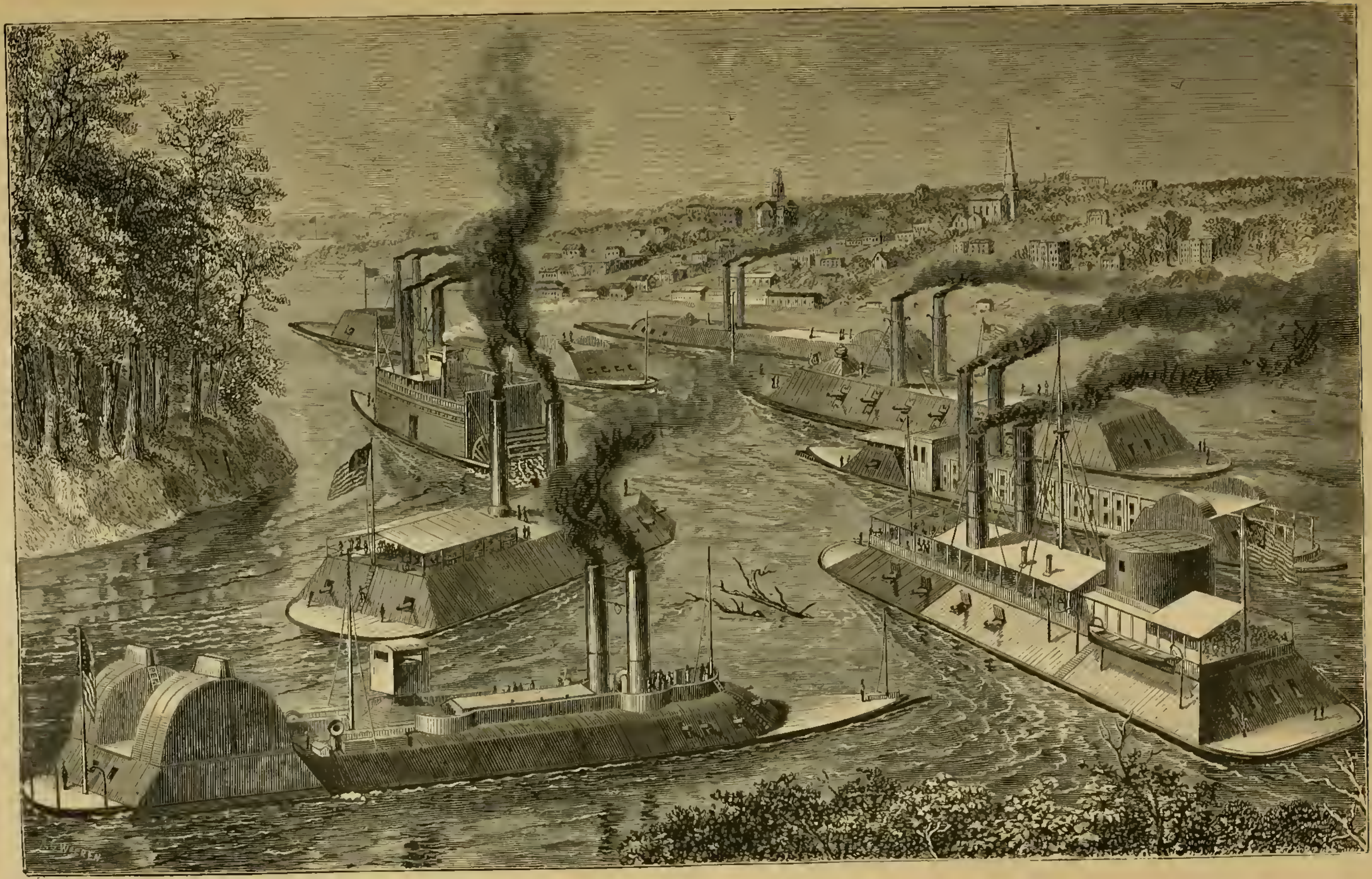
Field-Gun Carriage.

A, stock.
B, cheek.
a, lunette.
b, trail-plate.
c c, pointing rings.
d, handle.
e e, prolonge hooks.
f, wheel-guard plate.
g, lock chain, bolt, nut, and washer.
h, turn-buckle, chain, and hasp for sponge and rammer.
i, stop for rammer-head.
k, ear-plate for worm.
l, elevating-screw.
m, under-strap.
n, implement-hook.
o, D-ring for hand-spike.
q, trunnion-plate.
r, cap-square.
s, cap-square chains and keys.
1, prolonge.
2, sponge and rammer.
3, hand-spike.

The detachable forepart of the carriage is called the limber. It carries a chest for containing ammunition, upon which the cannoniers sit. The limbers for all field-carriages differ only in the interior fitting up of the chest, adapting it for receiving different kinds of ammunition.

A *caisson* for carrying ammunition accompanies each field-piece. This vehicle has a limber similar to that of the gun-carriage. Its rear part, or body, carries two ammunition-chests, the three, with that on the carriage-limber, containing the full supply of ammunition for the piece.

Each field-battery of four or more pieces is also accompanied by a *traveling-forge* and a *battery-wagon*,



GUNBOAT FLOTILLA ON THE MISSISSIPPI RIVER.

See page 1034.

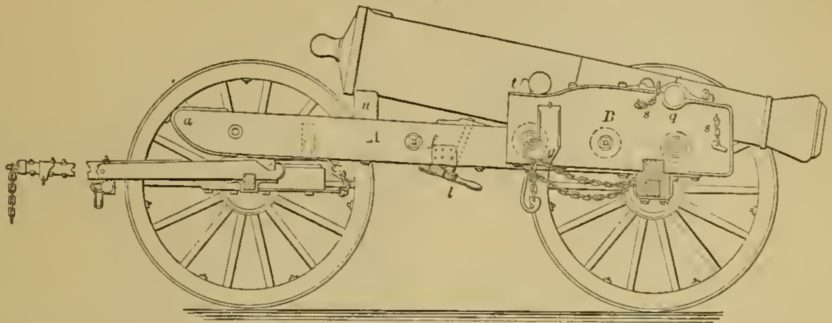
PLATE XXIII.

which contain the necessary tools and materials for ordinary repairs.

Each carriage is drawn by six horses, harnessed in a manner somewhat different from the ordinary way, the traces of the wheel horses being directly attached to the splinter-bar of the limber, and the traces of the leaders connected to those of the wheel-horses. Swingletrees and whiffletrees are thus dispensed with.

The siege-carriage (Fig. 2340), though larger and heavier than that for field service, differs little from it in general construction. For transportation the gun is moved backward, the trunnions resting against the head of the traveling trunnion-bolt *t*, the breech supported on the bolster *u*. The small parts for holding the implements are wanting.

Fig. 2340.



Siege-Gun Carriage.

Three sizes are employed in the United States artillery service, one for the 4½-inch rifled gun, one for the 18-pounder smooth bore and 30-pounder rifled gun, and one for the 24-pounder and 8-inch howitzer.

Barbette carriages are intended for firing over the parapet of a fortification, and are adapted to mount guns of 32-pounder, 8-inch, 10-inch, 15-inch, and 20-inch caliber. The carriage proper rests on a frame called the *chassis*, which turns about a fixed pintle, so that it may be traversed to point wholly or partially around the circle. See BARBETTE.

Casemate carriages resemble the above in their general construction, but are somewhat less high in proportion. They are placed in casemates, where the gun is fired through an embrasure. See CASEMATE.

These two latter classes of carriages, and also mortar beds, have since 1860 been made of wrought-iron, which material has also been tried to some extent for field-carriages with a promise of good results. Cast-iron was at one time tried and found utterly unsuitable.

Ordinary broadside naval gun-carriages much resemble the army casemate carriage, but have no chassis. They are mounted upon four small wheels, called "trucks," and are run in and out and pointed by means of two *side tackles*, hooked respectively on the left and right to the side of the ship, and a *train-tackle* hooked to a ring-bolt behind the carriage. Excessive recoil is checked by the breeching, a stout rope passing through a hole in the cascabel of the gun, and shackled to the ship's ribs on either side. Elevation is given either by means of a graduated quoin or an elevating screw.

In the *Marsilly* carriage the two front rollers are wanting, the front transom resting immediately on the deck.

Light broadside guns and boat guns have their carriages arranged to run on slides corresponding to a chassis, and have compressors for moderating the recoil. Boat guns are also provided with field-carriages of iron in order that they may be employed on shore.

Heavy pivot guns as 11-inch, on upper decks, are mounted on a peculiar carriage, which enables them to be directed to any point around the circle by means of side tackles and *in* and *out* tackles hooked to bolts appropriately placed around the deck.

Very heavy guns, as 15-inch or 20-inch, being always placed in revolving turrets, their carriages need have no lateral motion, as this is obtained by the rotation of the turret itself, operated by connection with the engine of the ship. Devices similarly operated are also provided for loading. See BATTERY-FORGE, BATTERY-WAGON, CAISSON, BARBETTE-CARRIAGE, CASEMATE-CARRIAGE, MORTAR.

The necessities of modern warfare, land and marine, have given rise to many inventions for operating heavy guns and for the protection of those working them. For the latter purpose, besides mantelets and shields, arrangements have been made for rotating the turret in which the gun is mounted so as to cover the embrasure; depressing the gun during loading below the embrasure, etc.

For counterpoise carriages see: —

Brewer's gun-carriage, 1870, is supported on a platform which is supported by levers within a curb, and a weight suspended from the ends of the levers counterpoises the gun, carriage, chassis, and platform.

Callender and Northrup, 1864, have a platform supported by a piston in an air-cylinder beneath.

Eads (1865, 1869, and 1871) causes the recoil of the gun to depress it backwardly and downwardly, it being poised on its trunnions on the end of an arm which oscillates in an arc. As the gun descends, a piston traverses in a cylinder, compressing air therein, and the elasticity of the air assists in restoring the gun to its position when the loading is complete.

Coughlan, 1870, has a cogged segment and weighted toggle which allow the gun to depress by the force of recoil.

Taggart, 1863, has two guns on a cylindrical carriage which is on an axis reaching athwart the vessel. The gun beneath is in loading position below decks, while the one above is in firing position. The latter being fired, the axis is rotated and the guns change places.

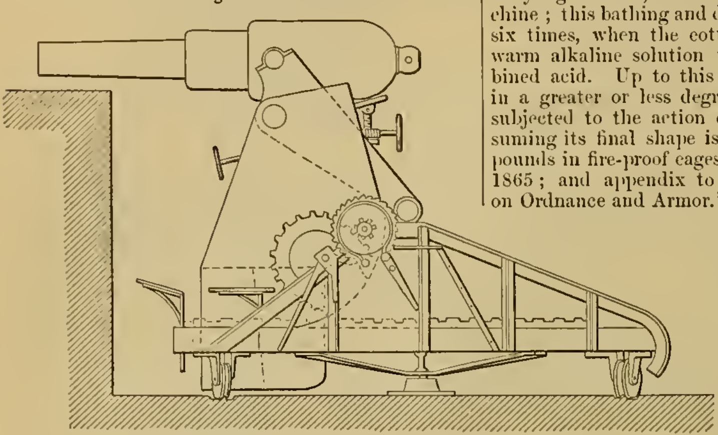
Winans, 1865, lifts his gun, carriage, and traverse into firing position by steam piston and cylinder beneath.

Houel and Caillet have a system of levers which oscillate backwardly by the recoil, and in so doing bring into action a spring which afterward assists in restoring the gun to firing position. See also Coon, 1863; Foster, 1869.

Wappich, 1863, has a toggle-joint and screw for elevation and depression. Also screws beneath the trunnions.

In Moncrieff's gun-carriage (Fig. 2341) the gun is supported upon a moving fulcrum, which, on the firing of the gun, is caused to shift nearer to the gun and farther from a counterweight, spring, or other force, while at the same time the gun is brought into a lowered position for reloading, and is then automatically raised into position for firing. By the shifting of the fulcrum, the statical momentum of the balance weight is made to preponderate so greatly over that of the gun that it will, when allowed free action, after the loading of the gun, raise the same into its original position.

Fig. 2341



Moncrieff's Gun-Carriage.

For running the gun in and out of battery, and traversing and operating guns in turrets, see patent of Ericsson, 1866, 1870; Perley, 1865, 1867; Eads, 1864, 1865; Bartol, 1863. Training twin guns in parallelism in turrets, Eads, 1866.

Eads, 1864, 1865, has a means for training the gun upon an imaginary center, which is the center of the exterior opening of the port or embrasure, so as to reduce the opening to the smallest size.

Gun-cot′ton. The first notice of the discovery of gun-cotton was made by Braconnet, in 1833, who detailed the action of nitric acid on starch, sawdust, linen, and cotton. He called it *xyloidine.*

Pelouse, in 1838, called attention to this compound.

Dumas, in 1843, again cited a mode of preparing, and made suggestions for the application.

Schönbein, in 1846, brought forward his plan of using nitric and sulphuric acids. It was described by W. H. Ellet of Columbia, S. C., in 1846.

Baron Von Lenk, 1864, used cotton skeins instead of employing the wool in masses, thus rendering the saturation more complete and the manipulation easier. The loose cotton thread is first boiled in an alkaline solution and afterwards placed in a cylinder with perforated wire sides, making from 600 to 800 revolutions per minute, by which the alkali is expressed; it is then washed in clean water and again subjected to the action of the cylinder, after which it is thoroughly dried by exposure to air and by heating in a chamber to about 120°.

One-pound charges of the cotton thus prepared are next immersed in a mixture composed of 3 parts of sulphuric to 1 of nitric acid, which has been allowed to cool from 48 to 72 hours; the vessels containing the cotton and acid being surrounded with cold water to prevent undue heating during the chemical action which ensues.

The cotton is then placed on a strainer and expressed until it retains but about ten times its weight of acids, when it is removed to an earthenware jar, surrounded by water as before, where it is allowed to remain forty-eight hours to insure its complete conversion into "trinitro cellulose," or gun-cotton. It is then taken out and washed by plunging suddenly in water, to prevent heating; and afterwards placed in a tank of running water for forty-eight hours, and dried in the centrifugal machine; this bathing and draining process is repeated six times, when the cotton is finally washed in a warm alkaline solution to remove all the uncombined acid. Up to this period the cotton has been in a greater or less degree damp, since it was first subjected to the action of the acids, but after assuming its final shape is dried in charges of twenty pounds in fire-proof cages. See also Revy's process, 1865; and appendix to A. L. Holley's "Treatise on Ordnance and Armor."

Mr. Abel, of the Woolwich (England) Dock-Yard Chemical Department, has discovered that the explosive force of gun-cotton, like that of nitro-glycerine, may be developed by the exposure of the substance to the sudden concussion produced by a detonation, and that if exploded by that agency the suddenness and consequent violence of its action greatly exceeds that of its explosion by means of a highly heated body of flame.

Charges for sporting or blasting purposes are sometimes put up with a core of raw cotton, to diminish the force of explosion.

Wet gun-cotton is of course proof against explosion by heat, but it has been found that its explosive energy is rather increased than diminished when wet and fired by percussion. A body of gun-cotton thrown into the sea in a net, with a protected priming of dry cotton and fulminate, will explode with as much force as if confined in a water-tight vessel.

The rapidity with which gun-cotton detonates has been computed at 20,000 feet per second. Its energy is from two to four times that of gunpowder. See Explosives.

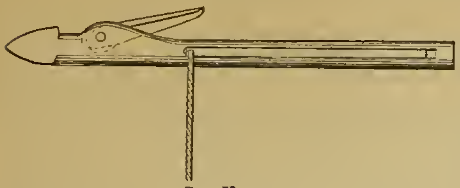
Gun-cotton is not soluble in alcohol or ether, but in a mixture of the two it dissolves readily, giving rise to a perfectly colorless mucilaginous liquid, known as *collodion.* This dries quickly to a hard skin, quite structureless, and possessing considerable strength. It is used in surgery, and also, in conjunction with iodides and bromides, to form the collodion of the photographer. See Pyroxyline.

Gun-deck. The lower deck of a ship of war.

Gun-har-poon′. One fired from a gun, used mounted in a crutch on the gunwale of a whaleboat. It is made of steel, and has a chain or long-shackle attached to it, to which the whale-line is fastened. Some gun-harpoons carry a grenade or flask of poison which breaks and sickens the whale.

In the illustration, the harpoon has a hinged barb

Fig. 2342.



Gun-Harpoon.

and a slotted shank, in which is a sliding link to which the line is fastened. The rear end of the slot has an elastic guard to receive the shock of the ring as the harpoon is fired. See HARPOON.

Gun-lock. The combination of parts by which the propulsive charge is caused to ignite. The matchlock, the first known employment of which was at the battle of Morat, 1476, was the earliest known form. In this a piece of slow-burning cord was passed through a hole in the cock, which was thrown forward on pulling the trigger, bringing the lighted end of the cord in contact with the priming. The gun with this attachment was called an arquebus. It continued in use until the invention of the wheel-lock in Italy, about 1521. In this, a furrowed steel wheel was, by means of a spring and chain, caused to revolve in contact with a piece of native sulphuret of iron, producing sparks which ignited the priming. This mineral is said to have originally derived its name pyrites, or firestone, from having been thus employed.

The "snaphaunce" lock comprised a hammer carrying a flint, which was caused to strike against a furrowed piece of steel, which performed the office of the battery in the more modern flint-lock. It is said to have been contrived by German or Dutch marauders, to avoid the exposure attending the use of the matchlock in nocturnal expeditions.

The flint-lock is said to have originated in France about 1635, and its general features do not appear to have essentially changed in the two centuries, nearly, during which it was used to the exclusion of all others. The parts corresponded to those of the percussion-lock of the present day, except that the hammer was provided with a pair of jaws for holding the flint, which was caused to strike a pivoted lip called the *battery*, throwing it back and dropping a shower of sparks into the "pan" containing the priming.

In 1807 Rev. Mr. Forsyth obtained a patent in England for a fulminating powder, which was to be placed in a magazine at the breech of the gun and fired by a pin. Various modifications were devised prior to the introduction of the common copper cap, about 1816. This, however, made its way rather slowly. It was not until 1842 that the percussion lock and cap were adopted in the United States military service.

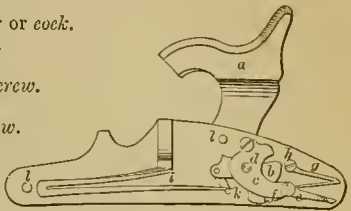
The adaptation of the flint-lock to cannon was easy, it being merely necessary to secure the lock in position by a ring around the breech of the gun; when the hammer fell back, on firing, the blast from the vent passed freely, without injury to the lock. It was otherwise with percussion-locks when applied to a vent two tenths of an inch in diameter. The shock of the blast would soon have destroyed such a lock without the hammer was withdrawn from over the vent at the very instant of firing. This difficulty was obviated by E. Hidden's lock, first patented in 1831 and subsequently improved.

In this, that end of the hammer to which the lanyard is attached is longitudinally slotted, so that the same pull which brings the hammer down upon the head of the primer withdraws it back a slight distance, leaving the blast unimpeded. Friction primers for cannon have generally superseded the use of this lock, though it still maintains its place in the United States navy.

The elements of all gun-locks of the modern pattern, which have no breech-loading or revolving machinery to operate, are essentially as follows. The illustration shows that employed in the United States muzzle-loading small-arms.

Fig. 2343.

a, hammer or *cock.*
b, tumbler.
c, bridle.
d, bridle-screw.
e, sear.
f, sear-screw.



Gun-Lock.

g, sear-spring.
h, sear-spring screw.
i, mainspring.
k, swivel.
l l, side screws.

The hammer fits on the *square* of the *tumbler*, which it rotates when drawn back, so as to allow the *nose* of the sear to fall into notches of the tumbler when at half-cock and at cock. Both the sear and tumbler are held in place by the *bridle*, which confines them to the lock-plate. The trigger, when pressed, acts on the rear end of the sear, lifting the other end out of the cock-notch of the tumbler, which is then permitted to move by the action of the mainspring, carrying the hammer around with it.

Revolving, breech-loading, and repeating arms, having their firing mechanism necessarily operating in connection with those for loading and for withdrawing the cartridge-cases, require very different arrangements from those described, in many instances involving great multiplicity and complexity of parts. These will be found noticed under the head of FIRE-ARM, where a list of about 1000 occurs.

The lock of the needle-gun is the widest departure from the well-remembered form, the striker being a pointed rod which explodes the fulminate, either in the base of the ball, as in the Prussian gun, or in the base of the capsule, as in the American form of rifles. The percussion powder may be in a cap placed on a nipple on the side of the barrel; in a cap over a nipple on the cartridge; a pellet on an anvil at the base of the cartridge; a pellet or ring in a basin or in the flange of the cartridge; a pellet in the base of the bullet.

By position it may be *rear*-fire, *front*-fire, *side*-fire, *center*-fire. See CARTRIDGE; FIRE-ARM.

Gun-lock Ham'mer. The cock or striker of a fire-arm lock. See GUN-LOCK.

Gun-met'al. A bronze from which cannon may be cast. Ordinarily 9 parts copper and 1 tin. Other metals have been sometimes added or substituted for the tin, copper still remaining the basis of the alloy.

A few examples are given.

	Copper.	Tin.	Zinc.	Iron.
Common formula . .	9	1		
Stirling's (English) .	50		25	1 – 8
Rosthorn's (Austrian) .	55.04	0.83	42.36	1.77
Rosthorn's (Austrian)	57.63	0.15	40.22	1.86
Navy (Austrian) . .	60		38.12	1.8
Birkholtz (U. States)	60		38	2.0

	Copper.	Aluminum.	Zinc.	Iron.
Keirs (English, 1799)	100		75	10
Lancaster's (English)	90	10		

See Alloy.

The Rosthorn (Austrian) alloys are known as "sterro-metal." One variety is soft, ductile, and capable of being worked into sheets or wire. The other is hard, and is represented as suitable for ordnance. From experiments made at the Imperial arsenal at Vienna, its tensile strength was, after single fusion, 28 tons to the square inch; after forging at a red heat, 32 tons; drawn cold and reduced from 100 to 77 sectional aréa, 37 tons. The metal thus tested contained a rather less proportion of tin and iron than is indicated above. Its specific gravity was 8.37. It is represented as possessing unusual elasticity. Field-guns of from 4 to 12 pounder caliber were worked out of single pieces under the hydraulic press, without impairing its tensile strength.

M. Sorel's alloy, composed of 8 copper, 1 zinc, and 1 tin, is said to resemble zinc in appearance, to be equal to copper and iron in hardness, more tenacious than soft cast-iron, readily turned, filed, and delivered from the mold in casting, and to endure exposure to moisture without tarnishing. It is susceptible of being bronzed, and is adapted for statues or exposed ornamental objects.

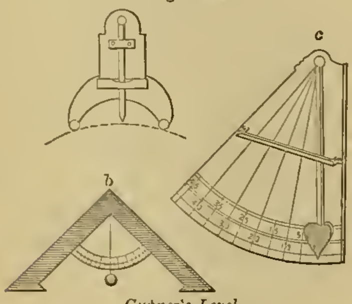
Gun'ner's Cal'i-pers. An instrument made of sheet-brass with steel points. The graduations show the diameters of shot and shell, the calibers of guns, linear inches, degrees of the circle, etc.

Gun'ner's Hav'er-sack. A leathern bag worn by a gunner for containing the smaller implements required in the discharge of his duty.

Gun'ner's Lev'el. An instrument for ascertaining the highest points at the breech and muzzle of a piece of ordnance, when on uneven ground, in order to determine the true line of sight.

It consists (*a*, Fig. 2344) of a spirit-level mounted on a frame having two branches with rounded ends, and an upright piece with a perpendicular slider. The instrument is placed transversely on the upper part of the gun, say at the base ring, and moved to the right or left until the bubble of the level is central, the point of the slider then indicates the highest point of the piece at that part; repeating the operation at the muzzle gives another point in the line of sight, along which the gunner must aim to hit the object. These points are then marked on the metal.

Fig. 2344



Gunner's Level.

Called also gunner's perpendicular.

b and *c* represent forms of what are called gunner's levels in the British service. Each of these is designed to be applied longitudinally to the gun to give it the proper elevation, the degree of which is ascertained by the graduated quadrant and plumb-bob.

Gun'ner's Per'pen-dic'u-lar. Another name of the gunner's level. It is made of sheet-brass, the lower part being cut out in crescent shape. It has a perpendicular slider, pointed at the lower end, and is used for finding the line of sight of siege-guns and mortars. See Gunner's Level.

Gun'ner's Quad'rant. The gunner's quadrant is a graduated arc of 90°, or rather more, made of brass or wood, and having an arm attached which is passed into the bore of the gun for the purpose of ascertaining the elevation. The wooden level has a leaden bullet suspended by a string, which indicates the perpendicular, the deviation from which is measured on the arc. The metallic quadrant is of more elaborate construction, and has a spirit-level attached. See Gunner's Level.

Gun'nie. (*Mining.*) *a.* A large, open, excavated space in a mine.

b. In Cornish, a term applied to breadth or width; *single* gunnies are three feet wide.

Gun'ny. (*Fabric.*) A heavy coarse goods used for wrapping bales of cotton, for cotton bags, etc. Made of jute, manilla, or hemp. A heavier grade than *burlaps*. Gunny is a Hindoo word, and the real article is made from fibers of the *cochorus* (jute); the bag made thereof is used to carry grain, etc., on the backs of buffaloes, and for enclosing articles for exportation, — rice, saltpeter, pepper, coffee.

Gun-pend'u-lum. 1. A pendulous box with sand-bags to receive the impact of a ball fired from a gun or cannon, and used to determine the strength of powder. See Ballistic Pendulum.

2. A gun suspended from trunnions to measure by recoil the power of the powder of the exploded charge. See also Eprouvette.

A substitute means is a measurer of the rate of motion of the projectile, which forms one factor in the calculation for the power of the powder. See Chronoscope.

Gun'pow-der. A composition of niter, charcoal, and sulphur. The proportions in which these ingredients are mixed vary slightly, according to the place of manufacture or the destined use of the article. By the atomic theory there should be in 100 parts, 74.64 niter, 13.51 charcoal, 11.85 sulphur. In practice there are employed, —

	Niter.	Charcoal.	Sulphur.
In the United States, military purposes	76	14	10
Or	75	15	10
In the United States, sporting	78 77	12 13	10 10
In England, military purposes	75	15	10
In England, sporting	78 75	14 17	8 8
In France, military purposes	75	12.5	12.5
In France, sporting	78	12	10
In France, blasting	62	18	20
In Prussia, military purposes	75	13.5	11.5

Although the use of gunpowder in Europe can be traced back only to the middle or earlier part of the fourteenth century, yet it seems fully proved from various passages in ancient authors that it is one of those inventions whose origin is lost in the obscurity of a very remote antiquity. The fact appears indisputable that it originated in Central or Eastern Asia, where it was used for many ages previous to its introduction into Europe, where it appears to have been first made known by the Saracens.

In a code of Gentoo laws occurs a prohibition against the use by the ruler of "deceitful machines, poisoned weapons, and weapons of fire." To this document is assigned the date 1500 B. C. When Ghengis Khan invaded China, A. D. 1219, he carried with him *ho-pao*, or fire-tubes, which killed men and set fire to buildings.

Passages in Quintius Curtius and Philostratus indicate that Alexander was met in India by a people who used against him "storms of lightning and thunderbolts."

There are many scattered passages in the old writers, and many facts, quoted by Dutens, Sir George Staunton, Halhed, Hallam, M. Langles, Muratori, Reinaud, and Grove, which indicate the very early use of gunpowder.

It must be recollected that in many parts of Asia saltpeter occurs as an efflorescence on the surface of the ground, and its sputtering effects upon ignited charcoal, when a fire was built upon it, must have been very commonly observed. Sulphur is useful in the combination, but not essential for some purposes to which the explosive compound is applied.

In early ages, probably as early as the time of the exodus of the Israelites from Egypt, fire-works were common in China, and from thence, at a very remote period, they spread to India, where they were used on a scale which made them dangerous weapons when Alexander invaded that country, 327 B. C. There is no reasonable doubt that, long before they were employed as weapons, rockets and other pyrotechnic devices were used among these Eastern Asiatic nations, especially among the Chinese, with whom they have for many centuries formed an important item in public celebrations and festivals. From those devices, in which a charged paper tube expels fire-balls or pellets of explosive material, the transition is very easy to larger tubes with projectiles, which depend for execution upon percussive force. Such were the original fire-arms, and the strengthened paper tube or the bamboo was the first barrel.

We have occasion to notice, in the course of this work, that many arts in which the Chinese excelled were carried to India, and were cultivated in that congenial soil, until an irruption of another nation scattered the artificers or scholars, and gave to the world the secret or the industry which was locked up, as it were, within circumscribed limits. This has commonly occurred in the history of the industrial arts.

War quickened the extension of printing. In 1482 the storming of Mentz dispersed the workmen, and gave the art of printing to the world.

In 1146 Roger of Sicily plundered Greece, and took home with him to Palermo silk-worms, workmen, and the art of weaving silk. From Sicily it spread to France, Italy, and Spain, and from Italy to England.

Other instances might be cited where the irruptions of tribes or nations, or internecine disturbances, have disseminated arts, but the one most to our purpose is the invasion of India by Mahmoud of Ghizni, A. D. 1004, which seems to have been the means of diffusing the knowledge of gunpowder, the mariner's compass, and the art of glazing pottery and earthenware. The Saracens were the means of publishing the knowledge thus dispersed, and we regard it as certain that they introduced the knowledge of gunpowder into Europe.

The art of making felted fabrics was reintroduced into Europe by the Tartar hordes who took Thrace and Adrianople in 1361, and under Bajazet overran the provinces of the Eastern Empire before the end of that century.

The arts of making silk and other fine goods, crystal glasses, and jewelry, were carried to the Netherlands and to England by the Revocation of the Edict of Nantes, granted by Henry IV. in 1598, confirmed by Louis XI. in 1610, and Louis XIV. in 1652, and revoked by Louis XIV., Oct. 22, 1685. Fifty thousand Protestant families left France for more tolerant countries, and the world is the better off from the diffusion of their skill.

The more closely we examine the record, the more do we discover our indebtedness to the East; and the extreme East seems to have been the primary fountain of our industrial civilization.

The use of an explosive compound, *pulvis nitratus*, is mentioned in an Arabic writing in the Escurial collection, dating about 1249. The Moors used it in Spain in 1312, and in 1331 the king of Granada battered Alicant with iron bullets, discharged by fire from machines. In 1342-43, the Moorish garrison of Algesiras defended themselves against Alonzo XI., king of Castile, by projectiles fired from cannon by powder.

The Venetians used gunpowder in their wars with the Genoese in 1380. Gunpowder is mentioned in the French national accounts, 1338, and is said to have been used at Cressy, 1346, and to have contributed much to the success of the English.

The two Europeans whose names have been prominently brought forward as inventors of gunpowder are Roger Bacon and Michael Schwartz.

Roger Bacon, in 1216, wrote a work entitled "The Secrets of Art and Nature," wherein he states that "from saltpeter and other ingredients we are able to make a fire that shall burn at what distance we please; and that sounds and coruscations resembling thunder and lightning might be formed in the air, much more to be dreaded than those that happen naturally, inasmuch as by its power armies and cities might be destroyed." Bacon did not claim the discovery, and had probably read the "Liber Ignium" of Marcus Græcus, written about A. D. 825, in which he describes the nature of the composition for making rockets. His formula is stated by one authority to have been, — sulphur, 1; charcoal, 2; saltpeter, 6. It is now difficult to sift the error from the truth, but it is said that in the recipe of Bacon the ingredients saltpeter and sulphur were given, and that the charcoal was stated anagrammatically, by the transposition of the letters of the words, *carbonum pulvere;* which he wrote "Lura nope cum ubre." This looks as though he considered it a secret; not necessarily his invention, but a dangerous compound not adapted for the use of the vulgar.

Michael Schwartz, a Cordelier monk. of Goslar, in Germany, about A. D. 1320, seems to have combined the three ingredients, and has been credited with the discovery. A commemorative statue of Schwartz was erected in 1853, at Freiburg.

Artillery was known in France in 1345.

In 1356, the city of Nuremberg purchased gunpowder and cannon.

The same year Louvain employed thirty cannon at the battle of Santfliet against the Flemings.

In 1361, a fire broke out at Lubec from the careless use of gunpowder.

In 1363, the Hanse towns used gunpowder in a conflict with the Danes.

It is commonly stated that gunpowder was first made in England, at periods varying from 1411 to 1438; but recent research by Rev. Joseph Hunter has brought to light records of its manufacture for the uses of the English army before it landed at La Hague, and previous to the battle of Cressy.

The ingredients for the manufacture of gunpowder should be of the greatest possible purity. The crude saltpeter is refined by washing, and then dissolving in the least possible proportion of hot water, and clarified by adding a very small quantity of glue, and boiling until the impurities, such as chloride of sodium, are deposited and the liquid becomes perfectly clear. It is then drawn off into pans, where it is cooled and crystallized in very minute grains, and afterwards washed with cold water, dried, and sieved. It should not contain more than $\frac{1}{3000}$ part of chlorides. That used in the best powder does not contain more than $\frac{1}{18000}$, and for the best sporting powder it undergoes a second refining, and contains not more than $\frac{1}{60000}$ part.

The charcoal has a great effect upon the quality of the powder. It should be light, friable, and porous, burning freely, and leaving little ashes. The woods used are willow and black-alder, principally the former. Branches not exceeding ¾ inch diameter are selected, barked, and dried, after which they are charred in upright cast-iron cylinders, heated from the outside; about 65 per cent of the weight is found to pass off in the gaseous products distilled from the wood, leaving only 35 per cent of coal. It should only be prepared as required for use, owing to its liability to absorb moisture, and to spontaneous combustion when stored in quantities exceeding 30 pounds' weight.

Sulphur is refined by sublimation, the chamber in which the vapors condense being kept at a temperature of about 248° F., so as to allow the sulphur to be drawn off in liquid form. If much lower than this it condenses in the form of a powder, called flowers of sulphur, which always contains a proportion of sulphurous and sulphuric acids.

The three ingredients are now incorporated.

Dr. Scoffern's description of the process as conducted at the National Mills at Waltham, England, which produce powder of unsurpassed quality, gives a good general idea of the mode of manufacture.

It may be remarked that the process commonly employed in this country, though almost identical, differs somewhat in the preliminaries. Here the saltpeter is usually found sufficiently pulverized as it comes from the refinery. The charcoal is pulverized by being placed in a large cast-iron barrel, having ledges on its interior, with twice its weight of bronze balls, and the barrel is caused to rotate at the rate of from 20 to 25 revolutions per minute for two or three hours. The sulphur is similarly treated in barrels made of thick leather stretched over a wooden frame, and revolved from four to eight hours. The ingredients are incorporated by placing the charcoal and sulphur together in a rolling barrel, similar to that in which the sulphur is pulverized, and rolling them for one hour. The saltpeter is then added and rolled for three hours longer, after which the mixture is transferred to the cylinder or rolling mill, which consists of two cast-iron cylinders rolling in a circular trough with a cast-iron bottom.

At Waltham, the saltpeter, brimstone, and charcoal are ground separately in mills, each consisting of a pair of heavy circular stones slowly revolving on a stone bed. Next the ingredients are conveyed to the *mixing-house.* Here, in bins, are the saltpeter, brimstone, and charcoal, weighed in the exact proportions: saltpeter, 75; brimstone, 10; and charcoal, 15; in every 100 parts. Of the three ingredients, forty-two pounds are placed in a hollow drum, which revolves rapidly, and contains a fly-pan, which rotates in an opposite direction; in about five minutes a complete mixture is effected, and the charge is received in a bag tied over the lower orifice of the drum.

The *composition* is next taken to the *incorporating-mills*, and is now a *combustible* compound, which will acquire an *explosive* power by the thorough incorporation of ingredients. The mill consists of a pair of circular stones (*runners*) weighing about 3½ tons each, and slowly rolling over the powder, which is placed on the stone bed of the mill, surrounded by a huge wooden basin. The powder is previously damped, as it could not be safely ground dry; about seven pints of water (*liquor*) being added to the charge of forty-two pounds of powder during three and a half hours, the time of grinding. To insure this with precision, and to obviate the chance of any irregularity in a clock, the water-wheel which works two of these mills in one house also marks its revolutions on a dial, so that the attendant can never be mistaken in the time the charge has been "on," — a most important point, where the over-grinding of the too dry powder might cause it to explode. Sometimes a portion of the wood-work of the roof, or mill, becoming detached — such as a cog of the wheel — and falling into the pan, acts to cause a mass of powder to explode. As a protection, over each house containing a pair of mills is suspended a flat board, which, in case of an explosion, is first blown upward, and, being connected by wires to a cistern of water over the pan of the fellow mill, upsets the same, and drowns the gunpowder. The attendants are as little as possible in these mills, and only work by daylight. More hazardous processes, however, follow. The powder thus incorporated is in hard, flat lumps, and has again to be reduced to dust in the *breaking-down house*, by conveying it down an inclined plane, through rollers, which crush nearly 500 pounds in the hour. The powder is then taken to the *press-house*, and there, between gun-metal plates, is pressed in thin cakes to one third its bulk by a power of 700 tons in an hydraulic press. The cakes are roughly broken up, and sent in baskets to the *granulating-mill,* where the powder is again broken down into grains, the size being regulated by sieves. The floor is covered with hides fastened down with copper nails, and the mill can be started or stopped by a rope passing through the wall, which is bomb-proof. The powder is then dried, by heat, in the *stoving-room,* which is flanked externally by *traverses* (mounds of earth thirty feet thick), to confine explosion, should it happen, as much as possible to one house. Lastly, the powder is sifted in the *dusting-house,* where the sieves revolve with great velocity; the dust escapes through the meshes, and the gunpowder is drawn off through a sort of tap, into barrels, for packing. The finest powder is *glazed* by black-lead being shaken up with it; but cannon powder has not this finish.

The size of grain of gunpowder is varied according to its intended use. The finest is known as *sporting*, the next *rifle*, then *musket*, and lastly *cannon* powder. The rapidity of burning is in inverse proportion to the size of the grain. For very heavy ordnance a much larger grained powder than either of the above, called *mammoth* powder, was introduced by the late General T. J. Rodman. He also proposed the use of a powder composed of small uniform cakes with cylindrical perforations. This has since, under the name of *prismatic* powder by the Germans and Russians, and *pebble* powder by the English, been received with considerable favor.

The use of sawdust, resin, bran, sand, ashes, wood shavings, is as old as the writings of Siemienowicz,

1651. He remarked, very truly, that they have the effect of making the powder burn more slowly. The practice has been again and again introduced, in Brazil about 1800; by Thurnagel in Germany; Thomassin and Leblanc in France; Firzoo in Russia.

Dr. Gale has shown that by the addition of sand in certain proportions the powder is rendered nonexplosive.

The white gunpowder invented by Captain Schultze, of the Prussian army, is prepared by sawing suitable kinds of wood into thin slices transversely of the grain. These are then, by means of a manifold punch, cut into grains of a definite size and shape, which are chemically washed to remove calcareous and other non-woody matters, and then treated with a mixture of nitric and sulphuric acids, washed with a solution of carbonate of soda and dried. In this condition the powder is stored away until it is wanted for shipment. It may be considered as a dense form of pyroxyline. The explosive quality is imparted by steeping in a solution of some one of the nitrates, ordinarily that of potash (saltpeter), but for some purposes the inventor prefers nitrate of baryta.

Another recipe for white gunpowder consists of equal parts of chlorate of potash, white sugar, and ferro-cyanide of potassium. Mix very cautiously, as it explodes by percussion. It is exploded by a red-hot body or a drop of sulphuric acid.

The following table shows the first recorded use in making gunpowder of the ingredients stated.

Charcoal, sulphur, and nitrate of potassa	*Time immemorial.*
Bituminous coal	1838
Bark (morus)	1855
Peat	1856
Cork (burned)	1856
Lycopodium	1856
Horse-dung	1853
Sawdust	1856
Sugar	1856
Tan	1858
Starch	1858
Flour	1858
Bran	1858
Gum	1859
Cannel coal	1861
Caoutchouc	1863
Dextrine	1864
Petroleum products	1864
Lamp-black	1865
Cutch and gambier	1866
Grahamite	1869
Paraffine	1869
Logwood	1869
Carbolic acid	1869
Tannin	1869

Aloes	1869
Fats and oils	1871
Lime	1861
Phosphorus	1864
Bisulphide carbon	1863
Ferro-cyan. of potassa	1850
Chlorate of potassa	1850
Carbonate of potassa	1859
Bichromate of potassa	1864
Carbazotate of potassa	1868
Azotate of potassa	1868
Chloride of sodium	1856
Nitrate of sodium	1857
Sulphate of sodium	1862
Potasso-tartrate of sodium	1864
Barilla	1864
Carbonate of sodium	1864
Chlorate of lead	1862
Red sulphate of arsenic	1850
Sulphate of magnesia	1862
Nitrate of strontian	1862
Nitrate of baryta	1862
Nitrate of lead	1864
Nitrate of iron	1869
Binoxide of manganese	1864
Cyanuret of zinc	1864

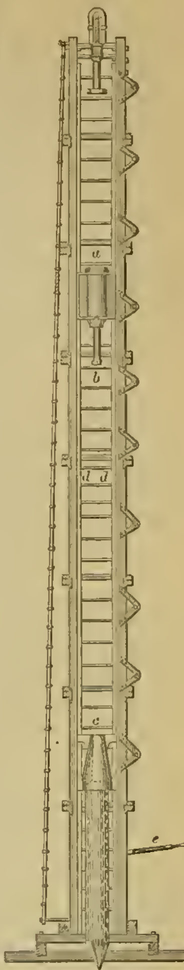
Gun'pow-der-en'gine. A form of gas-engine in which the motion of the piston is caused by the evolution of gas resulting from the combustion of gunpowder. D'Hautefeuille worked upon this problem, using the gas to obtain a partial vacuum in a chamber; the exploding of the gas expelled the atmospheric air, and the gases suddenly condensing left the vessel nearly void.

Huyghens adopted the same principle, but used a cylinder for his explosive chamber, the vacuum being utilized by the resulting atmospheric pressure upon the piston moving in the cylinder. Papin substituted a ball-valve over a hole in the middle of the piston for the leather tubes used by Huyghens.

In 1791, Barker patented a gas-engine having the main features of the modern gas-engine; streams of carbureted hydrogen gas and atmospheric air being introduced through different conductors into a cylinder, in which the gas was exploded, the effect being to drive a piston. See GAS-ENGINE.

Papin's apparatus consisted of a tube closed at bottom and having a valved piston below which a charge of gunpowder was exploded. The idea was, that the sudden blast of the explosion would expel the air, causing a vacuum and allowing the full atmospheric pressure to operate on the downward stroke. This was, however, not realized in practice, the pressure actually not being found to exceed half that of the atmosphere, owing to the non-production of a perfect vacuum by this means.

Fig. 2345.

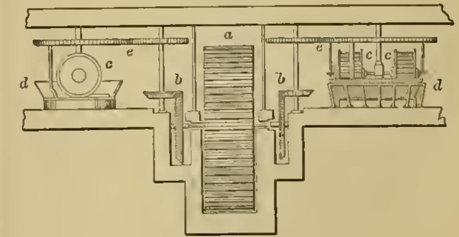


Gunpowder-Hammer.

Gun'pow-der-ham'mer. A pile-driver operated by the explosive force of gunpowder. The hammer *a* is, as usual, arranged to slide in guides in a vertical frame. It is bored out cylindrically in the upper central part, and has a plunger *b* below. The pile-cap *c* has a cylindrical hollow in its upper part for the reception of this piston and a cartridge, and a conical seat below to fit the head of the pile. It is also fitted to the guides *d d*. The lever *e* is connected by a rope with a trigger at the upper part of the frame, by which the hammer is held in an elevated position. A cartridge is placed in the pile-cap *e*, and the piston allowed to drop, compressing the air contained in the cap *c* sufficiently to ignite a cartridge placed therein. The explosion throws up the hammer, which again drops by its gravity, and so on. The powder used is composed of 1½ parts chlorate of potash and 1 bituminous coal, finely pulverized and intimately mixed. The charge is very small, one third of an ounce sufficing to operate a hammer of 675 pounds' weight. The piston, at the upper part of the machine, enters into the cavity in *a* and acts as a buffer, preventing injury to the machine and assisting the downward movement of the hammer.

Gun'pow-der-mill. Fig. 2346 shows an arrangement by which several gunpowder rolling-mills are driven from a water-wheel *a* by bevel and spur-gears *b b e c*. The cast-iron or stone rolling-cylinders

Fig. 2346.

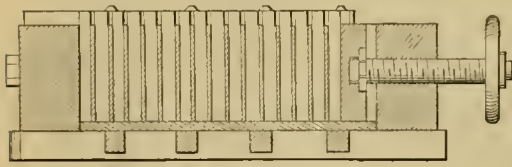


Gunpowder-Mill.

c c revolve on a horizontal axis which is carried around by a vertical shaft within the circular trough *d*, into which a charge, usually 75 or 150 pounds, of the incorporated materials from the rolling barrel has been placed. The rollers are set in motion, slowly at first, and afterwards more rapidly, and kept going three hours for a charge of 150 pounds, or for a less quantity a proportionately less time, a little water being added to prevent danger of explosion should the materials become too dry. A scraper follows each roller to keep the composition exposed to the action of the rollers. At the end of this time the mass has become thoroughly incorporated, is of a brownish red color, and is termed *mill-cake*. See GUNPOWDER.

Gun′pow-der-press. For pressing *mill-cake* into hard cake preparatory to granulating. That illustrated is particularly designed for compressing dust-powder into hard cakes between upright plates which are adjustably arranged in the box by means of a gage-bar. The pressure is applied by a follower operated by a horizontal screw.

Fig. 2347.



Gunpowder-Press.

Gun-room. (*Nautical.*) The purpose of this room, at the after end of the lower gun-deck, differs according to the rate of the vessel and also in different services.

In war vessels of moderate size it is occupied by the lieutenants and some other officers. In vessels of larger size the lieutenants occupy the *ward*-room, and the junior officers the gun-room.

Gun-search′er. An instrument with several projecting prongs to ascertain whether the bore of a gun be honeycombed.

Gun-stock. The part of a gun to which the barrel and lock are fastened. It is usually of walnut; in Europe the *Juglans regia*, in America the *Juglans nigra*.

Gun-stocks, until the invention of the Blanchard lathe, were made by hand in a laborious and tedious manner. This machine was introduced into the Springfield Armory about 1820.

A rough chunk of wood is placed in the first of the stocking machines, from whence it emerges with its sides cut to the proper shape for turning. In another machine its butt-end is sawed, and a diagonal line cut at the breech. The third, armed with two circular saws, fashions the upper part of the stock in its finished form. Another machine reduces the butt to its ultimate shape. Another simply planes various places in the sides of the stock as points for the working of yet other machines, — an operation which is known as *spotting*. A sixth machine performs six distinct items, called *grooving* for the barrel, breech-pin, and tang; *heading* down, *milling*, and *finish-grooving*. The stock is at this stage prepared for the *fitting* in of the barrel. A seventh machine planes the top, bottom, and sides, while the eighth and ninth do the *shaping* and *bedding* for the butt-plates. The next machine prepares the stock for the reception of the lock. Another machine is used to cut for the guards, to bore for the side screws of the lock, and two more to make places for tips and bands. After these various operations comes the second turning and smoothing of the work; then the grooving for the ramrod; then the boring for the ramrod from the point at which the groove ends. These machines are each provided with a pattern or templet, which is the exact counterpart of the cavity or other form to be produced in the stock. They are furnished also with cutters or borers, which, being placed above the stock, are made to revolve rapidly and cut the wood in exact imitation of the pattern below. The movements of the tool are controlled by a guide which is inserted within the pattern. The tool is made to revolve by means of small machinery within its frame, the latter and all within it moving together with both lateral and vertical motions, being governed by the guide, which is connected with it, by the aid of very curious and intricate machinery.

The work of the artisan, when the machine is in motion and the stock is adjusted in its bed within it, beneath the borers or cutters, is simply to bring the guide down into the pattern, and move it about the circumference and through its center. The cutting-tool follows the movements of the guide, and the result is a perfect duplicate in the stock of the form in the mold below. See LATHE FOR TURNING IRREGULAR FORMS.

Gun-tack′le. (*Nautical.*) The ropes and pulleys attached to the sides of the ports and to the gun-carriage by which the gun is run out. It consists of two single blocks, one movable and the other fixed, the standing end of the fall being secured to the movable block.

Gun′ter's Chain. A surveyor's chain 66 feet or 4 rods (of 5½ yards each) in length, having 100 links, each joined to the adjacent one by three links. A square chain is $\frac{1}{10}$ of an acre, or 10,000 square links.

It was invented by the Rev. Mr. Gunter (1581–1626), of England, to aid in calculating areas.

Gunter's Chain.

7.92 inches = 1 link.
100 links = 1 chain, 4 rods, or 22 yards.
80 chains = 1 mile.

Gun′ter's Scale. A large plane scale invented by Mr. Gunter of England. It has various lines of numbers engraved on it, by which questions in calculation, navigation, and surveying are solved mechanically by the aid of the dividers or a slider.

On one side of it are scales of equal parts, chords, sines, tangents, rhombs, etc.; on the other side are the corresponding logarithmic lines.

It consists of a flat ruler of boxwood, two feet long, having various lines laid down upon it, by means of which various problems may be performed by the extension of the compasses only. This will be best explained by a description of the line called the *line of number*, or Gunter's line, which is adapted to the solution of arithmetical questions, and exhibiting a few practical examples.

The *line of numbers* is the logarithmic scale of proportionals, which, being graduated upon the ruler, serves to solve problems in the same manner as logarithms do arithmetically. It is usually divided into 100 parts, every tenth of which is numbered, beginning with 1 and ending with 10, so that if the first great division stand for the $\frac{1}{10}$ of an integer, the next great division will stand for $\frac{2}{10}$, and the intermediate divisions will represent 100ths of an integer, whilst the large divisions beyond 10 will represent units; and if the first set of large divisions represent units, the subdivisions will represent 10ths, whilst the second set of large divisions will represent tens, and the subdivisions units, etc.

The general rule for using this instrument is as follows: Since all questions are reducible to proportions, if the compass be extended from the 1st term to the 3d, the same extent will reach from the 2d to the 4th term.

The following are a few examples of some of the uses of this line:—

1. To find the product of any two numbers, as 4 and 8: extend the compass from 1 to the multiplier 4, and the same extent applied the same way from 8 the multiplicand will reach the product 32.

2. To divide one number by another, as 36 by 4: extend the compass from 4 to 1, and the same extent will reach from 9 to 36.

3. To find a fourth proportional to three given numbers, as 6, 8, and 9: extend the compasses from 6 to 8, and this extent laid the same way will reach to 12, the fourth proportional required.

4. To extract the square root of a number, say 25: bisect the distance between 1 on the scale and the point representing 25; then half this set off from 1 will give the point 5, which is the root required.

In the same manner the cube-root or the root of any higher power may be found by dividing the distance on the line between 1 and the given number into as many equal parts as the index of the power expresses, then one of those parts set from 1 will extend to the number representing the root required.

An improvement which has rendered the compasses unnecessary consists in having two lines of numbers placed one over the other, one of which lines is engraved upon a slider moving in a groove and is applied as follows:—

The 1st term of the proportional upon the slider being set against the 3d term on the fixed scale, the 2d term upon the slider will stand opposite the 4th term upon the fixed scale.

Instruments of this description with scales suited to almost every branch of art in which calculation is required are now common among intelligent workmen, and the scale of chemical equivalents by which the labors of the chemist are so much facilitated is constructed upon the same principle.

Gun'wale. The upper planking covering the timber-heads round the ship.

A piece of timber around the top side of a boat, and having rowlocks for the oars.

Gur-glet. A porous earthen jar for cooling water. See ICE-MAKING MACHINE.

Gur'let. (*Masonry, etc.*) A pickaxe with one sharp point and one cutting-edge.

Gur'mie. (*Mining.*) A level or working. See GUNNIE.

Gus'set. 1. An angle-iron or bracket stiffening the angle of a structure.

2. An angular piece of iron inserted in a boiler, tank, etc., where it changes from a cylindrical to a square form, etc., as in the junction of the barrel and fire-box of a locomotive.

Gut. 1. Prepared sheep's entrails. See CATGUT.

2. The sac of silk taken from the silk-worm and stretched into a line for a snood.

Gut'ta. One of the ornaments resembling drops, placed in the epistylium of the Doric order below the triglyphs.

Gut'ta-per'cha. The hardened juice derived from the Isonandra, gutta-tree. It is said to take its name from the Malay words *gutta*, gum, and *percha*, the particular kind of tree which yields the juice. The tree is indigenous to the islands of the Indian Archipelago, and particularly to the Malayan peninsula, whose inhabitants have long used the gum for spear handles and other objects, formerly cutting down the tree for this purpose, but now, instructed as to its commercial value, collecting the juice in bowls or cocoa-nut shells from incisions made in the tree. It very soon hardens, and is ready for manufacture. It was first made known by Dr. Montgomery, in 1843; about the same time some was brought to London by Dr. D'Almeida. The former gentleman was rewarded by the London Society of Arts with a gold medal.

The juice consolidates in a few minutes after being drawn, and is then formed by the hand into oblong masses about seven inches long and six inches thick. These generally contain bits of wood and other impurities, which may be removed by immersion in boiling water until the mass is sufficiently softened to be rolled out into a thin sheet, when they may be picked out by hand. Its plasticity when heated allows it to be readily molded into various forms, such as vessels for holding liquids, etc., which are made and offered for sale by the natives.

It is completely unaffected by cold water, and is insoluble in boiling alcohol, but may be readily dissolved by boiling spirits of turpentine, also by coal-tar or naphtha. It resists alkalies and acids, being only affected by the nitric or sulphuric in a highly concentrated state, and is a non-conductor of heat and electricity.

Though applicable to many of the purposes for which india-rubber is employed, it differs greatly from that gum in many respects, being lighter, of finer grain, and very tough and unyielding. Its appearance in the crude state is also very different, the color being a grayish white.

The peculiar adaptability of gutta-percha to many kinds of surgical appliances, and to coating telegraph-cables, is well known.

The mode of manufacture is simple.

The first process consists in cutting the masses into thin slices by means of a vertical wheel whose face has fixed cutters.

These slices are then thrown into a steam-heated tank, by which they are softened, depositing the dirt and heavier impurities, after which the mass of gum in a pasty condition is transferred to another rotary machine provided with teeth, by which it is torn into fragments. These fall into a tank of water, on which they float, any remaining impurities falling to the bottom. The fragments are next softened to a dough-like consistency by immersion in hot water, and thoroughly kneaded by being placed in heated hollow cylinders, within which rotating drums mix the plastic mass and impart to it a uniform consistency. It is now ready for being drawn into sheets or tubes. In forming sheets the mass is passed between steel rollers at a distance apart corresponding to that of the sheet to be made; by this time it has cooled to a solid consistency, and may, by means of adjustable knives, be cut into strips of any desired width before leaving the machine. In making tubes, the gum while yet soft is placed in heated cylinders and forced through hollow molds in a manner similar to that used in making clay drain-pipes. For stamped articles the sheets are cut into appropriately sized pieces, which are heated and compressed between dies. In coating telegraph-wires several of the wires are laid parallel, a strip of gutta-percha is placed above and another below them, and the whole is passed between two polished grooved rollers. The pressure binds the two surfaces of the gutta-percha firmly together and to the wires, while the ridges between the grooves indent the gum so deeply that it may be easily separated longitudinally, each strip containing its own core of copper.

Gut'ta-per'cha Plates. Forms for the ordinary printing-press taken with gutta-percha. An intaglio impression is taken from the form. This, when cold, forms a matrix for obtaining a cameo gutta-percha impression which is used in the press.

Gut'ter. 1. (*Hydraulic Engineering.*) The trench made to hold puddling on the side of a canal.

2. A channel or ditch alongside a traveled road or path to lead off surface water.

3. (*Architecture.*) A trough or channel collecting the water which runs from a roof and leading it to pipes in which it descends to the earth.

A (Fig. 2348) shows the usual arrangement of gutters in England, where parapets are generally carried up above the supporting wall.

This appears, and is said to be, very productive of leakage and injurious to the woodwork of the roof. The Greek or Gothic eave is much better; let the water go, and catch it afterwards if you want to.

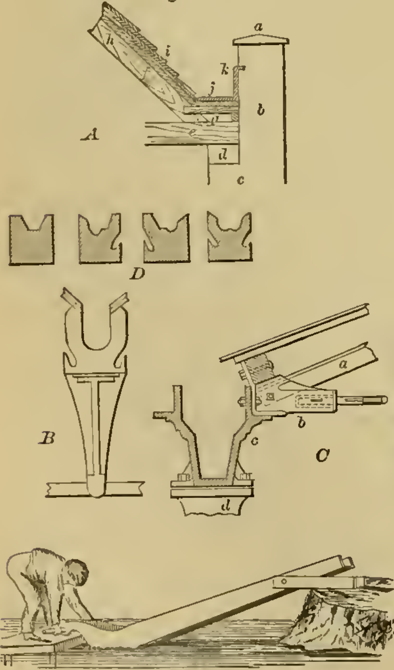
a, *coping.*
b, *parapet*, the outer edge *throated.*
c, *wall.*
d, *wall-plate.*
e, *joist.*
f, *rafter.*
g, *gutter-board.*
h, *eave-board.*
i, *slates or shingles.*
j, *gutter.*
k, *flashing.*

B is the form of gutter, scored out of a solid piece of timber, which was used in the London Crystal Palace of 1861. It was supported on the upper flanges of the main trusses.

C is the arrangement adopted at the Smithfield Market, Manchester, England. The principal rafter *a* and tie *b* rest on the cast-iron gutter *c*, which is supported by the column *d*.

D exhibits several forms of top and side gutters worked out of the solid.

Fig. 2348.



Gutters.

4. (*Hydraulic Engineering.*) A device (*E*, Fig. 2348) for raising water by the vertical oscillation of a trough. As a crude and cheap device it is represented in the accompanying cut, which does not need lengthy description. As a more important machine it is shown under BAIL-SCOOP (which see). It is principally used for small lifts, but by a succession of lifts it may be useful for higher elevations.

The *jantu* of the Bengalese is a counter-weighted *gutter.*

A pendulous *gutter* with several steps of ascent for water is shown in Ewbank's hydraulics.

5. (*Printing.*) One of the *sticks* placed between the pages in a *form* to separate them to such a distance that when the sheet is printed and folded the margin shall be regular and uniform.

Gut'ter-ledge. (*Nautical.*) A bar laid across a hatchway to support the covers.

Gut'ter-snipe. (*Printing.*) A single slip-poster for attaching to curbstones.

Gut'ter-stick. (*Printing.*) One of the pieces of furniture which separate the pages in a form.

Guy. 1. A stay-rope passing from the top of a spar to a post or anchor in the ground, and used to steady it. As the *guys* of a *derrick* or *shears.* See DERRICK; SHEARS.

2. The stay-rod which connects the floor of a suspension bridge with the land on each side, in order to prevent swaying.

3. A rope to steady a body in hoisting.

4. A rope which trims and steadies a *lower studding-sail boom.* The *fore-guy* leads from the boom-end to the *spritsail-gaff*, thence to the heel of the bowsprit, and thence inboard; the *after-guy* leads from the boom-end to a sheave in the ship's side, and thence inboard.

5. A rope from the end of a jib-boom or flying jib-boom to the end of a *spritsail-yard* or *spritsail-gaff*, and thence to the ship's bow, to stay the spar laterally.

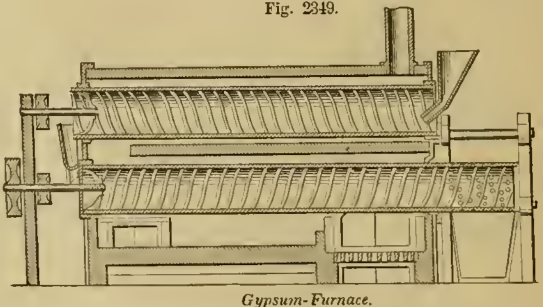
Gybe. (*Nautical.*) The shifting over of the boom of a fore-and-aft sail.

Gyle. 1. Fermented wort for making vinegar.

2. A large vat or cistern. The liquor gyle in a brewery is the water-cistern or vat. A *gyle-tun.*

Gyp'sum-fur'nace. A furnace in which natural gypsum, a hydrate of sulphate of lime, is calcined at a comparatively low heat — about 300 F. — in order to drive off the water of constitution. The process is called *boiling*, as the ebullition is very marked. In the illustration is shown a furnace containing two rotary boilers placed one over the other and provided with rotary conveyors. The gypsum is fed through the boilers consecutively, and is thence emptied upon a cooling surface and packed in barrels.

Fig. 2349.



Gypsum-Furnace.

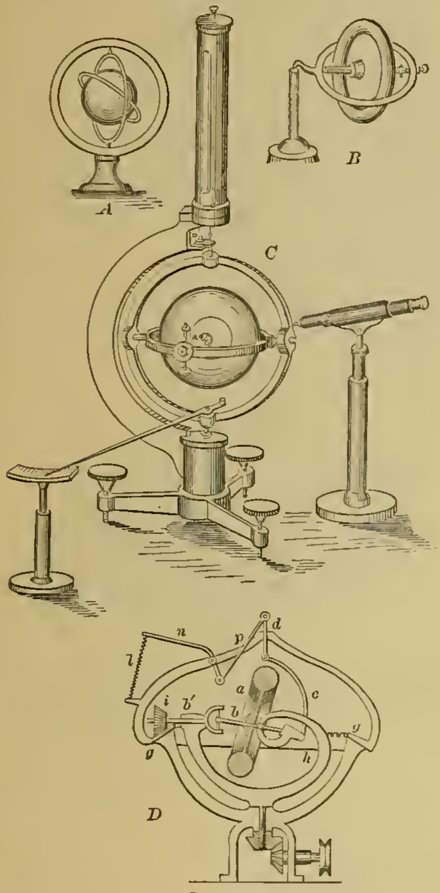
Gy'ro-scope. An instrument for illustrating the tendency of a revolving body to maintain its rotation in a fixed plane when free from the influence of disturbing forces.

It is susceptible of various forms. The earliest, probably, was that of Laplace, for illustrating the precession of the equinoxes.

The principle involved is that of Galileo's second law of motion, that a body actuated by several forces moves in the direction of their resultant.

Several centuries back the Italian academicians noticed the apparent displacement of the plane of vibration of the pendulum. Foucault (1852) first connected this fact with the diurnal motion of the earth, which he illustrated by means of a pendulum (see PENDULUM) and a gyroscope contrived by him.

Fig. 2350.



Gyroscopes.

Bohnenberger's (1765–1831) apparatus (*A*, Fig. 2350) consists of a disk or sphere suspended in gimbals, which are mounted in a ring supported on a stand.

The interior ball and ring may be set at any angle with the outer one, and rotation imparted by a string, when it will be found strongly to resist any attempt to turn it from the plane of its rotation. This disposition of a rotating object to maintain its revolutions in one plane, designated as fixity or persistence of the plane of rotation, may be farther illustrated by the tendency of a trundling hoop or rotating top to remain upright, and by the directness of flight of rotating projectiles.

About 1832, Professor W. R. Johnston, of Philadelphia, devised an instrument which he termed a *rotoscope*, for illustrating this principle. He also showed the effect of rotary motion in overcoming the force of terrestrial gravity by the device shown at *B*, Fig. 2350.

In this a disk is pivoted within a ring, its axis is extended and turned down, so that one end may be supported in a depression at the top of an upright standard. When the disk is placed vertically and rapid rotation imparted, it will maintain its rotation around the standard in a horizontal plane so long as its velocity is considerable, but when this ceases it falls.

C illustrates Foucault's gyroscope for demonstrating the rotary motion of the earth.

A carefully constructed disk is delicately suspended in gimbals within an outer ring vertically pivoted in a frame. The disk is brought into the plane of the meridian and rotated at a great velocity by machinery capable of instantaneous disconnection.

As the plane of the meridian at the moment of starting the apparatus coincided with some celestial meridian, the gyroscope will, while it maintains its rotation, keep in the plane of the latter, that is a fixed line in the heavens, while the terrestrial meridian is carried past it at the rate of 15° per hour. This is shown by a graduated horizontal arc affixed to the gyroscope, which is viewed through a telescope whose axis is fixed in the plane of the terrestrial meridian. It is obvious that were the earth a fixed body the axis of the telescope would always coincide with the same point on the arc, but the latter always maintaining the same vertical plane in space while the direction of the former is constantly changing with the diurnal revolution of the earth, the arc will appear to move in a direction contrary to the earth's rotation.

Gy′ro-scope-gov′ern-or. In Anderson's governor (*D*, Fig. 2350) the principle of the gyroscope has been adapted as the means of regulation.

a is a heavy wheel, the axle *b b′* of which is made in two pieces connected by a gimbal joint, the respective sections carrying the wheel *a* and pinion *i* respectively. The piece *b* is connected at its middle by a hinge joint with the revolving frame *h*, so that variations in the inclination of the wheel *a* will cause the outer end of the piece *b* to rise and fall. The frame *h* is driven by bevel gearing from the engine, and by that means the pinion *i* is carried round the stationary, toothed circle *g*, and the axis of the wheel *a* thus receives a rapid rotation. When the frame *h* and wheel *a* are in motion, the tendency of the wheel *a* is to assume a vertical position, but this tendency is opposed by a spring *l*. The greater the velocity of the governor, the stronger is the tendency above mentioned, and the more it overcomes the force of the spring, and *vice versa*. The piece *b* is connected with the valve-rod by rods *c d*, and the spring *l* is connected with the said rod by lever *n* and rod *p*.

Gyves. Shackles or fetters.

H.

Ha'beck. An instrument used in dressing cloth.

Hack. 1. A tool for cutting jags or channels in trees for the purpose of bleeding them. Pines are *hacked* for turpentine; maples *tapped* for *sap*, or *sugar-water* as Western farmers prefer to call it.

The turpentine hack is a tool with a curved or angular edge to cut channels through the bark and alburnum in an oblique direction, so as to lead the resin towards a *boxing* cut in the tree, or to a cup suspended to catch the drip.

2. A drying-frame for fish. A *flake*.

3. A *pile* of bricks arranged in regular order for *drying*, previous to building up in the *clamp* or *kiln* for *burning*.

4. Wooden bars in the tail-race of a mill.

5. A dung-fork.

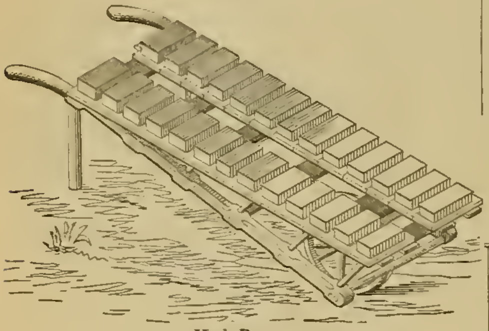
6. A large pick used by miners in breaking stone.

7. A carriage for hire (hackney-coach).

8. A feed-rack for cattle.

Hack-bar'row. A barrow on which bricks are conveyed from the molder's table to the drying-ground, where they are sun-dried or *hacked*, and temporarily covered with a thatching of straw to protect them from rain. Covered sheds are sometimes used.

Fig. 2351.



Hack-Barrow.

Hack'but. (Ger. *hackbret*, a *hackboard*, or chopping-board.) An old name for the *dulcimer*. See Piano-forte.

Hack'er. A cutting-tool for making an oblique incision in the pine-tree for leading the gum turpentine towards the *box* in which it is collected. A *hack*. The *round-shave* is used in chipping, and the *scraper* for removing the gum from the *box face*.

Hack'er-y. An East Indian two-wheeled cart, drawn by bullocks.

Hack'et. (*Joinery.*) A hatchet.

Hack-file. (*Locksmithing.*) A coarse slitting-file.

Hack-ham'mer. A hammer terminating at each end in an obtuse chisel-edge, kept in repair on the grindstone. It is used as the *peen* of an ordinary hammer, but is narrower, and therefore more local and energetic in its effects. The *hack-hammer* for reducing unequal protuberances on grindstones is shaped like an adze and has a short handle. When the grindstone has worn unequally, it becomes necessary to dress it, and the high places, being marked, are hacked by oblique and crossing checker lines, which cause it on the next grinding operation to wear more at those points and thus restore equality.

Hack'ing. 1. (*Masonry.*) The division of a portion of a course of stones into two of smaller hight when the larger stones do not hold out.

2. A process employed in dressing the faces of rough grindstones by the use of a hack-hammer, an implement resembling an adze. In some cases the faces of metallic or wooden polishing-wheels are similarly treated, a sharper implement being used.

3. Piling of molded bricks to dry. See Hack.

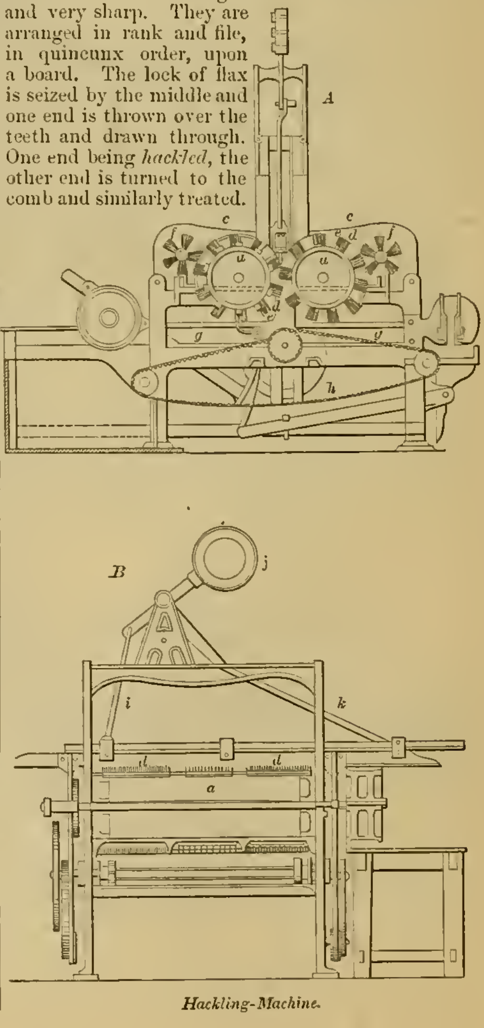
Hack'ing-out Knife. The glazier's knife for cutting out the old putty from the fillister of a sash, in reglazing.

Hack-i'ron. (*Mining.*) A miner's pick. A *hack*.

Hack'le; Heck'le; Hatch'el. A board set with sharp steel spikes for combing or pulling out hemp or flax to dispose the fibers in parallelism, and to separate the *tow* and *hards* from the finer fiber.

The teeth are of steel from 1 to 2 inches in length and very sharp. They are arranged in rank and file, in quincunx order, upon a board. The lock of flax is seized by the middle and one end is thrown over the teeth and drawn through. One end being *hackled*, the other end is turned to the comb and similarly treated.

Fig. 2352.



Hackling-Machine.

This separates the ribbons of fiber, removes any remaining traces of the *boon* or cellular matter, and divides the fiber into two portions, the *short* and the *long*, the *tow* and the *line*.

The process is repeated on a fine hackle whose teeth are more numerous and thickly set. The produce is from 40 to 60 per cent of fine flax; *line*.

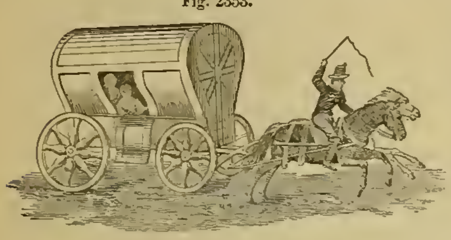
Hack'le-bar. One of the *gills* or spikes over which the lock of flax or hemp is thrown and drawn to lay the fibers parallel and comb out the refuse.

Hack'ling-ma-chine'. A machine for dressing flax.

Fig. 2352, *A* is a side and *B* an end elevation of a hackling-machine adapted for dressing short or cut flax. The two rollers *a a* are caused to rotate inwardly toward each other, and are fed with the raw material from a trough *c*. The peripheries of the cylinders are interspersed with alternate rigid hackles *d* and brushes *e*, so that they alternate on each. The exterior rotating cylinders *f* are also provided with brushes. The broken flax from an upper trough passes between the rollers and is deposited in the trough *g*. Refuse falls between the bars of a grate, and is removed by the endless carrier *h*. One of the cylinders *a* and the brushing cylinders *f* may have a longitudinal movement. On raising the receiving-trough, the rod *i* pushes up the weight *j*, which, by means of the connecting-rod *k*, causes the holder to traverse the width of one set of brushes.

Hack'ney-coach. (*Vehicle.*) An English term for a coach plying in the streets for hire. It has two facing seats inside.

Fig. 2353.



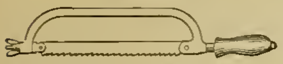
The First (English) Hackney-Coach.

They were introduced into France in 1650 (*fiacre*), and about the same time into England. They are mentioned by Pepys, 1660.

The name is French (*coche-à-haquenée*).

Hack-saw. A frame saw of moderate set, tolerably close teeth, and good temper; used in sawing metal. Such a saw is used to cut the nicks in heads of screws, in cutting off bolts, etc.

Fig. 2354.



Hack-Saw.

Hade. (*Mining.*) The *dip*, *inclination*, or *slope* of a vein or stratum. The angle it bears to the horizon. The *underlay*.

Had'ley's Quad'rant. (*Optics.*) An instrument for measuring altitudes. Used principally at sea. See Quadrant; Sextant.

Hag'but. An old fire-arm with a stock bent down to form a ready means of grasping. An *arquebus*.

Hæm'a-dyn-a-mom'e-ter. An instrument for ascertaining the force of the circulation of the blood. *Hæmatometer; hæmatodynamometer.* See Sphygmometer.

Haft. The handle of a tool or knife. Some handles have specific names, as *helve*, *nib*, etc. Some hafts are solid, others have a central plate and side pieces called *scales*; e. g. knife-handles.

Ha-ha. A fence or division wall so depressed below the ground surface as not to obstruct the view. A *sunk-fence*. A ditch with a *scarp*.

Hair. 1. A filament growing from the skin of an animal.

Curled hair for stuffing sofas, cushions, etc., is carded by hand-cards, which straighten, disentangle, and clean it; this is taken in bunches and spun into a rope, the next *top*, as the bunch is called, being interplaced with the loose strands of the former. The rope is wound on a wheel, and the coil steeped in water for three or four hours, and dried in a hot oven. The ropes are then untwisted, the hairs torn apart, and are ready to form stuffing.

Spun into smaller strands, hair is used for *nose-bags* of horses, bags for containing ground and heated flax-meal in the press, and also for containing prepared lard in the press from which lard-oil flows.

Curled-hair cords are also used for clothes-lines, and when fine also form fishing-lines.

Long and fine horse-hairs are used for the bows of violins and other instruments of this class. Also for making Hair-cloth (which see).

The English lawyers affect horse-hair wigs, and horribly funny they look. Goat's hair is sometimes substituted for the true equine capillus, and this may partially account for their pugnacity and the fact that they are in bad odor with peaceable persons.

2. (*Fire-arms.*) The secondary spring device in one form of pistol and rifle lock, which is freed by the hair-trigger, and collides with the tumbler-catch to unlock the tumbler.

Hair-brush. A fine description of brushes of bristles assorted by color, strength, and quality, and put up in superior manner, hard, soft, or silky, according to purpose and taste. The better class are *trepanned*, a mode of secretly fastening the bunches without gluing a scale of veneer over the wires.

Hair-clip'ping Shears. A scissors for clipping the human hair, or one for clipping horses; the latter have sometimes a guide-bar, which forms a gage for length in cutting.

Hair-cloth. Cloth of goat's hair was used for covering the military engines of the Romans, as we read in Arrian, Thucydides, Ammianus, etc. Curtains of goat's hair were used in the Wilderness tabernacle of the Hebrews. The goat's hair cloth was called *shac* or *sac* in Hebrew, Chaldee, and Syriac; in the Septuagint it became *saccos*; in the Vulgate *saccus*. The Latin *sagum* and English *sack* perpetuate the sound and sense. (See Sack.) The nose-bags of the Arabian horses are of goat's hair cloth, and from them they eat their barley habitually. Goat's hair cloth also covers their tents. See also Camlet.

Horse-hair for the manufacture of hair-cloth is principally derived from South America, and is imported in bales weighing about 1,000 pounds.

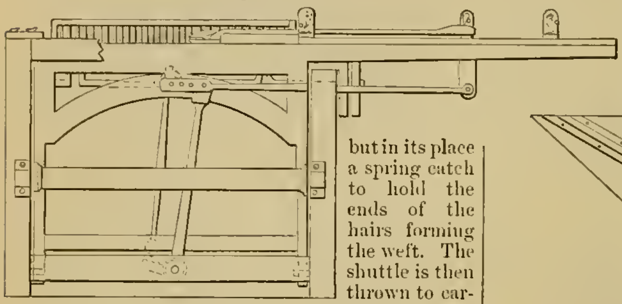
In the process of manufacture, it is first sorted according to color, and then hackled to get the hairs straight and remove dirt. A number of tufts are then placed between the teeth of two cards, and the longer hairs removed by hand, so as to leave only those of uniform length remaining. It is now ready to be woven or curled, according to quality. Hair is curled by forming it into a rope which is afterwards boiled, and then baked so as to set the kink in the hairs.

Hair-cloth is made from the longer and better varieties. The hair is first dyed, usually of a black color, and is merely employed as the weft of the cloth, the warp being composed of cotton or linen thread, according to quality and purpose. The process formerly required two hands to each loom, but those at present used only require the attendance of one person, and recently power-looms have been employed.

After leaving the loom, the cloth is pressed between hot metallic plates to polish it.

Hair-cloth Loom. The *warp* of the web is of black linen yarn; the hair *weft* is thrown with a long hooked shuttle or a long rod having a catch hook at its end. The length of this boxwood shuttle is about 3 feet, its breadth ½ inch, and its thickness ⅛ inch. The *reed* is of polished steel. The weaver passes the shuttle through the *shuttle-way* when it is opened by the treadles; a child presents a hair to the catch of the shuttle, and the weaver draws it through the *shed* and beats it up by two motions of the *batten*. The hairs are laid in a trough of water to keep them supple. The warp is dressed with paste, and the hair-cloth web is hot-calendered to give it luster.

Fig. 2355.



Hair-Cloth Loom.

The shuttle for hair-cloth weaving has no pirn, but in its place a spring catch to hold the ends of the hairs forming the weft. The shuttle is then thrown to carry the hair through the shed; at the other end of the shuttle-way the hairs are released by raising the catch.

In the illustration, the moving jaws of the nippers are raised by cams to allow the introduction of the hairs, and are opened by cams at different times to drop the hairs at different positions in the shed.

Hair-com'pass. A pair of dividers, one of the legs of which is provided with a set screw and spring, admitting of very nice adjustment.

Hair-cord. (*Fabric.*) A cotton goods, the warp of which consists of corded ribs.

Hair-di-vid'er. A dividing compass having one leg arranged for minute movements by a screw; used for fine adjustments.

Hair-line. 1. The fine line or up-stroke of a letter.

2. A kind of type having all fine face-lines.

3. A fishing-line of horse-hair.

Hair-pen'cil. A fine brush for painting. Small tufts of hair inserted into quills. The hairs of the camel, fitch, sable, badger, squirrel, martin, minever, European polecat, raccoon, goat, or other animal, are used for brushes of different qualities.

A small tuft of the hairs is collected with the points all in one direction, and the bunch is bound by a strong thread, and passed point first through a wet quill, so that the point projects to the required distance. The quill shrinks tightly upon the bunch in drying.

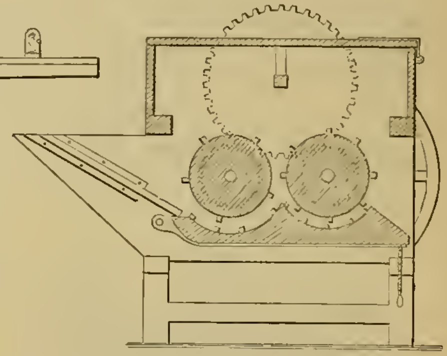
The various sizes require the quills of the crow, pigeon, goose, turkey, or swan. Larger bunches are secured in tin-plate tubes.

The ancient Greek painters used hair-pencils and palettes.

They are now principally used by artists in water-colors, and to some extent by house and sign painters in lettering, graining, and other fine work.

Hair-pick'er. A machine for cleansing and straightening hair. The one represented is for operating on loose hair. The two rollers have similar rotation by connection with a common motive wheel, and turn in a double recessed, adjustable, concave block. The faces of the rollers and concave are armed with pins. The hair is straightened and dirt removed by being drawn through between the rollers and the concave surfaces.

Fig. 2356.



Hair-Picker.

Hair-pin. 1. A pin used in fastening up the hair. A *corking-pin.*

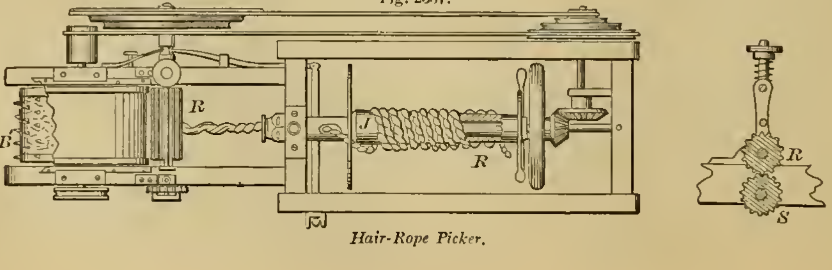
2. A forked pin commonly used by ladies in securing the braids or bands of hair.

Hair-py-ri'tes. (*Mining.*) A native sulphuret of nickel which occurs in capillary filaments of a yellow-gray color.

Hair-rope Pick'er. A machine for unwinding and picking to pieces hair-rope which has been twisted, wetted, and baked to give a permanent curl to the hair.

The rope is coiled around the shaft *J*, the revolution of which untwists it. It then passes between the fluted rolls *R S* and toothed drum *B'*, by which it is straightened and cleansed.

Fig. 2357.



Hair-Rope Picker.

Hair-salt. (*Mining.*) A native sulphuret of magnesia occurring as a fine capillary incrustation.

Hair-side. (*Leather.*) The grain side.

Hair-space. (*Printing.*) The thinnest space used by printers.

Hair-spring. The recoil-spring of a watch-*balance.*

The balance is pulsating, and is the *time* measurer. It is driven in one direction by the power of the mainspring imparted through the escapement, and is returned by the power of the hair-spring, the running of the *train* of wheels being intermitted meanwhile.

It is one of the most delicate of steel articles, and is a favorite illustration of the value given to a cheap article by protracted manipulation.

Hair-springs are made of fine steel, which comes upon spools like thread. To the naked eye it is a round hair, but under a glass it is seen to be a flat steel ribbon, which the gage shows to be $\frac{2}{2500}$ of an inch in thickness, about one half the thickness of an average human hair.

A hair-spring weighs $\frac{1}{15000}$ of a pound Troy. In a straight line it is a foot long. It is exquisitely tempered, for it is to spring back and forth 18,000 times an hour, perhaps for several generations. A pound of steel in the bar may cost one dollar; in hair-springs it may be worth $4,000.

The hair-spring of a watch is usually a flat helix, but chronometer balance-springs are coiled cylindrically.

Hooke introduced the balance-spring into the watch. He made it straight. Huyghens soon after gave it the coiled form. This was about 200 years ago. We are indebted to this brilliant pair of philosophers and mechanicians for much that we enjoy in the approximate perfection of our instruments of precision, — mathematical, optical, and horological.

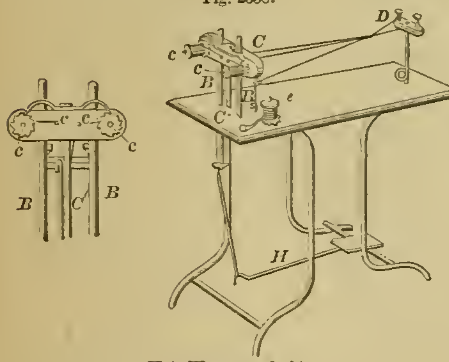
See under HOROLOGICAL INSTRUMENTS, etc.; CHRONOMETER; BALANCE, WATCH.

Hair-stroke. (*Printing.*) A fine line at the top or bottom of a letter; a ceriph.

Hair-trig'ger. (*Fire-arms.*) The secondary trigger of a gun. Its movement is effected by a very slight force, and unlocks a secondary spring device called a *hair,* which strikes the tumbler-catch and throws the sear out of the notch in the tumbler.

Hair-work'ing. A term which includes the making from human hair of bracelets, brooches, ear-rings, rings, chains, necklaces, shawl-pins, purses, bags, book-markers, pencil-cases, guards, studs, etc. These are braiding or plaiting devices.

Fig. 2358.



Hair-Weaving Machine.

In the invention figured, designed for weaving hair for wigs, etc., the head *C,* carrying the spools *c c,* has vertical reciprocation on the pins *B B,* and is operated by the treadle *H.* The ends of the threads on the spools *c c c* are held by the clamp *D.* A slip of hair is passed between the upper side threads and the lower central one, the treadle depressed, the end of the hair turned, and the sliding head rises by the force of a spring. These operations are successively repeated.

Hake. A shed for drying draining-tiles.

Hal'berd. 1. A weapon formed of a blade on the end of a pole.

This was a common weapon among the Romans (*falx, falcula*), either short-handled like the English bill-hook, or on a long handle like the Tudor halberd. It differed from the *cultus* in having a curved cutting edge.

2. A piece of iron welded to the forepart of a horseshoe to relieve the toe of a lame horse.

Half-bas'tion. (*Fortification.*) A *demi-bastion.* That half of a bastion cut off by the capital, consisting of one base and one front.

Half-bent. The half-cock of a fire-lock.

Half-bind'ing. (*Bookbinding.*) A style of binding in which the backs and corners are of leather and the sides of paper or muslin.

Half-breadth Plan. (*Shipbuilding.*) A plan or top view of one half of a ship divided by a vertical longitudinal section in the line of the keel.

It shows the *water* lines, *bow and buttock* lines, and *diagonal* lines of construction.

Half-breadth Staff. (*Shipbuilding.*) A rod having marked upon it half the length of each beam in the ship.

Half-cap'o-niere'. (*Fortification.*) A communication in the dry ditch of a fortress, constructed with but one parapet and glacis.

Half-chess. (*Bridge-building.*) A short *chess* or platform board of a military bridge.

Half-cock. (*Fire-arms.*) The position of the gun-lock when the nose of the *sear* is in the first or deep *notch* of the *tumbler.* From this it cannot be pulled off by the trigger.

Half-cut Line. Flax cut in two lengths for spinning.

Half-floor. (*Shipbuilding.*) One of the timbers of a frame whose heel is over the keel, and upon whose head rests the heel of the second futtock. It lies for half its length alongside the cross-timber, and the other half alongside the first futtock.

Its heel butts against the heel of the corresponding timber of the other half of the frame, at the middle line of the ship, where they are clamped between the keel and keelson, and coaked or bolted thereto.

Half-fur'nace. (*Metallurgy.*) An ore-smelting furnace of but about 36 feet hight. The high furnace is 50 to 72 feet in hight.

Half-gang. (*Weaving.*) The part of warp of twenty threads, warped round the bank after a lease.

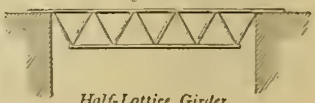
Half-head'er. (*Bricklaying.*) A half-brick laid at the angle of a building to finish the course.

Half-high Fur'nace. See HALF-FURNACE.

Half-hitch. (*Nautical.*) Passing the end of a rope round its standing part and then through the bight. A *clove-hitch* is two *half*-hitches. See HITCH; KNOT.

Half-lat'tice Gird'er. (*Bridge-building.*) A form of girder sometimes known as a "Warren Girder," and consisting of horizontal upper and lower

Fig. 2359.



Half-Lattice Girder.

bars, and a series of diagonal bars, sloping alternately in opposite directions, and dividing the space between the bars into a series of triangles. See Truss.

Half-mer′lon. (*Fortification.*) That solid portion of a parapet which is at the right or left extremity of a battery.

Half-min′ute Glass. (*Nautical.*) A sand-glass which determines the time for the running out of the log-line. See Log.

Half-moon. (*Fortification.*) A *redan* in front of the *curtain* on the outside of the main ditch.

Half-moon Knife. (*Leather.*) A double-handled knife used by the dresser of skins for parchment. The knife has a crescent shape, and projects in a plane at right angles to the axis of the handles.

Half-pace. (*Building.*) *a.* A raised floor in a bay-window.

b. A resting-place at the end of a flight of steps. A *foot-pace.* A *landing.*

Half-pike. (*Nautical.*) A short pike employed in boarding.

Half-port. (*Nautical.*) A port-shutter having a hole for the protrusion of the gun-muzzle.

Half-prin′ci-pal. (*Carpentry.*) A rafter which does not extend to the crown of the roof. Their tops are connected by collar-beams, or rest on a purlin.

Half-re-lief′. The moderate prominence of a sculptured figure from the plain surface to which it is attached. It is also known as *mezzo-rilievo*, or *demi-relief*, and is a grade between *alto-rilievo* or *high-relief*, and *basso-rilievo* or *low-relief.*

Half-rip Saw. (*Carpentry.*) A species of hand-saw with a narrower set than a rip-saw and somewhat finer gage of teeth.

Half-round Bit. A demi-cylinder bit.

Half-round File. A file flat on one side and rounding on the other.

The curve usually varies from the half to the twelfth of a circle, but the name *half*-round is indiscriminately applied. Files with the larger curvature are known as *full* half-rounds ; others as *flat* half-rounds.

Half-sheet. (*Printing.*) The off-cut portion of a duodecimo.

Half-shoe. (*Farriery.*) A shoe on the one side only of a horse's foot as a protection or corrective, when the horse is not fully shod.

Half-stuff. (*Paper-making.*) The partially ground rag-pulp, the produce of the *washing-engine*, which is the first of the two engines by which the reduction is made. See Rag-engine.

Half-stuff Ma-chine′. (*Paper-making.*) A washing-machine in which ground rags are cleaned and cut to a greater degree of fineness than in the rag-engine. It resembles the *pulping-machine* in everything but being adapted to work on a coarser article.

Half-sunk′en Bat′tery. (*Fortification.*) A battery having its interior space or terre-plein sunk some inches below the natural surface, and its parapet composed of the earth thus obtained, and of that taken from a narrow ditch in front. This description of battery admits of being more quickly constructed than any other, as the diggers can work both in front and rear at the same time.

Half-thick File. A large, coarse file with three flat and one rounded side. It is used as a *rubber-file* for coarse work.

Half-tim′ber. 1. (*Shipbuilding.*) One of the short futtocks in the cant-body.

2. (*Carpentry.*) A mode of building houses practiced extensively in the Tudor times. The foundations and principal supports were of stout timber, and the interstices of the fronts were filled with plaster.

Half-tub. Half a cask cut off at right angles to the axis. Such is a deck tub, for swabs in deck-cleaning, and for gun-sponges on shipboard. Such is also the *match*-tub.

Half-turn′ing Bolt. One with a thread occupying one half of its cylindrical surface. See Bolt, *n.*

Hal′liard. See Halyard.

Hal′lier. A birding net.

Hal′lo-type. (*Photography.*) Another name for the Hellenotype (which see).

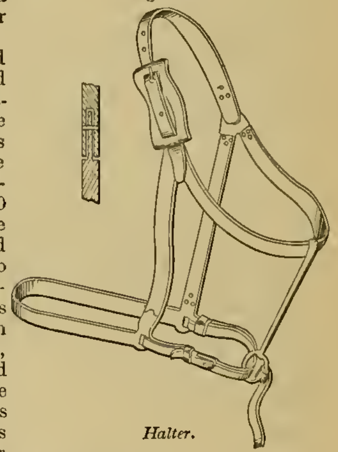
Ha-lom′e-ter. An instrument for measuring the forms and angles of salts and crystals.

Hal′o-scope. (*Optical.*) An optical instrument invented by M. Bravais for exhibiting the phenomena connected with halos, parahelia, etc. It comprises prisms and a mirror, which are rapidly revolved about an axis, and two plates of glass for intercepting the light. The rotating prisms receive the light from a lamp in a darkened chamber, the refracted rays assuming the form of the parahelion circle.

Hal′ser. A large rope. See Hawser.

Hal′ter. (*Menage.*) A headstall and strap by which an animal is hitched to a stanchion or manger.

Fig. 2360.



Halter.

Cattle and calves were tied in stalls for fattening by the Hebrews. Horses and oxen were also stalled. Solomon had 40,000 horse-stalls. The animals were tied up by halters, no doubt. Headstalls for animals were common then in Babylon, Persepolis, and Egypt. The horses and asses of the Syrians were tied in their camp (892 B. C.) when the four leprous men went in and found the camp deserted.

Halters are shown in the sculptures of Nimroud. The army is represented in the act of crossing a river, and the horses are haltered behind the sterns of the boats, swimming in the wake.

Hal′vans. (*Mining.*) Impure ores which require to be washed and freed from impurities.

Halve-net. A fixed bag-net placed within low-water mark to prevent fish returning with the tide.

Halv′ing. A mode of joining timbers or scantling in which each is equally cut upon one of its faces, and the two new faces are laid together and secured. The timbers *lap* upon and are *let into* each other.

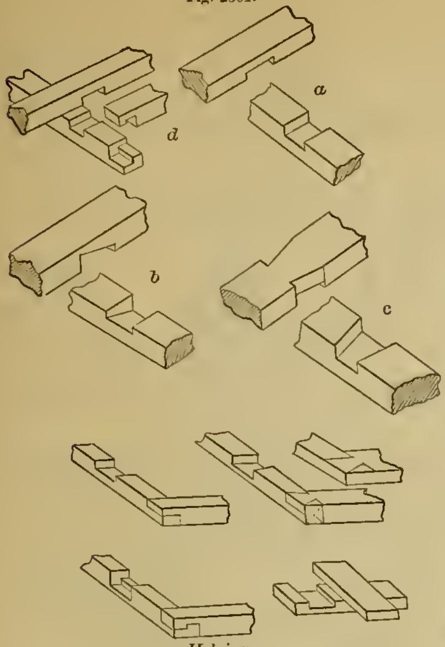
The joint thus made may be a simple *lap-joint*, or it may be a *dovetail*, a *scarf*, or a *notched joint.* It may be secured by *pins*, *wedges*, or *bolts*, according to circumstances.

Among the varieties specific names are given to *a*, *common* halving ; *b*, *beveled* halving ; *c*, *dovetailed* halving ; *d*, *notched* halving.

Halv′ing-belt. (*Machinery.*) A belt crossed between pulleys, so as to revolve them in opposite directions. A *crossed* belt. See Belt.

Hal′yard. (*Nautical.*) A rope, chain, or tackle

Fig. 2361.



Halving.

for hoisting or lowering *yards*, *spars*, *sails*, or *flags*. The halyards of the lower yards are called *jeers*. *Haulyard; halliard.*

They are named from the spar, etc., to which they are applied; as, —

The *throat* or *peak* halyards of a gaff.

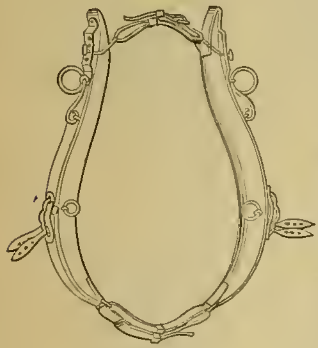
Main-sail, *top-sail* halyards, *driver*-halyards, etc.

Signal-halyards, *pendant*-halyards, *ensign*-halyards.

To haul a yard aloft is to *sway* it; to lower is called *striking*.

Hame. (*Harness.*) One of the pair of curved bars of wood or metal which fit in the crease between the roll and the body of the collar, and to which the traces are connected. The flat wooden hame is still used in heavy gears, secured by thongs (*hame-strings*). The trace-chains are attached to the hooks, and the reins pass through the rings above. The *trace-hooks* of carriage-hames are looped to the staples of the hames.

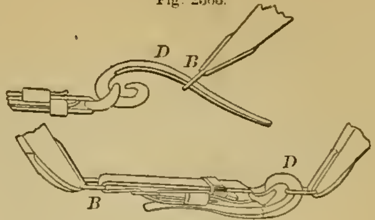
Fig. 2362.



Hames.

Hame-fas'ten-er. (*Harness.*) A device to fasten the ends of hames together, clasping them around the collar. A substitute for a hame-string. In the example, the device is buckled to one hame-loop *B*, and the hook *D* passed through the other loop. The hook is then turned over, as in the lower figure, tightening the hames.

Fig. 2363.



Hame-Fastener.

Hame-lock. A Hame-fastener (which see).

Hame-ring. (*Harness.*) With carriage-hames there is one ring on each hame for the driving-reins; with wagon-hames, an additional ring is provided on each for the breast chain or strap.

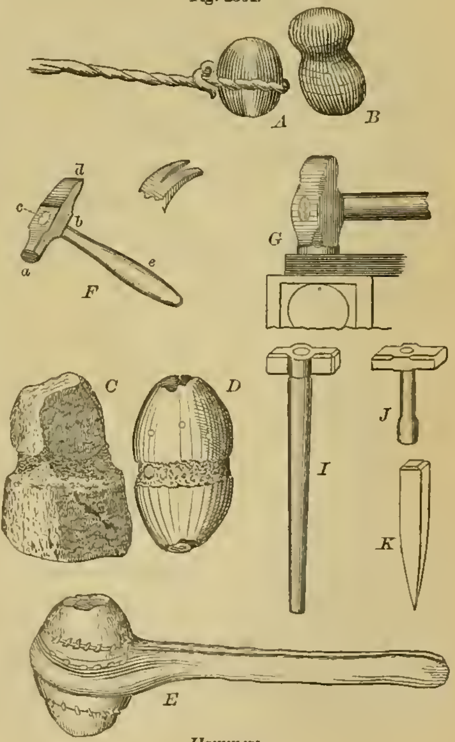
Hame-strap. (*Harness.*) A strap at the upper end of the hames unites them above the collar, and another strap unites them below the collar. The lower is the one which is unfastened to remove the gears.

Ham-knife. In some restaurants, a peculiar long, round-ended carving-knife for shaving off very thin slices of ham or beef.

Ham'mer. 1. A tool for driving nails, beating metals, and the like.

We can hardly admit the statement of Pliny that the hammer was invented by Cinyra, the discoverer of copper-mines in the island of Cyprus. Tools of metal, of which the hammer was among the first, must have been in use for many centuries. Tubal Cain, the descendant in the sixth generation from Cain, was an "artificer in brass and iron"; copper, probably, rather than brass. Brass and bronze are

Fig. 2364.



Hammers.

not distinguished from each other, by name, either in Greek or Latin.

The initial form was perhaps a stone fastened to a handle, and used as a club, *A B C D E*. Many such are found in the relics of the stone age, before man had learned the use of metal, the most useful of which, iron, was about the last to be discovered, of those which are applied to the common affairs of life. This stone age is so far in the remote past as to antedate all historical accounts of manners, customs, and appliances. The use of stone, however, in the mode described, still exists among many nations imperfectly provided with a better substitute. In the Bible we read of hammers for nails, forging, and planishing, and for breaking stone.

A B are ancient stone hammers, found in long-neglected workings of the Lake Superior copper region, and are identical with those of other parts of the world. It is not necessary to give them an equal antiquity to the "celts," stone axes and hammers of the stone age of Europe, as many of the implements yet in use among the more barbarous North American Indians are of the same general character. See Axe.

Modern hammers are of many shapes and kinds. The parts are the *handle* and *head*. The latter has an *eye*, *face*, *peen*, or *claw*.

F shows a riveting hammer. Of its parts *a* is the face, *b* the poll, *c* the eye, *d* the peen, *e* the helve.

G is a large hammer used by machinists. Between *F* and *G* is a *claw*, which takes the place of the *peen* of the other hammer. *I* and *J* are miners' hammers; *K* a miner's wedge.

Hammer-making forms a very important part of the industry of the great manufacturing center, Birmingham, and its satellite, Wolverhampton.

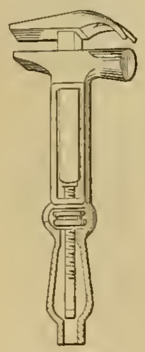
The nomenclature of the various kinds, which are numerous, is generally derived from their application, though in some instances from the form.

File-maker's, *sledge*, *riveting*, *lift*, *raising*, *claw*, *planishing*, *gold-beater's*, *hacking*, *veneering*, may be enumerated among the numerous varieties, as well as *tilt* and *steam hammers*.

Hammers employed in engine work are of three sizes, the *sledge*, *flogging*, and *hand* hammers. See also Miner's Hammer.

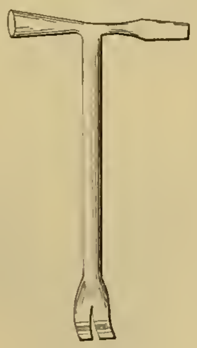
Fig. 2365 is a combined hammer and wrench. Fig. 2366 is a tack-hammer with claw handle and a sharp peen which forms a screw-driver.

Fig. 2365.



Hammer-Wrench.

Fig. 2366.



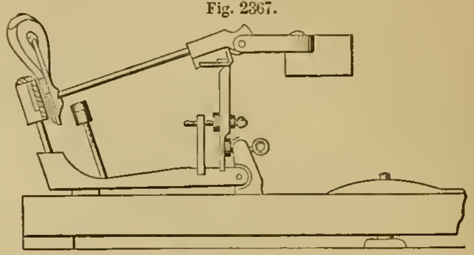
Hack-Hammer.

The Japanese hammers are solid cylindrical pieces, not made shapely with waists and graceful outlines like ours. They have the same flat-sided handles as the saws.

2. The *striker* of a clock.

3. (*Fire-arms.*) Formerly, the hammer of the flint-lock was the steel cover of the priming-pan, and the parts connected therewith which received the blow of the flint which was held in the *cock*. With the old flint-lock, the parts of the *hammer* were the *body*, *face*, *back*, *seat*, the *heel* or *tail*, and the *toe*. The hammer of the percussion-lock is the striking part itself, — the *cock*. Such changes are not uncommon in mechanics. The piano-jack is another instance. See Gun-lock.

Fig. 2367.



Piano-Movement Hammer.

4. (*Music.*) A small padded mallet by which the string of a piano is struck.

See also under the following heads: —

About-sledge.
Atmospheric-hammer.
Ball-peen hammer.
Barking-mallet.
Bat.
Beetle.
Bench-hammer.
Bolt-hammer.
Bott-hammer.
Bricklayer's hammer.
Bucking-iron.
Bush-hammer.
Celt.
Chasing-hammer.
Chop-hammer.
Claw-hammer.
Clock-movement hammer.
Closing-hammer.
Commencing-hammer.
Cooper's hammer.
Creasing-hammer.
Dead-stroke hammer.
Dental-hammer.
Drop-hammer.
Enlarging-hammer.
Fid-hammer.
Finishing-hammer.
Flat-hammer.
Flatter-hammer.
Flogging-hammer.
Flue-hammer.
Foot-hammer.
Fore-hammer.
Forge-hammer.
Forging-apparatus.
Friction-hammer.
Furrowing-hammer.
Gavel.
Gold-beater's hammer.
Gun-lock hammer.
Gunpowder-hammer.
Hack.
Hammer-axe.
Hand-hammer.
Hatchet.
Helve.
Holding-up hammer.
Knapping-hammer.
Lathing-hammer.
Lift-hammer.
Machinist's hammer.
Mallet.
Marcus.
Marteline-hammer.
Maul.
Meat-hammer.
Mill-pick.
Millstone-hammer.
Miner's hammer.
Monkey.
Nail-hammer.
Oliver.
Peen.
Percussor.
Piano-movement hammer
Pick-hammer.
Pig-iron breaker.
Planishing-hammer.
Pneumatic-hammer.
Polishing-hammer.
Power-hammer.
Ragging-hammer.
Raising-hammer.
Ram.
Rammer.
Ramrod.
Revolving-hammer.
Riveting-hammer.
Scabbling-hammer.
Set-hammer.
Set-up hammer.
Shingling-hammer.
Shoe-hammer.
Sledge-hammer.
Spalling-hammer.
Spreading-hammer.
Stamp-head.
Steam-hammer.
Stone-breaker's hammer.
Stone-hammer.
Striker.
Swaging-machine.

Tack-hammer.
Tilt-hammer.
Trip-hammer.
Veneering-hammer.
Wrench-hammer.

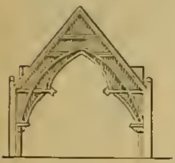
Ham'mer-axe. A double tool having a hammer at one side of the handle and an axe at the other.

Hammer-beam. (*Carpentry.*) A timber tie connecting the two rafters of a pair at a point between the apex and footings. A *collar-beam.*

Ham'mer-beam Roof. (*Carpentry.*) A roof, the feet of the principal rafters of which are not connected by a tie-beam, but usually rest in corbels.

Half-rafters, carrying a vaulted superstructure, usually partially span the severy.

Fig. 2368.



Hammer-Beam Roof.

Ham'mer-cap. A cover for the cock of a gun.

Ham'mer-catch'er. (*Music.*) A padded shoulder which catches the hammer on its return. See Piano-movement.

Ham'mer-cloth. (*Carriage.*) The cloth which covers a coach-box; so called from the old practice of carrying a hammer, nails, etc., in the box of the seat; or from *hamper.*

Ham'mer-hard'en-ing. Beating metal with a hammer while cold, to close the pores and condense the texture.

Ham'mer-helve. The shank of a forge or trip-hammer. On the *helve* is fastened the *hurst* or ring, which has projecting trunnions forming the axis.

Ham'mer-joint. The joint of the pan in the flint-lock.

Ham'mer-mark. A *forge-mark.* A mark of the hammer left from forging.

Ham'mer-nail. The pin securing the cock to the plate of the gun-lock. A *lock-nail.*

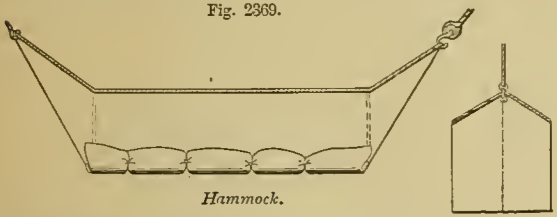
Ham'mer-spring. The spring of the hammer in a gun-lock. Its parts are the *play-side, stud-side,* the *turn,* the *flower,* the *stud,* the *eye;* through the latter passes the rod of the spring-pin.

Ham'mer-tail Spring. (*Horology.*) A long and stiff spring in a clock which gives the effective impulse to the striking hammer, when the latter is retracted for a blow and then released.

Ham'mock. (*Nautical.*) From *hamac;* the suspended bed of the Bahama-Islanders when discovered by Columbus.

A swinging sea-bed, common in South American countries and elsewhere, and made of manilla, sea-grass, and other fiber, often ornamented and of delicate material. "The undisputed invention of Alcibiades" (Admiral Smyth). It is a piece of canvas, 6 by 4 feet, the end gathered by *knittles* and a *grommet,* forming the *head* and *foot clews,* to which is attached the lanyard by which it is suspended from rings in the deck beams.

Fig. 2369.



Hammock.

The illustration is rather a swinging cot.

The orders on board ship are, "Down all hammocks!" "Up all hammocks!" "Lash hammocks!" Their respective meanings are, to carry below and sling; to unsling and stow away; to brail up to allow a clear passage between decks.

Ham'mock-net-tings. (*Nautical.*) A row of forked, upright, iron stanchions, supporting a netting or wooden trough, in which the seamen stow their hammocks during the day.

Ham'per. 1. A large wicker-work covered basket, used for packing up liquors, etc., for carriage.

2. A fetter.

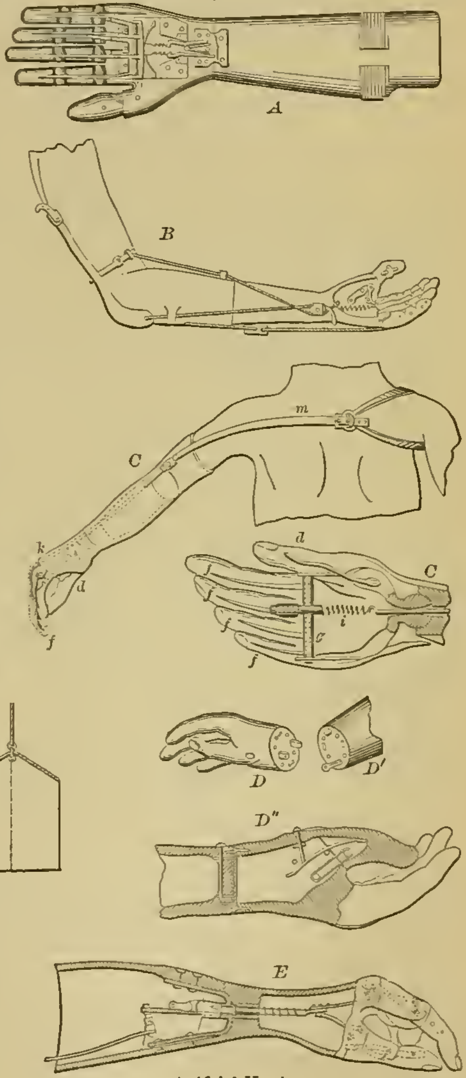
3. (*Nautical.*) Equipment and gear about the decks of a vessel.

Ha'mu-lus. (*Surgical.*) An instrument for extracting the fetus.

Hance. (*Architecture.*) The two lower portions of a four-centered arch; the part between the *hanch* (haunch) and the *springing.* *Hanch.*

Hand. 1. (*Horology.*) The pointer or index-finger of a watch, clock, or counter: *hour, minute, seconds,* as the case may be; or known by the dial

Fig. 2370.



Artificial Hands.

to which it belongs, as in the respective dials of the gas-meter or other dial-register.

2. (*Menage.*) Four inches; horse measure.

3. The small of a gun-stock.

4. A handle or helve.

Hand-an'vil. (*Locksmithing.*) A small movable anvil used by locksmiths. It may be supported by the work-bench or held in one hand. A *stake.*

Hand, Ar'ti-fi'cial. A prosthetic member to be attached to the stump of the forearm, and having fingers and a thumb with some capacity for grasping. The terminal portion of the artificial arm. See Arm, Artificial, where the subject is considered at some length. Of mere hands and wrists a few examples may be given.

A is a hand in which the steel ligatures of the fingers are applied to a transverse rod which is connected to a toothed sliding bar; the position of the bar is regulated by two sliding pawls which can be operated by the other hand, and thus the fingers can be retained in any position.

B is for an amputation of the forearm, and has cords which pass from points of attachment on the arm so as to flex or extend the metacarpus and phalanges by the flexor and extensor movements of the stump.

C C are two views of the Selpho arm, in which the spiral spring *i* draws the fingers *f* constantly towards the thumb *d*, and retains any article placed within the hand and between the thumb and the fingers. The artificial hand may be opened by a motion of the opposite shoulder drawing on the shoulder strap *m* and cord *k*, or by extending the artificial hand and arm. *g* is a metallic cross-pipe on which the fingers are constructed.

D D' D'' are views of a hand which is detachable at the wrist. The clasps issuing from the artificial stump have sliding motion to clamp any article placed between their claws. These clasps enter slots in the wrist-plate of the hand. The thumb is adjustable in two positions by means of a spring and catch, the latter being freed by a trigger.

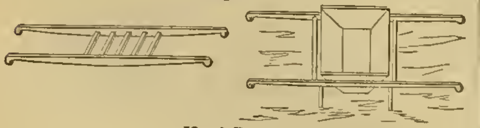
The spring thumb has a latch for holding it open when desired, and means for releasing the thumb from the latch when required.

In *E*, the detachable hand is so fitted to the forearm as to admit of a natural degree of rotary motion at the wrist, and that the hand may be detached by simply unlatching and withdrawing it from the socket without the trouble and delay usually necessary in disuniting the mechanism employed in moving the fingers. In place of the hand a grasping claw, having a swiveling socket, may be attached to the arm at will.

Hand-axe. A light axe which may be used in one hand in the manner of a hatchet.

Hand-bar'row. A device which has a pair of handles at each end, and is adapted to be carried by two men. A *hand-bearer, litter, bier,* or *stretcher.* The difference is in the fitting up. The hand-barrow is intended for a load of packages, goods, or materials, and the illustrations explain its structure.

Fig. 2371.



Hand-Barrows.

Hand-bell. A small bell with a handle, used for various purposes. They are sometimes silver-plated or gilt, or even of solid silver. The illustration shows an *altar*-bell for church service.

Fig. 2372.

Hand-Bell.

Hand-bill. A bill-hook. A chopping tool. See Bill-hook.

Hand-board. One used in rolling port-fire cases and similar work.

Hand-bor'er. (*Well-boring.*) A *pitching-borer* or *short borer* used at the commencement of a well or shaft.

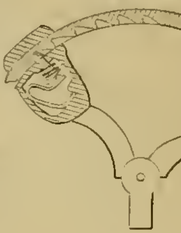
Hand-brace. A tool for boring, consisting of a cranked spindle, at one end of which a broad head or breast-plate is attached by a swivel; at the other end a socket, into which a drill can be fixed. See Brace.

Hand-car. A car for laborers or track-repairers, and adapted to travel on a railway, being propelled by hand-cranks.

Hand-cart. A two-wheel vehicle, its body balanced on its axle, adapted to carry loads of parcels or goods, and propelled by hand. The varieties are somewhat numerous, but preserve the general features stated.

Hand'cuff. Usually in the plural, *handcuffs.* A chain and locking-rings; a strap or other *manacle* for the hands. That in the example may be closed fast by slipping the parts together, but the spring-bolt can only be disengaged by a key.

Fig. 2373.



Handcuff.

Hand-cul'ti-va'tor. (*Agriculture.*) One on a small scale, adapted to be drawn or propelled by manual power.

Hand-drill. A drilling-tool for metal, operated by hand, in contradistinction to a drilling-machine.

The cut shows a drill mounted on a bench by means of a clamping vise. *A B* represent two positions of the drill, one arranged for oblique presentation and the other for vertical.

C is a drill in which pressure is applied by the foot, and motion by the hand. *D* is a common hand-drill, with a cast frame. *E F* are side and front elevations of Nasmyth's drill.

There are many other forms of hand-drills, such as ratchet, bow, dental, Persian drills, etc. See list under Drill.

Hand Feed-pump. (*Nautical.*) A deck feed-pump.

Hand-file. A somewhat generic term, including most forms of files. See File.

Hand-gear. (*Steam-engine.*) The handles of the working gear. The parts by which the driver controls the action of the engine; three sets of levers and rods connected to the slide-valve, eccentric-rods, regulator-valves, and feed-pipe cocks, whereby he can *put on* or *shut off* steam to the cylinders, water to the boiler, or place the slide-valves in a *forward* or *backward* position at his pleasure.

Hand-glass. 1. A bell glass or glazed frame, for the protection of plants.

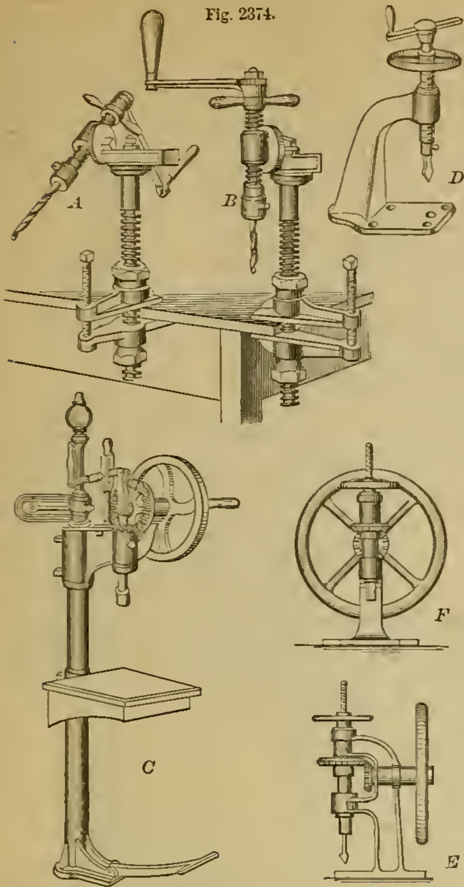
2. A half-minute glass, used as a measurer of time in running out the log-line. See Log.

3. A small mirror with a handle.

Hand-grap'nel. (*Nautical.*) A small anchor.

Hand-gre-nade'. An explosive projectile of small weight; a shell adapted to be thrown by

Fig. 2374.



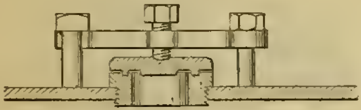
Hand-Drills.

hand, and used of course at near quarters. It is principally used in repelling an attack, being thrown over the parapet at the assaulting party. Also boarding-parties at sea. See Grenade.

Hand-ham′mer. The machinist's working hammer used in engine and boiler work, in contradistinction to the two-handed *flogging* hammer and the *sledge*.

Hand-hole. (*Steam-boiler.*) A small hole at or near the bottom of a boiler, for the insertion of the hand in cleaning, etc. It is closed by a *hand-hole* plate, and is smaller than a manhole.

Fig. 2375.



Hand Hole and Plate.

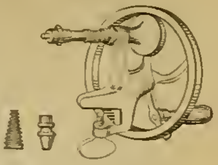
Hand-hook. 1. (*Forging.*) A bent instrument used by smiths in twisting square iron.

2. A hook for handling shells. A *shell-hook.*

Hand-jack. A jack worked by hand or by a lever, pinion and rack, screw, etc. See list under Jack.

Hand-lathe. 1. A small lathe mounted on a bench or table and turned by a hand-crank or by a bow. It is usually portable, and may be secured by a clamp to the bench. It is used by watch and clock makers, dentists, and other workers in small machinery.

Fig. 2376



Hand-Lathe.

2. A *bar-lathe ;* one whose puppets slide on a prismatic bar.

Han′dle. A portion of or added to a tool, by which it is grasped. The *hand-hold.*

The *helve* of a hammer or axe.

The *haft* of a knife.

The *hilt* of a sword.

The *stale, staff,* or *stilt* of a plough.

The *stale* of a rake. Qy. from *hale,* to pull or draw.

The *stock* of a drill, bit, or gun.

The *bail* of a kettle.

The *rounce* of a printing-press, by which the form is run in and out, under and away from the platen.

The *shaft* of a boat-hook, spear, lance, or harpoon.

The *hand-lever* of a steam-engine, by which it is started, reversed, etc.

The *knob* of a door, or lock.

The *brake* or *lever* of a pump.

The *crank* of a winch or crab.

The *nib* of a scythe.

The *pommel* of a saddle.

The *trigger* of a gun-lock.

The *helm* or *tiller* of a rudder.

The *dolphin* of a gun. In bronze guns of the old construction handles were usually cast over the center of gravity of the piece, for convenience of handling and slinging. These were formerly made in the shape of a fish, and hence were called *dolphins.*

Handles for case or pocket knives are made of various materials : elephant and walrus ivory ; stag, buffalo, and cow horn ; tortoise-shell, bone, mother-of-pearl ; cocoa, snake, rosewood, etc.

With *case knives* or *table knives* the tang of the blade is secured in the haft by means of cement, transverse rivet, end nut on the through tang, spring catch, or other device. Balance handles are made by introducing lead into the handle to counterbalance the weight of the blade.

With *pocket knives* the sides of ivory, horn, bone, wood, etc., are secured by rivets to the *scales,* as the side-plates of iron or brass are called.

Machines for making handles are of the nature of lathes, planers, etc., according to the material and the shape required. By such means are manufactured in quantity handles for brooms, scythes, shovels, chisels, whips, plows, etc.

Hand-lead. (*Nautical.*) A small lead for sounding ; the term is used in contradistinction to *deep-sea lead.*

The hand-lead weighs from 7 to 11 pounds, and is used with 20 fathoms of line. See Sounding.

Hand′ler. (*Tanning.*) A pit containing a weak ooze for the early portion of the tanning process.

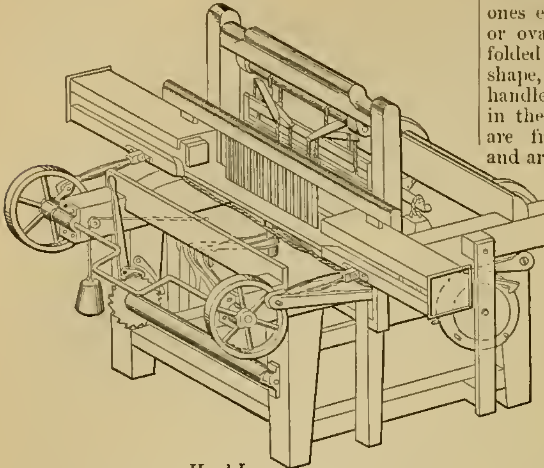
Pits containing a stronger solution, and used towards the conclusion of the process, are called *bloomers.*

Hand-let′ter. (*Bookbinding.*) A finisher's hand-tool whose face is a single letter.

Hand′ling. (*Leather-manufacture.*) An occasional removal of hides from the vat, allowing them to drain, and then replacing them. The object is to equalize the action of the lime in the process of *unhairing ;* of the ooze in tanning, etc.

Hand-loom. A form of loom in which the motions are derived from hand power, either by a crank or by pushing the lathe or batten. In the example, the driving shaft, at the front end of the machine, is provided at its middle with a crank, so as to enable the weaver to use both hands when required, and also to reach any broken thread in the warp. A feed pawl attached to a fly-wheel on the driving shaft operates a ratchet-wheel on a rearward shaft, provided with tappets which depress in succession the treadles. The picker staff projects from a shaft journaled vertically to the batten, and on this shaft is a strap, the ends of which are divided and secured to the alternate treadles. Thus the harness, let-off, take-up, and shuttle motions are all derived from the crank which is by the breast of the weaver.

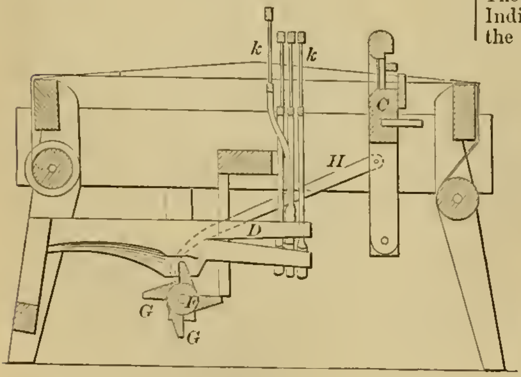
Fig. 2377.



Hand-Loom.

Fig. 2378 is an example of the other kind, in which the motions are all derived from the batten *C*, in which is the shuttle-race. The harness levers *D* are actuated by means of a hooked arm *H* engaging cams *G G* on a shaft *F*. The upright rods *k k* carrying the harness are interchangeable on the treadles, in order to vary the twill or style of the cloth. See Loom, p. 1354.

Fig. 2378.

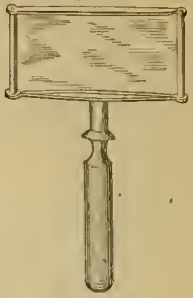


Hand-Loom.

Hand-made. (*Paper.*) Said of paper made with a wire-cloth and deckel, by slipping out a quantity of pulp, allowing a partial drainage, and then transferring the mat to the felts.

Hand-mag′ni-fi′er. A lens, usually of doubly convex form, mounted and provided with a handle. They are of various shapes and sizes; some, the smaller ones especially, being round or oval, and adapted to be folded within a case of similar shape, which constitutes the handles, so as to be carried in the pocket. Larger ones are frequently rectangular, and are used as readers. The lens may be of meniscus or concavo-convex form, to adapt it to the sight of the user, having a large field of view, for convenience in reading print or viewing objects which do not require a large magnifying power.

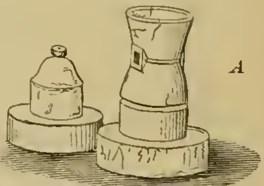
Fig. 2379.

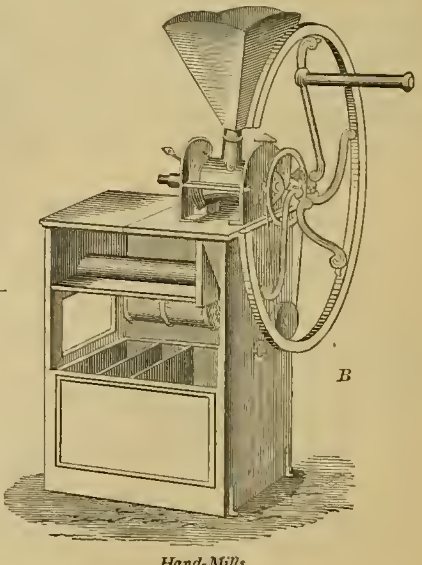


Hand-Magnifier.

Hand-mill. The original mode of making meal was by bruising the grain. This plan was earlier than any form of grinding by a mill. In the time of Pliny one variety of bread was made from pounded grain, and was highly esteemed. (See Bread.) The references to mills in the Bible all concern the hand-mill, which was universal throughout the Orient, the references to it in old writings, the illustrations of old monuments, and the remains of the machine itself, being very numerous and widely scattered. *A* (Fig. 2380) represents two mills of Pompeii. A golden hand-mill was one of the most honorable presents from a Persian king to a subject. The Romans found the British in possession of the *quern*. The North American Indians adhered to the *mortar*, and the

Fig 2380.





Hand-Mills.

hollowed stones yet mark the sites of their villages in those parts where corn was cultivated. The Mexicans use a spindle-shaped rub-stone in a hollow bed-stone.

The almost universal form of hand-mill was two circular stones, the lower was the bed-stone and stationary, and had a central pivot for the upper one, which had an eye. The upper stone was turned by means of a vertical handle. See Grinding-Mill.

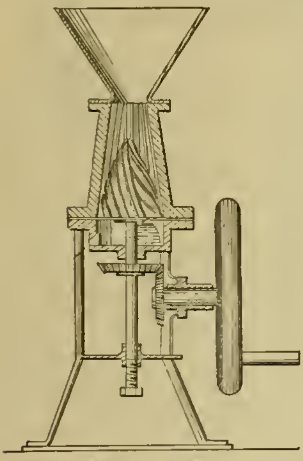
The mill adopted by Napoleon, and used by him in his invasion of Russia in 1812, consisted of two circular cast-iron plates, about 12 inches in diameter, placed in a vertical position. One was fixed, the other rotated by a hand-crank. The plates were indented all over with radiating grooves, and the corn was conducted to the center, or eye, by a lateral hopper. The meal, as it was ground, was projected from the periphery by the centrifugal force of the revolving plate.

Hebert's hand-mill (English) is adapted to grind and dress; an annular surface of fine wire gauze surrounding the bed-stone receives the meal as it issues from beneath the stone. Brushes on the skirt of the runner pass continually over the wire gauze and drive the flour through the interstices, while the offal is swept to an opening and carried by a chute to a separating sieve, which sorts it into grades.

The mill *B* has a conical grinder, and the meal falls into a rotating sieve which sorts it into flour, shorts, and bran. The fly-wheel is shown partly broken away to expose the parts more fully. See Grinding-Mill; Coffee-mill.

Fig. 2381 is a hand-mill in which a conoidal metallic buhr works on a vertical axis in a conical serrated shell.

Fig. 2381



Metallic Buhr-Mill.

Hand-mold. The mold in which hand-made type is cast. It has a lip to receive the metal which runs into the mold containing the matrix. The mold is then opened and the type drops out.

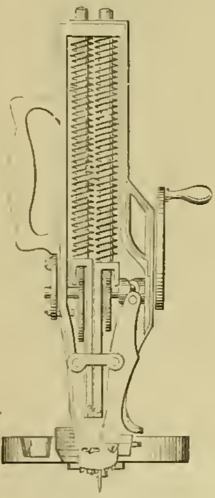
Hand-or′gan. An organ arranged to play automatically from a rotatory motion; its parts consisting of the pipes, arranged vertically in the front, the barrel, placed at the top and back, the keys, vertical between the two, the bellows under the barrel, and the *grinding* and *shifting* gear at the side. The barrel extends the length of the hand-organ, and is about four or five inches in diameter. This has little brass staples of a length corresponding to that of the note, and which, when the barrel revolves, open the pipe valves. They project about an eighth of an inch above the cylinder, and for each tune are allowed one sixteenth of an inch along the length of the barrel to every key, the latter being placed at a distance apart corresponding to the number of tunes. One revolution invariably plays the whole tune, and longer tunes have to be cut down to this, except for regular operatic organs, where an automatic shifting apparatus is used. Otherwise the barrel is shifted by gear at the side under control of the grinder, which makes a difference of one sixteenth one way or the other along the barrel. The pipes are made from hard wood, as boxwood, or from reeds. The blast for them is furnished by the bellows, which is worked by gear from the crank, like the barrel. The keys resemble those ordinarily used in musical instruments. The most important part of the manufacture consists in arranging the position of the points or staples of the barrel. An ordinary piece of sheet music is before the workman, and the barrel of a hand-organ is mounted below it so as to revolve with a large wheel at his left hand. This wheel is divided up into parts which correspond to the bars in music. Above the barrel are a set of keys, with little teeth that indent the paper wound around the barrel. He sits down before the instrument, revolves the wheel one bar, and strikes with a hammer the proper keys, then revolves again, and so on. The indentations mark the places for the brass points and staples, which another man inserts.

Hand-peg′ger. A portable pegging-machine, operated by hand and fed around the shoe, the operator holding the machine in a vertical position and turning a crank which sets all its working parts in motion.

The illustration shows a machine which is held upon the sole of the boot or shoe by one hand of the operator, who turns the crank with the other. The awl is first driven through the sole, and as it rises the machine feeds itself along the distance between the pegs, which brings the peg end of the strip over the hole just punched; the peg is then cut off and driven down by the plunger which holds it, and the end trimmed off by the machine.

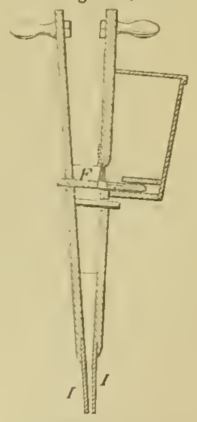
Hand-plant′er. A corn-planter carried in the hands, or by one hand, and thrust into the ground like a stick. The thrust and lift usually work the seed-slide, but in some two-handed planters, as in the example, the thrusting together of the portions opens the plates *I I* and allows the seed to drop into the ground. Pulling the handles apart works the slide *F*, and draws seed from the box ready for the next hill. See Corn-planter.

Fig. 2382.



Hand-Pegger.

Fig. 2383.



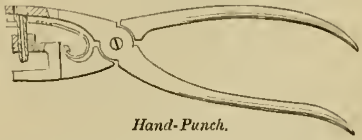
Hand-Planter.

Hand-pump. 1. (*Steam-engine.*) A pump placed alongside the fire-box of a locomotive and worked by a hand-lever, to feed the boiler when the engine has to stand with steam up. The Giffard injector obviates the necessity for a hand-pump, as it is always operative when steam is up. Hand-pumps are also arranged for other engines. Small auxiliary boiler-feeding engines are used for the Western rivers.

2. An ordinary small pump for domestic and other uses; as distinguished from a power pump. See list under Pump.

Hand-punch. A punch for perforating tickets, leather, or paper, for the insertion of eyelets or for other purposes. It has a cutting tube and an anvil, or a punch and hollow die. The conductor's punch is a familiar instance.

Fig. 2384.



Hand-Punch.

Hand-rail. 1. The horizontal rail of a balcony, a baluster, on a stairs, or along the sides of a locomotive engine, to protect the engineer in going forward and back on the engine.

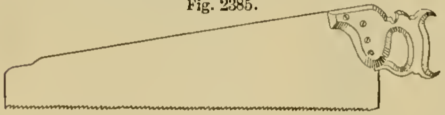
2. Also on the companion and quarter-deck ladders, on the break of the poop, quarter-deck, or forecastle, permanent gangway ladders, etc.

Hand-rail Plane. A round-soled plane for dressing the upper surface of a baluster rail. A *capping* plane.

Hand-saw. A saw riveted at one end to the handle, and adapted to be driven by one hand.

There are several grades and some variations.

Fig. 2385.



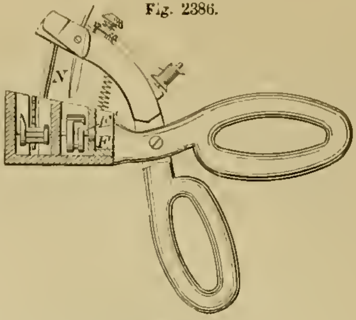
Hand-Saw.

Names.	Length in Inches.	Breadth in Inches.		Thickness in Inch's.	Teeth to the Inch.
		At Handle.	At End.		
Without Backs.					
Rip saw . .	28 - 30	7 - 9	3 - 4	0.05	3½
Half-rip saw .	26 - 28	6 - 8	3 - 3½	0 042	4
Hand-saw . .	22 - 24	5 - 7½	2½ - 3	0 042	5
Broken-space saw	22 - 24	5 - 7½	2½ - 3	0.042	6
Panel-saw . .	20 - 24	4½ - 7½	2 - 2½	0.042	7
Fine panel-saw	20 - 24	4 - 6	2 - 2½	0.035	8
Chest-saw . .	10 - 20	2½ - 3½	1½ - 2	0 032	6 - 12
With Backs.					
Tenon-saw . .	16 - 20	3½ - 4½		0.032	10
Sash-saw . .	14 - 16	2½ - 3½		0 028	11
Carcass-saw .	10 - 14	2 - 3		0.025	12
Dovetail-saw .	6 - 10	1½ - 2		0.022	14 - 18

Hand-screw. A jack-screw used for raising heavy weights. See Screw-jack.

Hand Sew'ing-ma-chine'. A form of sewing-machine in which the parts are pivoted jaws, operated in the manner of scissors. The machine illustrated employs two threads to form a lock-stitch. The looping-hook *E* makes a reciprocating instead of a continuous revolution around the disk bobbin *F*. The bobbin and looping-hook are contained in one part, and the eye-pointed needle *N* is attached to the other portion. There are other forms.

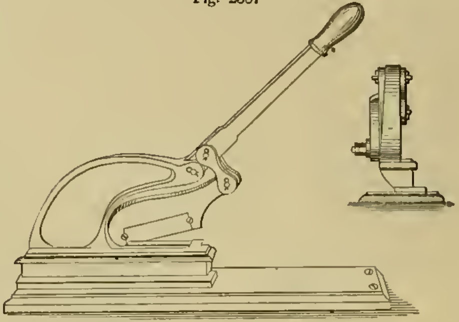
Fig. 2386.



Hand Sewing-Machine.

Hand-shears. (*Metal-working.*) *a.* A machine for cutting metallic plates, having a reciprocating knife, cutting shearwise, and moved by a hand-lever. The illustration shows side and end elevations.

Fig. 2387



Hand-Shears.

b. Snips. Shears used by hand in cutting sheet-metal.

Hand-shut'tle. (*Weaving.*) The common shuttle as distinguished from the *fly-shuttle.*

Hand'spike. A loose bar forming a lever for lifting or shifting an object.

In the United States ordnance department, handspikes are commonly made of three sizes, viz.: trail handspikes for field service, maneuvering handspikes for siege and garrison purposes, and handspikes for mechanical maneuvers. The two former are 66, and the latter 84 inches in length. *Shod* handspikes — that is, handspikes having an iron plate under their lower end — and *roller* handspikes are also employed for certain purposes. A *heaver.*

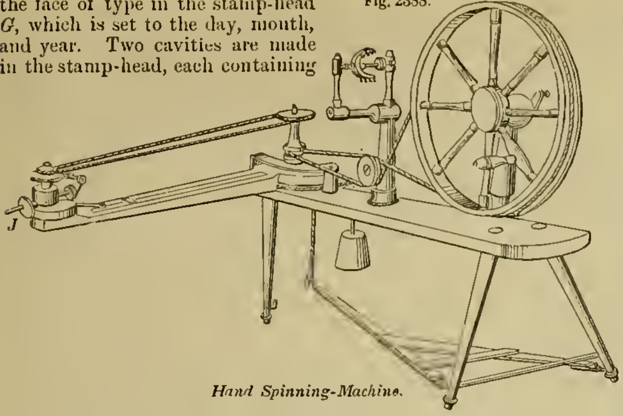
Handspikes are used in working windlasses; those for capstans are known as *bars.*

Hand'spike-ring. (*Artillery.*) The thimble on the trail transom of the gun, for the handspike by which it is maneuvered.

Hand Spin'ning-ma-chine'. A form of spinning-machine in which a carding is fed by hand to the spindle, which is revolved by a cord from a large wheel, driven by the hand in the intervals of pieeing on new lengths of carding. The usual form of rustic spinning-machine is familiar, but the example is intended to allow a person to sit and spin, the spindle *J* being carried away from the person by pressure on the treadle instead of the person walking backward from the spindle to draw out the carding.

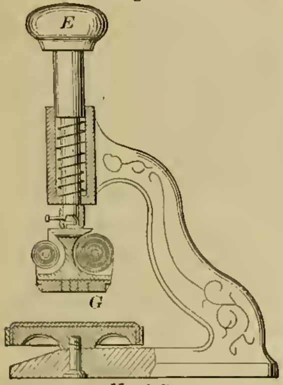
Hand-stamp. One for canceling, dating, or addressing papers, envelopes, documents, etc. The example has a colored ribbon, which is drawn over the face of type in the stamp-head *G*, which is set to the day, month, and year. Two cavities are made in the stamp-head, each containing a reel. One reel contains the inked ribbon, which is led under the head over the type, and is rolled up on the other reel. This head is secured to its stem by two screws, one catching in a nick in one side of the plate, and the other in a segmental slot on the opposite side. The head is depressed by a blow on the head *E* of the spring plunger.

Fig. 2388.



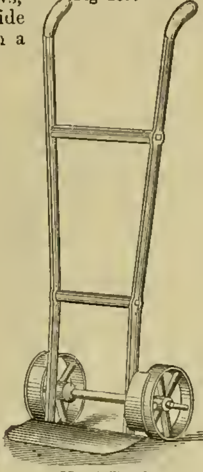
Hand Spinning-Machine.

Fig. 2389.



Hand-Stamp.

Fig. 2390.



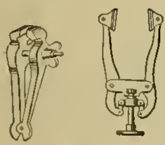
Hand-Truck.

Hand-swipe. A water-raising device. The *well-sweep* or well-pole of the West; the shadûf of Egypt and Syria. See SHADUF.

Hand-truck. A small truck used in mills, shops, and warehouses.

Hand-vise. A small vise for holding an article while it is being filed, shaped, bored, heated, or otherwise. A common form is a vise with a tang, in some cases driven into a handle. The jaws are operated by a thumb-screw. It is also known as a tail-vise.

Fig. 2391.



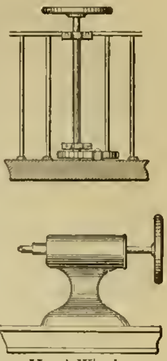
Hand-Vises.

The figure on the right is a hand-vise or clamp whose jaws are swiveled to the arms and are opened or closed by the traversing nut and connecting links; the cheeks of the jaws may be presented outward or inward.

When of peculiar forms, these implements have names indicative of their shape; as, *dog-nose*, *pig-nose hand-vise*, *cross-chap* vise.

Hand-wheel. The term is applied to wheels which are turned by hand to actuate machinery, to set it in motion or to stop it. As the wheel on the brake-shaft of a railroad car; on the tail center of a lathe; on the stem of a throttle-valve, etc. The applications are very numerous.

Fig. 2392.

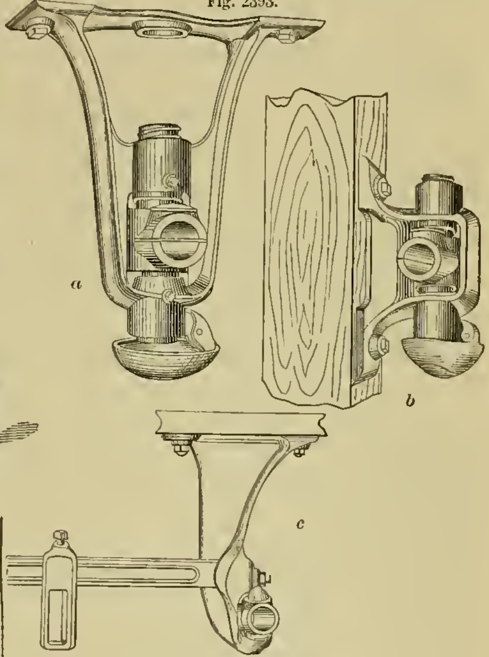


Hand-Wheels.

Hand-wheel Lathe. A small-bench lathe in which the spindle in the head-stock is turned by hand.

Hang. (*Shipbuilding.*) The curvature, concave on the downward edge, of a plank or strake when bent to the frames of a ship. A curve in the reverse direction is called *sny*.

Fig. 2393.



Hangers for Shafting.

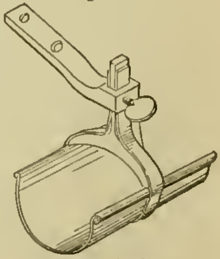
Hang′er. 1. A means for supporting shafting of machinery. The illustrations show several kinds.

a is a ball and socket hanger adapted to be attached to a joist or beam of the ceiling of a machine-shop.

b is a hanger attached to a post.

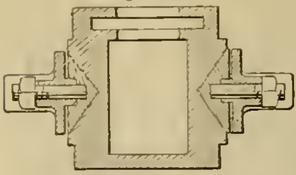
c is a countershaft

Fig. 2394.



Eave-Trough Hanger

Fig. 2395.



Axle-Box Hanger.

hanger ; has a ball and socket joint, and a belt-shifter arm.

2. A pedestal or frame dependent from the car or truck body, and in which the axle-box moves up and down as the springs contract and expand. (Fig. 2393.)

3. A means of suspending an object, as of spouting at the eave of a house (Fig. 2394), a cage, a basket, or what not. An overhanging bracket.

4. A seaman's cutlass ; a short curved sword.

5. (*Weaving.*) The lower part of the heddle, or the lower heddle of the harness of a fancy loom.

Hang'ing-bridge. 1. (*Steam.*) A hollow, vertical partition depending from the bottom of a boiler and serving to deflect the flame. The *hollow* forms a part of the water-space of the boiler. The usual water-bridge rises from the furnace floor at the rear of the grate space.

2. *a.* A suspension bridge.

b. A truss-frame bridge.

Hang'ing-but'tress. (*Masonry.*) A buttress supported on a corbel.

Hang'ing-com'pass. (*Nautical.*) A suspended overhead compass in a cabin, viewed from below ; known as a *tell-tale.*

Hang'ing-knee. (*Shipbuilding.*) One fayed vertically to the side, under the *deck-beam* knees, or *lodging* knees, which are horizontal.

A *hanging standard* knee is one directly beneath the beam, and fayed to it and to the side.

Hang'ing-ma-chine'. (*Bleaching.*) A machine on which cloth is hung to dry. It usually has tenter hooks for stretching the cloth by its edges. See HOOK-FRAME.

Hang'ing-post. (*Carpentry.*) That to which a door or gate is hinged. The other is the *shutting* post.

The *hanging stile* of a door is that one whose vertical edge has the hinges.

Hang'ings. Wall coverings, such as arras, tapestry, or paper.

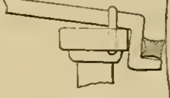
Hang'ing-side. (*Mining.*) The overhanging side of an inclined or *hading* vein.

Hang'ing-stile. (*Joinery.*) That stile of a door to which the hinges are attached.

Hang'ing-tie. (*Architecture.*) A tie which is supported by strap and collar, dependent from the rafters above.

Hang'ing-tool. (*Iron-turning.*) A crooked tool, which partially embraces the rest so as not to be easily displaced. The cutter is formed with hollow faces to facilitate grinding. It is used for smoothing the surfaces of iron ordnance, rollers, and similar objects.

Fig 2396

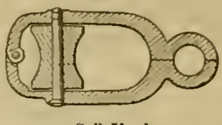


Hanging-Tool.

Hang'ing-valve. A hinged and gravitating valve in a rotary pump or engine, which falls down and forms an abutment, but is lifted by the passing piston so as to close an opening in the annular chamber while the piston is passing. A *clack*-valve. A *flap*-valve. See list under VALVE.

Hank. 1. (*Nautical.*) One of the *hoops* or rings of ash or iron to which the *weather-leech* of a *fore-and-aft* sail is *bent*, and by which it slides on the mast or stay, in hoisting by the *halyards* or lowering by the *downhaul.*

Fig. 2397.



Sail-Hank.

Sometimes the *head* of a *spanker* or *try-sail* is bent to *hanks* which slip on the *gaff.*

2. (*Yarn.*) *a.* Two or more skeins of yarn, silk, wool, or cotton, tied together.

A *hank* of *cotton* yarn is 840 yards in length, and consists of 7 *lays* of 120 yards each.

It is wound on a reel 4½ feet in circumference, 80 revolutions of which make a *lay.*

The *hanks* of cotton yarn are rated by the number which it takes to make a pound.

Throstle-spinning is seldom employed for yarns above Nos. 40 to 50, but with *mule*-spinning very high numbers have been reached. Previous to the introduction of the mule, few spinners could make yarn over No. 200. The natives of India, however, in their patient way and humid climate, made Nos. 300 to 400. Houldsworth, of Manchester, England, has made No. 700, which was woven in France. He is stated to have reached No. 10,000, a fineness beyond all useful range, but interesting as illustrating the perfection and capacity of his machinery.

b. A measure of 3,000 yards of *linen* yarn.

Table.

300 yards = 1 lea.
10 leas, 3,000 yards = 1 hank.
20 hanks, 60,000 yards = 1 bundle.

Han'som. (*Vehicle.*) A kind of cab, named after the inventor, in which the driver's perch is behind the cover of the occupant's seat, the reins passing above the hooded top.

Har'bor. 1. (*Hydraulic Engineering.*) A shelter for ships, where they may moor or ride at anchor.

2. (*Glass-making.*) A chest, 6 or 7 feet long, in which the ingredients for a charge are mixed and held.

Hard. 1. (*Hydraulic Engineering.*) A hard bottom of gravel laid across a swamp or at a muddy boat-landing.

2. The coarse part of flax. *Hurds.*

Hard'en-ing. 1. (*Metal-working.*) The process of giving an additional hardness to metallic articles after leaving the hands of the workman shaper.

Hammering and rolling will confer hardness, and in the reduction and shaping of articles by these means it becomes necessary to alternate annealing with the condensing processes.

The hardening of steel is accomplished by heating it to a certain temperature and then suddenly quenching it in water or oil. When the article is not required to be at its ultimate hardness it is *tempered* by *letting down* the temper. This is done by heating the article, observing the change of color. See TEMPERING.

Copper alloys for gongs are hardened by another process, in some respects the reverse of that adopted for steel. See ANNEALING.

Iron is surface hardened by heating to a bright red, sprinkling with prussiate of potash, allowing to cool to a dull red, and cooling with water. Two recipes : —

Prussiate of potash	3	1
Sal-ammoniac	1	2
Bone-dust		2

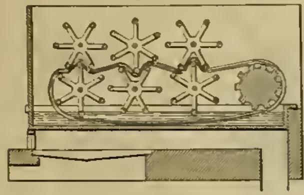
Or heat pieces of horn, hoof, bone-dust, or shreds of leather, together with the article to be case-hardened, in an iron box, bring to a blood-red heat, then immerse the article in cold water. Some cut up the shreds, etc., fine, and mix them with white wine, vinegar, and salt.

2. (*Hat-making.*) The process of pressing together the light layer of filaments collected in the *basket*, so as to form it into a sheet of *felt* with sufficient cohesion to bear handling. The hands and then a *skin* are employed to produce this effect, the pressure, rubbing, and jerking causing the filaments to interlace and become felted, the body gaining consistence and hardness at the expense of its bulk and area.

3. A process of heating in the course of porcelain making. See HARDENING-KILN.

Hard'en-ing-fur'nace. (*Hat-making.*) A furnace with an upper plate of iron, upon which hat-bodies, folded in wet cloths, are laid to be hardened by heat, moisture, and the pressure of traversing plates above.

Fig. 2398.



Hardening-Machine.

In the example, the fabric with its inclosing envelope is attached to the endless band, and carried alternately through the pan of hot liquid and between the star-shaped rollers, which causes the fur to work into the felted body of the hat and firmly adhere. The furnace has a descending flue for convenience in conveying away the smoke. The liquid in the pan may be a solution of sulphuric acid and water. The star-shaped rollers are moved by suitable gearing outside the tank.

Hard'en-ing-kiln. (*Porcelain.*) A kiln in which printed biscuit is placed in order to drive off the oil of the color previous to glazing. See PRESS-PRINTING.

Hard'en-ing-skin. (*Hat-making.*) A piece of half-tanned leather laid above a *bat* of felting hair while the latter is compressed by the hands of the workman.

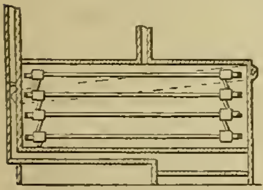
Hard-fin'ish. (*Plastering.*) Fine stuff applied with a trowel to the depth of about one eighth of an inch.

Hard Por'ce-lain. A ware composed of a natural clay containing silex (*kaolin*), and a compound of silica and lime, i. e. a quartzose felspar (*petuntze*). The glaze is also earthy, not metallic.

Hard Rub'ber. India-rubber mixed with a large proportion of sulphur, and subjected to an extreme heat. Other mineral substances, as white-lead, are also generally added. See CAOUTCHOUC; EBONITE.

In Mullee's process, the rubber, after washing, is rolled into sheets $\frac{1}{16}$ of an inch thick, and immediately placed in the sulphur-bath vessel in a horizontal position. The sulphur is kept at a temperature of 220° F. until foam has ceased to rise. At the expiration of the first hour, the heat is raised to from 30 to 40 pounds' pressure, and continued for a second hour, after which it may be allowed to rise to 80 pounds. The whole process takes from 5 to 10 hours. The sulphur used is known as "pure sulphur." Twenty or thirty minutes is sufficient for one immersion, after which the sheets are torn apart, rekneaded, and rolled into sheets. See VULCANITE.

Fig. 2399.



Hard-Rubber Bath.

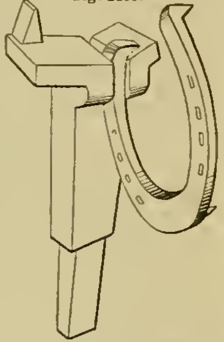
Hard Sol'der. The solder used for uniting the more infusible metals. Spelter solder and silver solder are the two principal varieties. The former, for copper and iron, is sometimes made in the proportion of 16 parts copper to 12 zinc; more frequently equal proportions of the two metals are employed. These are cast in a grated mold, forming squares of about two pounds' weight, which are then heated nearly to redness and granulated by beating on an anvil or in a mortar. The components of silver solder vary from 4 parts silver and 1 copper for the hardest, to 2 silver and 1 brass wire. Three fourths of a part of arsenic is sometimes added to render it more fusible and impart whiteness. See ALLOY; BRAZING.

Hard'ware. A term including articles of metal for sale, such as house trimmings and furnishings, and mechanic's tools. Sometimes distinguished as *builders' hardware, domestic hardware*, and *tools.*

Har'dy. (*Forging.*) A *chisel* or *fuller* having a square shank for insertion into a square hole in an anvil called a *hardy-hole.*

The hardy-hole is sometimes occupied by a smaller anvil, fullering-tool, or calking-swage, as in the illustration, in which in a steel-faced plate is sunk a vertical groove, and the faces on each side of the groove are inclined, so as to give the proper taper to the inner sides of the calk when the horseshoe is placed within the groove.

Fig. 2400.



Calk-Forming Anvil.

Hare. The fibrous portion of flax and hemp, as distinguished from the *shives* or scales of bark, etc., which fall from the hare in braking.

Harl. The filament of flax. *Hare.*

Har-mon'i-ca. (*Music.*) 1. *a.* A musical instrument formed of a number of glasses which are tuned by filling them more or less with water, and are played by touching them with the dampened finger. The less the quantity of water the lower is the tone of the scale. Called *musical glasses.* The instrument is said to have been invented by a German, and was improved by Dr. Benjamin Franklin. A stringed form is ascribed to Stein, 1788.

b. Dr. Franklin's "Harmonica" consisted of a nest of hemispherical glasses, of different sizes, tuned, and arranged on a revolving spindle impelled by a treadle, the tips of the fingers being applied to the edges of the glasses to produce the tones.

Each glass has an open neck or socket in the middle. The thickness of the glass is about $\frac{1}{10}$ inch near the brim, but thicker nearer the aperture, which in the largest glasses is 1 inch deep, with an aperture $1\frac{1}{2}$ inch wide. These dimensions lessen as the glasses diminish in size, the neck of the smallest being $\frac{1}{2}$ inch thick. The largest glass is 9 inches in diameter, and the smallest 3 inches. Between these are 23 different glasses, differing from each other $\frac{1}{4}$ inch in diameter. Each glass is marked with a diamond the note for which it is intended, and is tuned by diminishing the thickness of those that are too sharp. This is done by grinding them round the neck towards the brim, the breadth of 2 or 3 inches, as may be required, frequently testing them by a well-tuned instrument. The largest glass in the instrument is C, a little below the ordinary compass of the human voice, and the highest is two octaves above. The glasses of the full notes are painted the seven prismatic colors, and the semitones white.

The glasses are fixed on a spindle of hard iron, 1 inch in diameter at the larger end and tapering to ¼ inch at the smallest, and each glass has a bushing of cork where it is attached to the spindle. The glasses set within each other, a space intervening between the necks of the several glasses. The spindle is mounted horizontally in a box, its ends work in brass gudgeons, and it is impelled by a treadle and band. An inch of the brim of each glass is exposed to be touched by the finger as the spindle and glasses revolve.

The instrument is played upon by a person sitting before the instrument, turning the treadle with the foot, and wetting the fingers now and then with a sponge and clean water.

The fingers should be first soaked in water, and should be perfectly free from grease. A little fine chalk may be added to the water, and will assist in producing the tremulous action of the glasses which causes the tone. Both hands may be used.

2. A small instrument of music held in the hand and blown by the breath. At the edge are a series of holes which conduct the breath to free reeds, like those of an accordeon. A *mouth-organ.*

Har-mon′i-phon. (*Music.*) A small instrument with a key-board, in which the sounds are produced by small metallic tongues, acted upon by air blown through a flexible tube.

Har-mo′ni-um. (*Music.*) A musical instrument whose tones are produced by the vibration of metallic reeds operated by keys. The bellows are worked by pedals, and the keys are arranged in one or two banks. These instruments are made with a variety of stops, and with swell and tremolo attachments. The instrument is used as an organ of small size in parlors, and in churches in the performance of sacred music.

The melodeon and parlor-organ are of this class.

The *harmonium* is substantially the same as the *seraphine* introduced by Green, and has been blessed with a variety of names derived from the Greek and other sources. Among them are *æolophon, æolomusicon, physharmonica, melodeon, symphonium,* and *poikilorgue.*

The *free* tongues of the harmonium, though used from time immemorial by the Chinese, were introduced into Europe by M. Grenié in 1810.

Har′mo-nom′e-ter. An instrument for ascertaining the harmonic relation of sounds. It often consists of a single string with movable bridges.

Har′ness. 1. (*Menage.*) The means whereby a draft animal is attached to a vehicle.

The invention is ascribed to Erichthonius of Athens, who was made a constellation after his death, under the name of Boötes, about 1487 B. C. War-chariots are believed to be much older than this. The sculptures of the Egyptian conqueror, Osymandyas, who carried his arms as far as Bactria, 2100 B. C., disprove the Greek claim. The use of harness commenced as soon as the horse was tamed to draft. The wagons that Joseph gave to his brethren to fetch his father, 1706 B. C., were probably ox-carts or wagons. The root of the Hebrew word signifies to roll around.

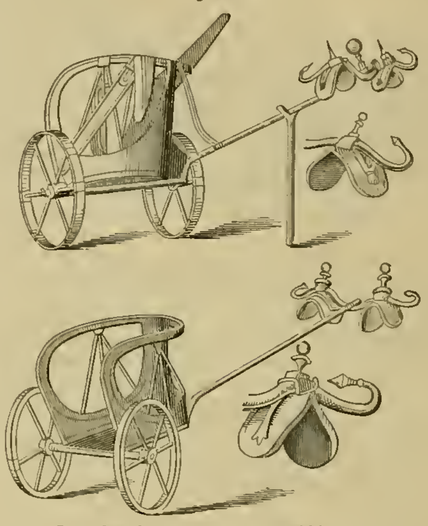
The harness shown in the sculptures of Egypt and Persepolis was of a very simple description. The horses were always hitched abreast to a tongue or pole, which was connected to a yoke. This passed over saddles which rested on the withers of the horses. The accompanying cut shows their relation and position. They were kept in position by straps around the neck and around the girth, and sometimes had a single trace on that side of the horse against the pole.

Solomon had 40,000 stalls for his chariots, 1014 B. C., and plenty of leather harness, no doubt. He bought his horses in Egypt.

While the Egyptian yoked his horses to the pole of his chariot, and gave a third horse a single trace on the side towards the chariot, still more primitive customs were adopted in other lands and at a later date.

In England and Ireland, horses were sometimes hitched to the plows by their tails, a barbarous custom that existed in Ireland, as late as 1634, for an act of the Irish Parliament, 11 and 12 Car. II. c. 15, entitled an "Act against plowing by the tayle and pulling wool off living sheep," sets forth, that "Whereas there have been for a long time practiced in this country a barbarous custome of plowing, harrowing, drawing, and working with horses and other animals by the tayle, whereby the breed of animals in the kingdom is much impaired, and great cruelty perpetrated, these practices were henceforward to be considered illegal, and the offender subjected to fine and imprisonment."

Fig. 2401.



Egyptian Car-Saddles (from Wilkinson).

"The Spaniards outwitted the French in lining their own harness with chains, so that it could not be cut." — PEPYS'S *Diary*, 1661. This was on the occasion of a struggle for precedence between the Spanish and French ambassadors in London, September, 1661.

The *single-line* mode of driving horses, usual on farms and with heavy road teams throughout the West, was made very familiar to many during the late war. The government six-mule teams are driven by a man riding the near wheel-horse, and having a single line to a bridle-rein on the near leader. The bit of the off leader is connected by a *jockey-stick* to a hame-ring of the near leader, which keeps him in place. The off-wheeler is governed by the whip, foot, or an occasional touch of his rein; the whip, however, and the word of command, are relied on so far as he is concerned. The near-wheeler, being ridden, is controlled in the usual way; and the middle span between the leaders and wheelers have no choice but to go with the others and pull when they are told to.

The *single-line* mode of driving is also used by the farmers in the Netherlands, the near horse being guided by the line and the bridles of the middle and off horse (three abreast) being connected to the near horse, "in a manner surprizing to a stranger," says Loudon.

Besides the different kinds of harness depending upon quality and mounting, other varieties are known by the names of buggy, coach, cart, or wagon, according to the vehicle, and the latter have a familiar division into *lead*, *hip-strap*, *breeching*, or *yankee*, according to the construction and arrangement. The latter is perhaps somewhat local, but is as extensive as the West, as we call it.

For a list of the tools and implements of the saddle and harness maker, and the kinds and parts of harness, see SADDLERY AND HARNESS.

For a list of the tools, machines, and various products of the leather manufacture, see LEATHER.

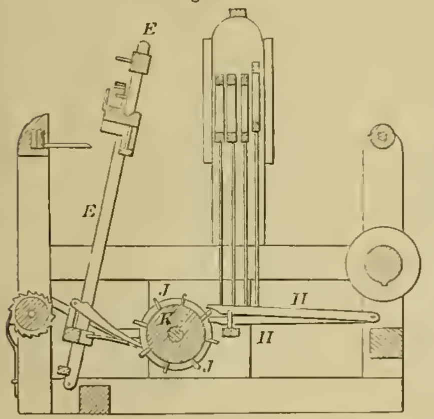
The traces of the wheel-horses in field-carriages are directly attached to the splinter-bar of the limber, no single or double trees being employed. The tongue is supported by neck-yoke and breast-chains. The traces of the leaders are directly attached to the traces of the wheel-horses, and not by means of single trees and spreader chains to the tongue.

2. (*Loom.*) The apparatus in a loom by which the sets of warp-threads are shifted alternately to form the *shed*. Each set of the warp-threads lies in the loops of knotted cords stretched in vertically reciprocating frames called *heddles*, or *healds*. These are moved by cords or straps connected to rods or levers, to which the appropriate recurrent motion is imparted. See LOOM.

The harness of a loom is termed the *mounting*; and the whole apparatus concerned in the motions of the warp-threads is the *shedding*.

The illustration shows a form of hand-loom in which the motion of the lathe *E* is the means of working the harness in the order required by the twill, check, or pattern. As the lathe *E* is moved toward the treadles *H*, the lever pushes the pin *J*, with which it may be in contact, and revolves the drum *K*, operating the treadles *H*. As the lathe moves forward, the spring raises the lever into position to take hold of the next pin and again revolve the drum at the next backward movement.

Fig. 2402



Harness-Motion

Har'ness-bell. A small bell, usually of globular form and carrying a bullet, attached to some part of the harness to produce a jingling sound. A *sleigh-bell.*

Har'ness-board. (*Weaving.*) The *compass-board* of a loom, having holes through which pass the neck twines.

Har'ness-cask. (*Nautical.*) A large cask or tub with a rim cover, containing a supply of salt meat for immediate use.

Har'ness-clamp. (*Saddlery.*) A kind of vise with a pair of jaws closed by a spring, wedge, or screw, and used to hold leather while being stitched.

Har'ness-hook 1. A hook or bracket on which harness is hung.

2. A check-rein hook on the gig-saddle.

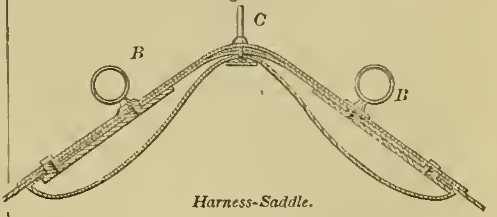
Har'ness-leath'er. A grade and quality of leather from which harness is made. It is blacked on the *grain* side.

Har'ness-pad. A lining or soft wad beneath a saddle to keep the harder portions from galling the back of the animal.

Har'ness-room. One attached to a stable, warmed by a stove, and used for putting away harness.

Har'ness-sad'dle. The part of the harness which rests across the back, and to which the girthing portions are attached. Upon it are the terrets *B B* and check-line hook *C*, and from it proceeds the back-strap, which reaches to the crupper.

Fig. 2403



Harness-Saddle.

Har'ness-snap. A hook for attaching the lines (reins) to the bit-rings; the breast-strap to the hame-rings, etc. A *snap-hook*.

Harp. 1. (*Music.*) An instrument with a three-sided frame, between two of which strings of varying lengths are stretched.

Jubal, the son of Lamech the first (say about 2400 B. C.), was "the father of all such as handle the harp and the organ." His brother Jabal had great stock of cattle, and his half-brother Tubal Cain was "an instructor of every artificer in brass and iron." Quite a distinguished and industrious family. Agriculture, the mechanics, and the fine arts pursued by the sons of one man, a descendant in the fifth generation of Cain.

The harps of Egypt were numerous and various, having from 4 to 11 strings as long ago as the reign of Amosis, about 1570 B. C., 900 years before Terpander. The strings were of catgut, and the form of the frame varied according to its purpose. To be carried or played standing, sitting, or squatting.

One harp discovered in Egypt in 1823 had several remaining strings which responded to a touch, and awoke from a rest of 3,000 years.

a is an Egyptian harp from a painting at Thebes.

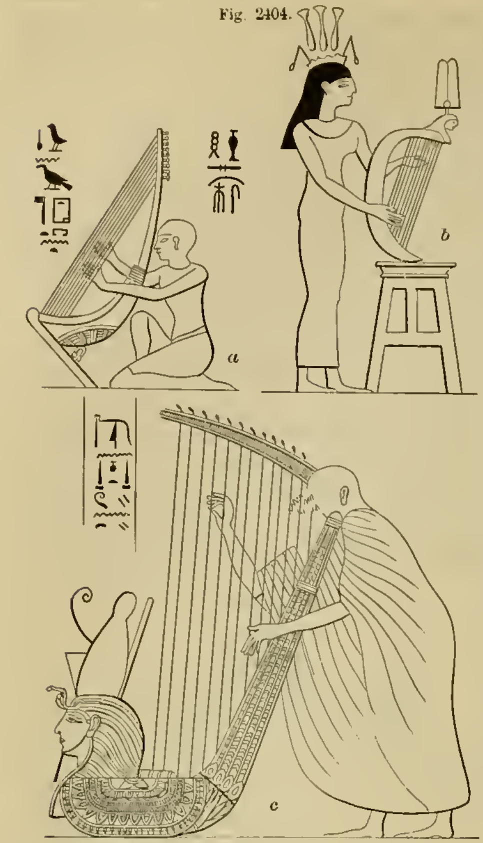
b from a painting at Dendera.

c one of the Bruce harpers, two of whom are shown in the original.

One of the harps has 21 strings, the other 12.

These most florid and striking of all the representations of the Egyptian harp are on the tombs of the

Fig. 2404.



Egyptian Harps

kings at Thebes of the time of Rameses III., 1235 B. C.; of them Bruce says: "They overturn all the accounts hitherto given of the earliest state of music and musical instruments in the East; and are altogether, in their form, ornaments, and compass, an incontestable proof, stronger than a thousand Greek quotations, that geometry, drawing, mechanics, and music were at the greatest perfection when this instrument was made, and that the period from which we date the invention of these arts was only the beginning of the era of their restoration."

Pythagoras and his compeers derived their knowledge from this source, and the services of Terpander are probably limited to inventing a method of expressing musical sounds, and perhaps of setting poetry to music. Fame enough for one man.

The Egyptian harps are shown, resting on the ground, supported in front of the person in marching, supported on a stool, and resting on the shoulder; the latter at Eléythya.

The present scale of musical notation is ascribed to Guido Aretino, a Tuscan monk, about 1025.

"Hermes invented the harp with three strings, causing the three several sounds; the base, treble, and mean." — DIODORUS SICULUS.

"From the song, the rhythm, and the instruments, all Thracian music is supposed to be Asiatic. The Orphic ceremonies had their origin among this people" (STRABO). The instruments were the cithera, pipes, cotylæ (probably castanets or cymbals); embracing wind, stringed, and percussion instruments.

Terpander of Lesbos added three strings to the lyre; he caused

> "New hymns to resound on a seven-stringed cithara."

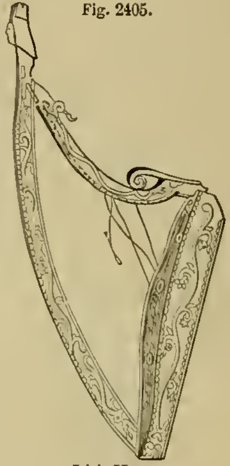
David is celebrated as a performer upon the harp, and it is said that he was a master of thirty-two other instruments. This was about 1063 B. C.

The *magadis* of the Thracians was a three-cornered harp, with twenty strings arranged in octaves. It was used among them in the time of Xenophon.

A band of 300 harpers was in the great procession of Ptolemy Philadelphus, preceding a column of 2,000 yellow bulls, with gilded horns and frontlets, crowns, necklaces, and breastplates of gold.

Egyptians, Jews, Persians, Thracians, Greeks, Romans, Saxons, Welch, Irish, all had their harps. The number and material of the strings differed, and also the shapes of the frames.

Fig. 2405.

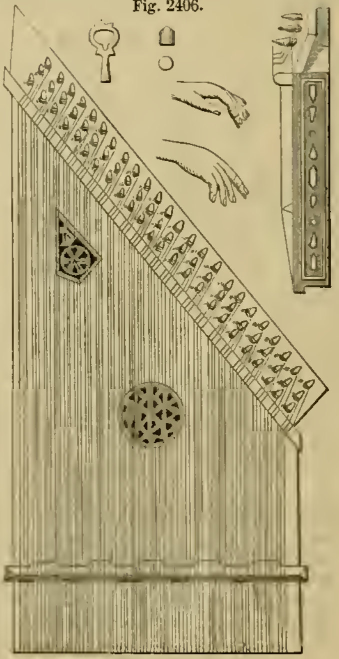


Irish Harp.

The Welsh harp was strung with gut. The Irish harp was strung with wire.

Donagh, the son of Brian Boiroimhe, a king of Ireland who was slain 1014, sought protection at Rome, carrying the harp and regalia of his father, and presented them to Pope John XVIII. in order to obtain absolution for the murder of his brother Teig. Adrian IV. urged this as a title to the kingdom in his bull, transferring it to Henry II. The harp was preserved in the Vatican, and given by Leo X. to Henry VIII. with the title "Defender of the Faith." It is needless to say how much the Pope was disappointed in his pupil. The gold crown of Brian was retained. The harp was given by Henry VIII. to the Earl of Clanricarde, and, after passing through several hands, was lodged in the College Museum, Dublin, 1782.

Fig. 2406.



Arabian Kânûn

The modern Arabian harp, or Kânûn, is laid flat in the lap while being played. The strings are arranged in groups of three, and the sounding-board is pierced. The strings are stretched as in our pianos, and rest on a bar near the tuning-pins, and on a bridge-piece above the sounding-board. This harp is played by the fingers, but thimbles with points are used on the two forefingers, forming an approximation to the *plectra* wherewith some of the Egyptian harps and psalteries were struck.

The prostrate harp is the original of a host of instruments played by keys; the early forms were known as the *clavichord*, *virginal*, *spinet*, *clavicymbal*, *clavicytherium*, and *harpsichord*. These grew out of various forms of stringed instruments, known as the *dulcimer*, *psaltery*, *citole lyre*, *cithara*, *cymphonia* or *cymbal*, *citherium*, and *harp*. See Piano-forte.

The *harpsichord* immediately preceded the *piano-forte*.

In the earlier forms of these instruments the number of strings was not equal to that of the keys, but the latter brought into action devices which shortened the strings, in the manner of a guitar.

We read of an instrument in 1600 which had a key for each string, but this was unusual at that time.

Pedals were introduced 1720; double-action about 1808.

2. A concave grating in a scutching-machine, through which refuse escapes as the cotton is beaten and driven forward by the revolving beater.

3. (*Husbandry.*) A Scotch grain-sieve for removing weed-seeds from grain.

Harp′ing-i′ron. A barbed javelin. The word is derived from its capacity for clawing or grasping. A *harpoon*.

Harp′ings. (*Shipbuilding.*) *a.* The wales of the bow, of extra strength.

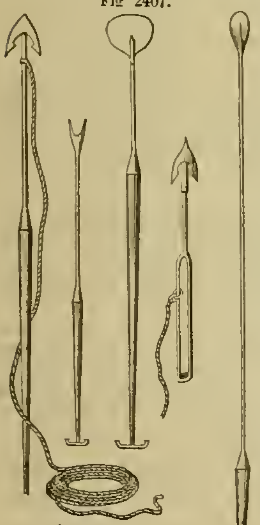
b. A ribband trimmed to the shape of and bolted to the shape of the cant bodies, to hold them together till planked.

c. Cat-harpings; frapping of the shrouds to the masts below the tops.

Har-poon′. A barbed javelin used to pierce and fasten to whales. It has a broad, flat, triangular, barbed, sharp head, and a shank about two feet long, furnishing a socket for the shaft. A line, about 70 fathoms long, is attached to the harpoon, and runs out rapidly as the struck fish dives below the surface.

The harpoon consists of the *point-head* and *shank*.

Fig. 2407.



Whaling-Implements.

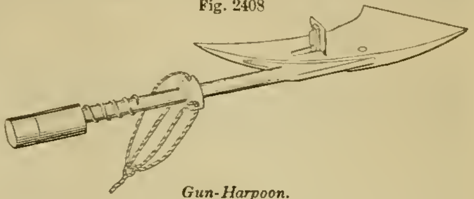
The *fore-ganger* is the section of line which unites it to the whale-line. A whale-line is 130 fathoms, and a boat is provided with several of such. It runs out over the bow, being taken over a *bollard*, which is kept wet.

The word *harpoon* is allied to the *harpago* of the Greeks, which was a grappling-iron, a drag, a flesh-hook. Specimens in bronze of the latter are in the British Museum.

In the accompanying cut are shown the ordinary whaling-implements, the hand-harpoon, pricker, blubber-spade, gun-harpoon, and lance. See Bomb-lance; Gun-harpoon.

Fig. 2408 is a gun-harpoon. The rubber spring on the end of the shaft of the harpoon prevents the recoiling of the gun. A spiral spring around the shaft prevents the line from checking against the butt of the harpoon too suddenly. A stop in the pivoted blade secures it parallel to the shaft until released by the stop, being forced down by the entrance of the blade into the whale.

Fig. 2408



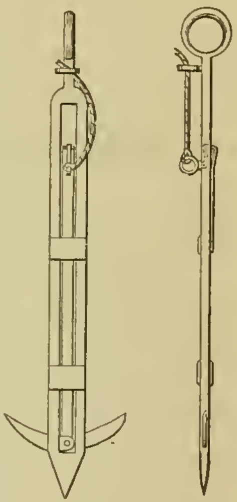
Gun-Harpoon.

The electric harpoon is fitted with two insulated conductors, connected by wires with a coil-machine kept in the boat. On the harpoon being plunged into the whale's body, electric shocks of a powerful nature are sent until the animal is prostrated.

Another plan proposed is that of firing an explosive shell into the body of the whale from a rifle, by which its vital parts would be destroyed.

Professor Christison has published an account of some experiments made in 1831 for the capture of whales by poison. The agency employed was hydrocyanic or prussic acid, inserted in glass tubes, and in weight about two ounces. A copper wire was attached to each side of the harpoon near the blade, the other end of which passed obliquely over the tube, then through an oblique hole in the shaft, and finally to a bight in the rope, where it was firmly secured. When the harpoon struck the whale, the tubes were crushed. After being struck, the whale dived, but rose in a few minutes quite dead.

Fig 2409.



Harpoon-Fork.

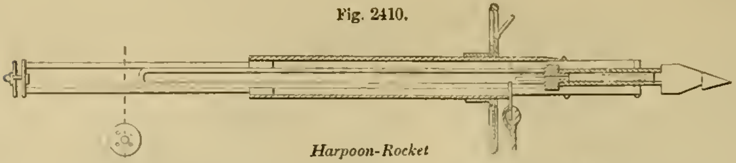
Har-poon′-fork. (*Agriculture.*) A form of hay-fork to be operated by tackle in lifting hay from a load to mow it away, or conversely in loading a wagon from a mow.

The rod being drawn up, the point of the fork is thrust into the hay, which movement depresses the rod and extends the tines, and enables the bent end of the spring to catch the top of the rod; the tines are thus held until the load is raised, when, by drawing on the cord, the spring is pressed back by the bell-crank, and the load discharged. See Hay-fork.

Har-poon′-rock′et. A bomb-lance for killing whales. That shown has an explosive shell at its head, and is propelled by a rocket-charge after being fired from a gun. The hinged barbs are secured to the breech-piece in the tube, and the line connected by a looped shank.

Harp′si-chord. (*Music.*) An obsolete stringed instrument resembling a harp laid prostrate, the strings being played by quills operated by keys like those of a *piano-forte*.

Fig. 2410.



Harpoon-Rocket

The harpsichord is believed to have been first made by Hans Rucken, in Germany, about 1510. Used in public festivals in Italy, 1522. Improved by Vincentino, 1555. Vertical form invented by Rigoli of Florence, 1620.

Pepys, in his Diary (1661), speaks of the "harpsichon" at Captain Allen's house, where he saw his dear "Mrs. Rebecca."

The *spinet* was a similar instrument with one wire for each note, and, like the harpsichord, was played with quills on jacks, operated by keys.

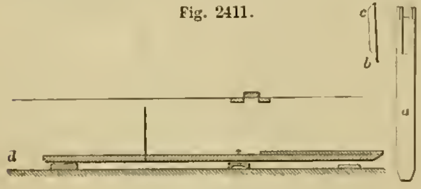
The *clavicytherium* may be considered the original of the whole train of stringed instruments whose strings were mechanically vibrated. See Piano-forte.

The harpsichord introduced two strings to a note, and preceded the piano, from which it differed specially in the mode of vibrating the strings.

It consisted of a harp whose wire strings were touched by quills operated by keys. Each quill was a plectrum, and was a substitute for the human finger, the musical effect being similar to that of the harp, as it was intended to be. The instrument might be called a horizontal harp in a frame, the strings being touched by quills set in motion by the fingers applied to keys on a key-board. We read of it first among the Provençals, the Troubadours who twanged ecstatically.

The *spinet* was so called because its quills or plectra resembled thorns. (*Spina*, Latin, a thorn.) The instrument was invented by the Italians, and was like the harpsichord, but smaller.

Fig. 2411.



Jack.

The quill was attached to an upright piece called a *jack*, *a*, whose lower end rested on the key which raised it, causing the quill *c* to bend and slip past the string, where it remained so long as the finger was pressed upon the key. In returning, the swiveled piece to which the quill was attached gave way to allow the quill to pass the string, and the swiveled tongue was restored by a bristle *b*, which acted as a delicate spring. A small piece of cloth on top of the jack rested on the wire and acted as a damper.

Whether the modes of *twanging* the strings by a plectrum or quill, in imitation of the action of a harpist, preceded all the devices for *striking* the string, it is not easy now to determine; but the latter mode, which appears to have originated in the *clavichord*, has entirely superseded the quill.

An early and obsolete predecessor of the piano was the *virginal*, which had *keys* and jacks, but only one string to a note. See Virginal.

It is mentioned by Shakespeare, —

> "Still virginaling
> Upon his palm" *Winter's Tale.*

And also by Gabriel Platte, who, in the succeeding century, describes a dibbling machine as formed of iron pins, —

> "Made to play up and down like virginal jacks."

The *clavichord*, *d*, is said to have consisted of a range of brass wires placed above the keys, which latter had wires on the rear ends, acting as hammers upon the strings when the keys were struck. A muffling-piece on the string limited the portion involved in the vibration and acted as a damper.

One mode of striking the wires in this instrument was by a leathern button on the top of a piece of strong wire fixed in the farther end of the finger key. This little device was the simplest possible form of a stringed instrument played by means of keys. The striking part was called a *jack*. It was a favorite instrument more than a century before the invention of the harpsichord, and must be considered the original of the piano-forte.

The pins formed wrest-pins for the strings, which vibrated only while the key was held down, and the place at which the pin struck the string determined the length concerned in the vibration. A damper fixed behind the string acted upon it when the pin quitted the string, the key, in fact, forming one of two bridges, between which the strings vibrated.

The instrument was an important one for several hundred years; the favorite of Bach and of Mozart.

The *hammer-harpsichord* is referred to in the "Giornale d' Italia," 1711, and was the first *piano-forte*, though the name was not given till about fifty years afterwards. It was the invention of Cristofori of Florence; the improvement consisting mainly in pivoted hammers, which were struck by jacks on the keys, and retired immediately from the strings. See Piano-forte.

The pedals were invented by Loeschman.

The *double-harpsichord* had two sets of keys and strings in a set. One key of one set struck two keys in unison; while one key of the other set struck a string tuned an octave higher. A farther change removed one bank of keys, and the three strings were tuned in unison.

Har'row. (*Husbandry.*) The harrow is a large rake, being a frame with teeth drawn over the ground to level it, stir the soil, destroy weeds, or cover seed.

It is a frame, usually of wood, and has downwardly projecting teeth which penetrate the soil. The shapes of the frame are various. The teeth are usually of square bar-iron, sharpened to a point, maintaining the square form. They are set in the harrow-frame so as to move in a direction parallel to their diagonals.

As stated under the appropriate heading, the cultivator is an improved harrow; handles being added to increase its manageability; and colters or shares substituted for straight teeth, thus increasing its efficiency.

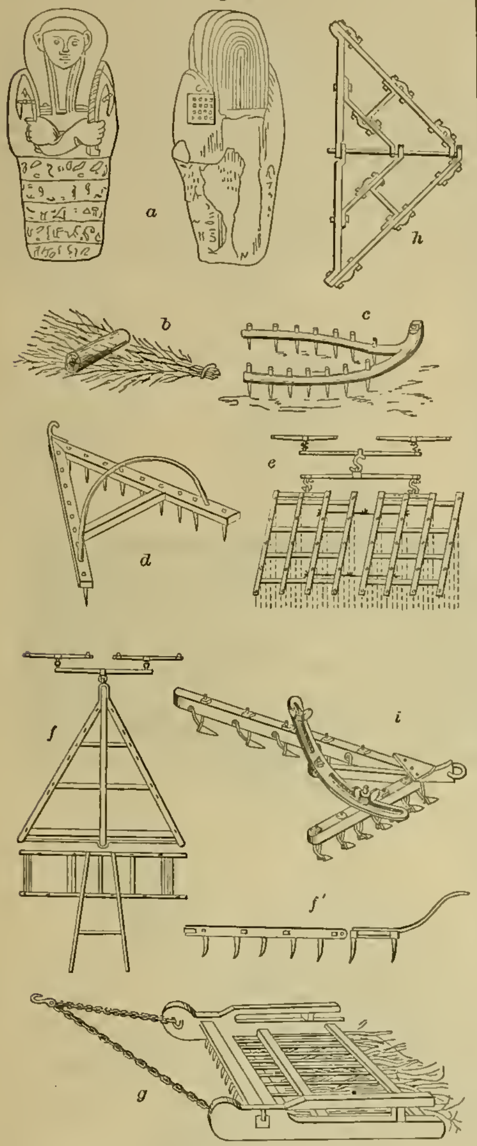
Harrows are made with the various modifications mentioned, and others might be cited, but still they are called harrows by their makers, setting classification at defiance. These hybrids are useful and efficient tools, many of them, but it is not easy to give them a "local habitation" or "a name" in a classified digest of machines.

Two notices of the harrow are found in the Bible. In Job is the inquiry, "Will he [the unicorn] harrow the valleys after thee?"

The word is said by some Hebraists to be a misnomer; a seed-covering tool is referred to, drawn by animal power, and may have been a plow. Their thrashing drag would have made a tolerable harrow. It was a frame of boards, studded with spikes. See Thrashing.

The other reference to the harrow occurs in the account of the cruelty practiced by David upon the men of Rabbah, 1033 B. C.: "He cut them with *saws*, and with *harrows* of iron, and with *axes*." (1 Chron. xx. 3.) The parallel passage in 2 Samuel xii. 31 states that "he put them under saws and harrows," etc. Adam Clarke disputes the rendering, and declares that the original means he made slaves of them, putting them to work with saws, harrows, and axes. *Quien sabe.*

Fig. 2412.



Harrows.

Although the images of Osiris are represented with a plow in each hand (*a*, Fig. 2412), and something like a harrow hanging by a cord over the left shoulder, still the harrow does not appear to have been in ordinary use in ancient Egypt. In the elaborate sepulchral paintings, the various operations of husbandry are carefully depicted, and these show that the clods were broken by hoes, and the seed was covered by hoes, plows, the tramping of men or animals, and perhaps by dragging bushes over the surface. Being sown on the mud left by the retiring Nile, the seed needed little attention and soon germinated. The amount of mud left by the Nile raises the cultivated land about six inches in a century at Elephanta.

An inscription of the age of the Emperor Antoninus on the pedestal of the vocal Memnon shows that the soil at Thebes has risen seven feet in 1,700 years, say five inches to the century. An excavation at the foot of one of the colossal sphinxes at Karnak shows a deposit of eighteen feet above the layer of spawls and rubbish forming the foundation. Beneath this is an alluvial deposit of unknown depth. The rise of eighteen feet indicates a period of 2,250 years B. C. for the erection of that sphinx. The elevation of the land by the sediment of the inundation decreases southwardly. The periodical rise commences about June 1, it increases for three months, remains stationary about twelve days, and then subsides. The rise is greatest in Upper Egypt, and less towards the mouth. Thirty-six feet rise is a "good rise" at Thebes, twenty-five feet at Cairo. The rise at the Damietta and Rosetta mouths may be about four feet. The land is gradually encroaching on the desert in most places; buildings and monuments originally erected on the barren land outside of cultivation have now a depth of many feet of soil around their bases. Many of the sites of antiquity are now buried. (See Wilkinson.) The amount of land inundated by the Nile is about 5,626 square miles (average). This does not include the river and lakes.

Harrows bore the same part in the operations of husbandry in the time of Pliny (A. D. 79) that they do now. "After the seed is put in the ground, harrows with long teeth are drawn over it."

The common harrow of the Romans was a hurdle, but they also used harrows made of planks studded with iron spikes.

The harrow is represented in the tapestry of Bayeaux, A. D. 1066, and is mentioned by Googe, in his "Heresbachius," A. D. 1578.

An act of the Irish Parliament was passed in 1634, forbidding harnessing horses by the "tayles" to harrows. See notice under Harness, p. 1062.

Harrows are made of various forms, and if we reject the harrow, if such it be, on the shoulder of Osiris (*a*), we may suppose it to have been originally a bundle of bushes (*b*) tied together at the butts, and thus dragged over the field. A log on the brush — as we of the West term it — would flatten as well as weight it, and would add to its efficiency. The bush-harrow is very efficient in covering timothy, clover, etc.

Directions for the construction of a harrow are given by an English agricultural writer in 1668, as follows: —

"Get a pretty big white-thorn tree, and make sure that it be wonderful thick, bushy, and rough grown."

In some parts of the north of Europe, the spiky limbs of fir-trees are bound together, and the spurs of the limbs make a reasonably fair substitute for the tines of a harrow.

In another form, the bush-harrow *g* is used under conditions where the teeth of an ordinary harrow would penetrate too far, as in covering grass-seed. The bushes are cut and so disposed in a frame as to present a moderately level surface of limbs, which, as they pass over the land, reduce inequalities and cover the seed as deep as desirable. The object, of course, in putting land down to grass is to obtain a good level surface over which to mow.

The thrashing-sled of the Egyptians and Syrians, the tribulum of the Romans, may have been used for dragging over the ground to cover seed, but it does not so appear. As stated, the harrow in the time of Pliny had long iron teeth.

A convenient limb of a tree has often furnished a ready frame for a harrow, *c*, which is attached by a clevis to the double tree of the team or the chain of the oxen. In still earlier periods it was hauled by a withe, a grape-vine, or a rawhide rope.

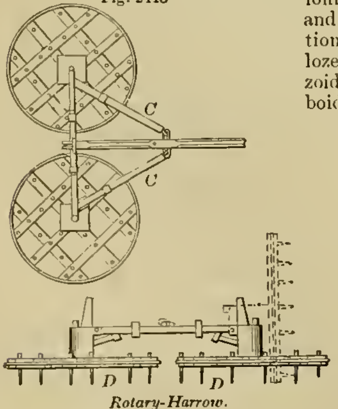
From this the step is easy to the letter "A" harrow *d*, which is a very familiar form in new countries. It is very handy in ground from which stumps have not been eradicated. It is easily lifted by the corner or by the bow.

The usual form of the British barrow is called the Berwickshire pattern, *e*. It consists of two parts joined together by iron rods, having hasps and hooks. Each part consists of four bars of wood connected by cross-bars mortised through them. The former of these are made of 2½ by 3 inch scantling, and the latter of 2 by 1 inch stuff. The bars meet at a certain angle, so that the figure formed is a rhomb, and the teeth are inserted into the bars at equal distances from each other. This obliquity is such that perpendiculars from each of the teeth, falling upon a line drawn at right angles to the line of the harrow's motion, shall divide the space between each bar into equal parts, so that the lines marked by the teeth in the soil shall be parallel and equidistant.

h is a double-harrow with folding sections. *f f′* is another form of double-harrow consisting of a triangular frame to which the team is hitched, and a square frame hinged to the former, so as to be brought into effective position or be laid over the other when not required. The rear portion has handles, and its teeth split the balks between the furrows left by the teeth of the preceding harrow. *f* is a top view, *f′* a side view.

Double-harrows are made in many other forms, two, three, or four leaved, and having sections square, lozenge, trapezoidal, rhomboidal, or triangular. Specimens of each would be given did space permit.

Fig. 2413



Rotary-Harrow.

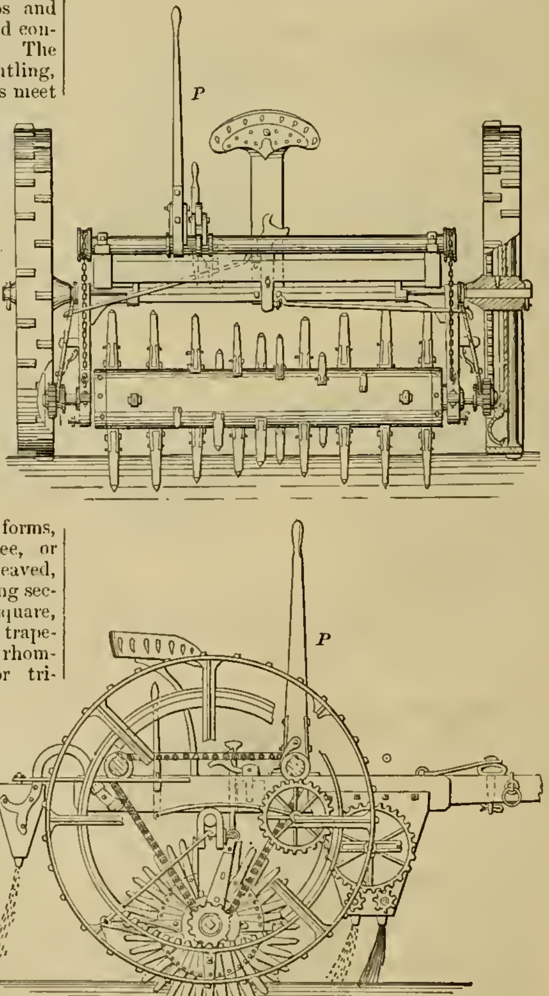
The harrow *i* is for grassy or weedy lands, and has teeth of cultivator form, presenting V-shaped blades which cut at a distance below the surface, say two or three inches. This in many cases is much more effectual than the mere jagged tearing action of simple spikes.

Another kind of harrow is drawn in the rear of and partly suspended from an axle and pair of wheels. This implement has also its proper place in some kinds of soil and modes of tillage.

Rotary harrows are made in many forms, and may have one, two, or more sections which lie flatly upon the ground, as in Fig. 2413. Each section *D* is eccentrically journaled by an upright axis to the frame *C*, and as a consequence of the eccentricity the sections rotate as the harrow advances over the ground. As a greater number of spikes are presented on one side of the axis of rotation than on the other, their hold on the ground is greater, and the lighter side is obliged to rotate forwardly.

The flexible spiked-chain harrow used in England is made of wrought-iron links, so shaped and com-

Fig. 2414.



Spiked-Cylinder Harrow and Seeder.

bined as to keep the harrow stretched, while a certain number of the teeth, at regular intervals, have dependent spikes.

The spiked-cylinder harrow, known in England as the Norwegian harrow, has three sets of rowels placed in gangs upon an iron axle. It is used for reducing the land to a fine tilth for the reception of seed, which it does to a depth of three or four inches in soil which is in suitable preliminary order. No amount of drawing spiked tools over a wet clay bed will make friable soil, and the use of this tool, as well as of crushing-rollers, is a thing to be done in the right time and place. Fig. 2414 shows an American form of this tool, which is intended for sowing fertilizers, grain, and grass-seed, and harrowing in the same. A portion of one driving-wheel is broken away in the upper view, in order to expose the internal cog-gear by which the spiked cylinder is rotated, as it does not depend upon its contact with the ground for its rotation. The feeding devices for seed and fertilizer are driven by chain-band connection with a wheel on the spiked drum. The spiked cylinder may be raised from the ground by the lever *P*, or adjusted as to depth of penetration.

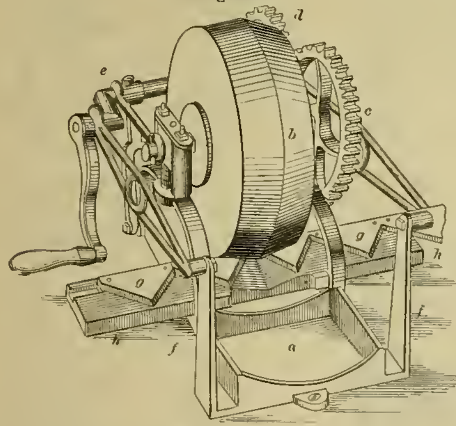
Har'vest-er. (*Agriculture.*) A machine for cutting grain or grass. See MOWER; REAPER.

See also under the following heads: —

Bean-harvester.
Binder.
Cane-harvester.
Clover-seed harvester.
Corn-harvester.
Dropper.
Finger.
Flax-puller.
Guard-finger.
Heading-machine.
Hemp-harvester.
Lawn-mower.
Rake.
Reel.
Sward-cutter.

Har'vest-er-cut'ter Grind-er. A machine adapted to the grinding of the section knives of harvesters, which are riveted to the knife-bar.

Fig. 2415.



Harvester-Cutter Grinder.

In Fig. 2415 a bed *a* supports a sliding carriage on which is the doubly beveled grindstone *b*, having a gear-wheel *c*, which engages with a wheel *d* on the shaft *e*. From the uprights *f* pivoted connections run to a crank at each end of the driving-shaft, and from each end of this shaft similar connections are made with the axis of the grindstone. The knives *g* are secured to the guide *h* fixed to the frame at a suitable angle. On turning the crank the stone is caused to rotate as usual, and is reciprocated back and forth, insuring the even grinding of the teeth, from root to point, and preserving the shape of the stone.

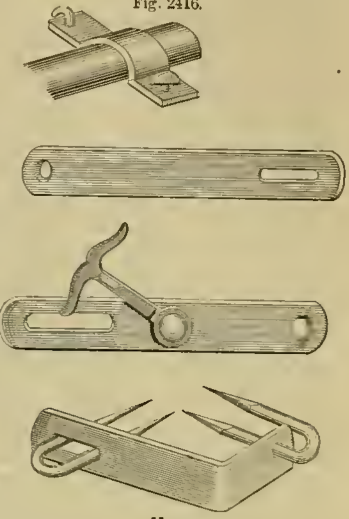
Har'vest-ing-ma-chine'. See MOWER; REAPER. See HARVESTER for list.

Hasp. 1. A fastening. A clamp or bar fast at one end to an eye-bolt or staple, the other end passing over a staple, where it is secured by a *pin*, *key*, *button*, *fore-lock*, or *padlock*.

2. A scarifier for grass lands.

3. A spindle for thread or silk.

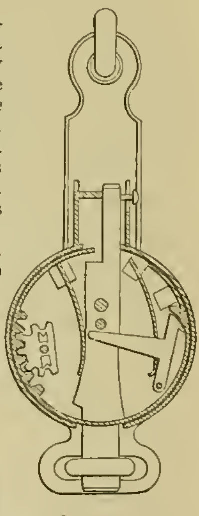
Fig. 2416.



Hasps.

Hasp-lock. One in which the hasp, which is attached to the trunk-lid, itself carries the locking-device. In the example, the bolt is shot longitudinally so as to protrude from the hasp and enter the staple. The locking-circle has an internal cog-gear *V* operated by a cog-segment *C*, and has a locking-tooth *W* and a pivoted engaging-lever *L*.

Fig. 2417

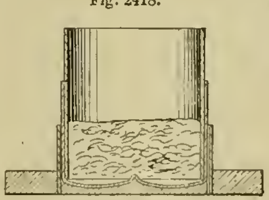


Hasp-Lock.

Has'sock-fil'ler. A device consisting of a curb and a charging cylinder, whereby the stuffing is packed into the cover. A tube is slipped inside the ottoman or hassock, and both are placed in the ring and upon the bottom piece. As the filling is introduced and pressed down, the tube is gradually withdrawn.

Has'ten-er. A kitchen stand before the fire to keep the radiated heat around the joint which is being roasted.

Fig. 2418.



Hassock-Filler.

Hat. 1. A head-covering with a crown, sides, and continuous brim. Made of cloth, felt, straw, silk, splints, grass, etc.

Felt hats are as old as Homer. The Greeks made them in various forms; skull-caps, conical, truncated. narrow or broad brimmed (*petasus*). The Phrygian bonnet was an elevated cap without a brim, the apex turned over in front. This form is very old, and indicates an inhabitant of Asia Minor. It is known now as the *cap* of liberty. In Rome, the ceremony of manumission of a slave, the head was shaved and a *cap* presented as an emblem of freedom. An ancient figure of Liberty, of the time of Antoninus Pius, A. D. 145, holds the cap in the right hand.

We even find them with brim and no crown. Tied before or behind, — we thought this was quite modern. A broad-brimmed hat is shown in the sculptures of Karnak.

Herodotus refers to the soft hats of the Persians. They wore round-top caps without peaks, somewhat resembling the modern *fez*. Hats encircled with plumes were the head-dress of the Lycian contingent in the army of Xerxes.

Herodotus said that the skulls of the bareheaded Egyptians were so baked that they would hardly decay, and were, in this respect, very different from the Persians, who protected their heads and kept them so soft that they soon rotted. He observed it, he says, on an old field of battle in Egypt; the former were as hard as a brick, and the latter decayed.

The broad-brim hat (*causia*) was worn by the Macedonian kings. It is said by Smith (Dictionary of Greek and Roman Antiquities) to have been made of felt. It is shown on a medal of Alexander I. of Macedon. It was adopted by the Romans, especially Caracalla.

In the accompanying cut are shown some of the forms which the ancient felt hat assumed. The *pileus* (Latin) was the common felt *cap*, the *fess* of the modern Greeks, the *fez* of the Turks. The *petasus* (Greek) was a *hat;* it had a brim; its name, in fact, comes from a word whose root meaning is extension, dilation.

a is from a sepulchral bas-relief in Bœotia.

b is a fisherman's cap, from a statue in the Townley collection, British Museum.

c is a coin of Bruttium, South Italy; the figures are Castor and Pollux. With us, *castor* means a *hat*, from the beaver (castor, from a Sanscrit word meaning *musk*), which supplies the best material.

d is a head of Dædalus, from a bas-relief in the Villa Borghese collection. This form is still worn by the shepherd boys in Asia Minor.

e is a head of Ulysses, from an ancient lamp. It represents him as tied to the mast while he listens to the songs of the sirens.

f is the modern Greek peasant's cap, introduced for comparison.

g is from a parian marble bust of Paris, wearing the Phrygian cap, and now in the Glyptothek, Munich.

h is from a coin of the Emperor Verus, now in the British Museum, and representing *Armenia capta*. The captive wears a *plug* hat.

i represents Dacia in mourning, with a pudding-crown hat on. It is the obverse of one of Trajan's coins.

j is from a coin of Antoninus Pius, and represents the goddess of liberty.

k is from a statue of the sleeping Endymion in the Townley collection of the British Museum.

l is from a bas-relief in the Vatican, and exhibits the head of a shepherd.

m shows the shepherd Zethus with his hat slung behind his back. Borghese collection.

n, horseman with a petasus. Parthenon.

o p, silver coins of Ætolia in the British Museum.

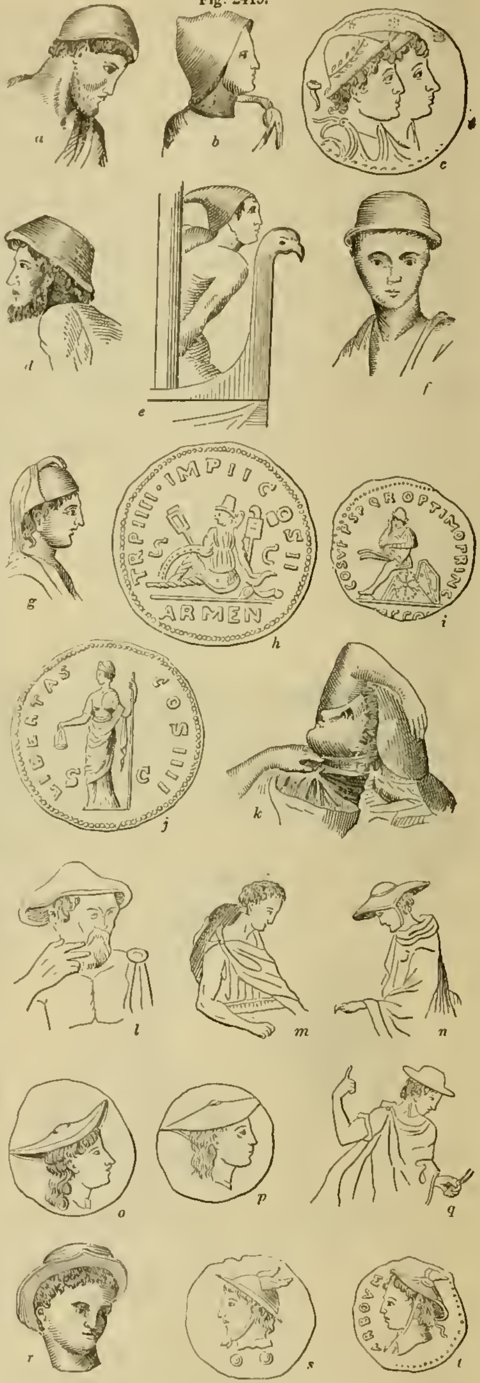
q, from a vase of Sir W. Hamilton's.

r is from an ancient marble bust.

s t are from coins of ancient Italy, and representing heads of Mercury.

In the thirteenth century, Pope Innocent IV. allowed the cardinals the use of scarlet cloth hats.

Fig. 2419.



Ancient Hats.

The introduction of felt hats is credited to a Swiss, in Paris, in 1410, and in 1440 it is said to have become a common article of wear for travelers.

In 1449, Charles VII. made his triumphal entry into Rouen, wearing a felt hat lined with red velvet and surmounted with a fine plume of feathers. This set the fashion, and hats soon superseded the old chaperons and hoods.

Chaucer, who wrote during the latter part of the fourteenth century, represents the merchant as wearing a Flanders beaver hat. This may antedate our Swiss friend mentioned above.

The hats referred to in the reign of Richard II. (1385) were probably of cloth.

Felt hats are stated by one authority to have been first made in England in 1470; and by another authority (Stow) to have been first made there, by Spaniards, in 1510. Before this time the people, both men and women, wore close woolen caps; originally of cloth and afterwards knit. Knitting is quite a modern art.

Two centuries since, hats were customarily worn indoors.

"Home to bed; having got a strange cold in my head, by flinging off my hat at a dinner, and sitting with the wind in my neck." — PEPYS'S *Diary*, September 22, 1664.

"Home to supper, having a great cold, got on Sunday last, by sitting too long with my head bare, for Mercer [his wife's maid] to comb [his hair ?] and wash my ears." —*Ibid.*, January 25, 1664.

"This day Mr. Holden sent me a bever, which cost me £4 5*s.*" —*Ibid.*, 1641.

In Lord Clarendon's essay on the decay of respect paid to age, he says that in his younger days he never kept on his hat before those older than himself, *except at dinner.*

Hats, besides those of straw and similar material, are made of fur, principally that of the Russian hare or coney, mixed with a small proportion of wool or cotton.

There is a legend that the process of felting was accidentally discovered by St. Clement, who, having put some rabbits' fur in his shoes to protect his feet during a long journey, found at its conclusion that the fur had become compacted into a homogeneous mass.

The use of the fur of the beaver, which certainly dates back prior to 1585, threatens now to become obsolete, it being superseded to so great an extent by the imitation made by covering a body with silk plush.

In any process of making felt or fur body hats, the first operation is weighing out a sufficient quantity of the material to make a single hat-body.

In the hand process, the fur is bowed by being placed in a heap over a table above which is suspended the *bow*, much resembling a fiddle-bow, though having but one string which is vibrated by the workman striking it with his thumb until the hairs are brought into a light even layer. The wool is then treated in a similar way with a larger bow, and the two layers of fur and wool are, by means of a light wicker frame adapted to receive the material, placed one over the other and again bowed, when the mass is compressed by the wicker frame, and afterward by an oil-cloth pressed upon it by the hands until the fibers have become sufficiently united to bear handling.

A triangular piece of brown paper is then placed above it, over which its edges are folded, and the whole is wrapped up in a damp cloth and manipulated until the fibers have become thoroughly intertwined and the body is brought into a triangular form. This is called *basoning.*

In the next process, called *planking*, the body is alternately immersed in a kettle of very dilute sulphuric acid, to which beer-grounds or wine-lees are added, and then worked upon an inclined plane at the side of the kettle until it is shrunk to half its former size and much increased in thickness, the operation being completed by the aid of a rolling-pin which smooths and compacts the felt. The body is then dried in a stove, and sized with a brush dipped in shellac dissolved in alcohol, and again dried; any superfluous sizing is removed by dipping in an alkaline solution and scraping. Beaver fur is applied to the exterior by being mixed with fine cotton, and the two are felted, in manner similar to that described, into a thin sheet, which is affixed to the exterior of the body by manipulating it in the boiler and on the plank; in this process the cotton separates. The body is yet of a conical shape, and is partially brought into proper form by hand, and then stretched upon a cylindrical block, after which it is dyed by boiling in a solution of copperas, verdigris, gall-nuts, and logwood in water. It is now drained, dried, and removed from the block, and *finished* by placing over a jet of steam which softens it, when the brim is turned up, the stiffening of the crown inserted, placed upon a block, the nap smoothed, and a glossy surface imparted by means of warm and damp hair-brushes and a plush-brush called a *velours* (sometimes *lewer* or *lure*), finishing with a hot iron. The trimmings and lining are next sewed in, and the hat is finally warmed and such slight variation of shape imparted as the style requires.

In the present mode of making felt hats, after being *carroted* by treatment with a solution of mercury and nitric acid, in order to render the felting easier, the fur, when dry, is removed from the skin and assorted, according to quality, into back, belly, and side, the latter being the finest. These are mixed as may be required, according to the quality of the hat, and farther mixed in the proportion of 4 to 5 ounces, that being the quantity required for a hat body, with from $\frac{1}{4}$ to $\frac{1}{2}$ ounce of fine carded cotton. This mixture is placed in a box above a toothed picker, revolving with great velocity, which seizes the material and conveys it on an endless belt to another picker. The agitation caused by the current of air from these assists in intermingling the ingredients.

The *stock*, as it is now termed, is next passed through a series of toothed rollers, where coarse materials and dirt fall into trays beneath, while the finer portions are forced out at the farther extremity of the machine. The stock, which is now said to be *blown*, is next placed on the feeding-apron of the *forming-machine*, in quantities just sufficient for one hat-body. Here it is drawn in between two horizontal, felt-covered feed-rollers, and seized by a cylinder provided with several longitudinal rows of stiff brushes, and making about 3,000 revolutions per minute. By this a current of air is generated, which scatters the stock and blows it out through a vertical slot at the top of the machine against a revolving copper *cone* having a great number of perforations, and partially exhausted of air by a rapidly revolving fan. When the stock from the first machine is thus all withdrawn and compressed against the side of the *cone*, a wet cloth is placed over it; a metallic cover is slipped on over this, and the whole transferred to a tank of hot water. The *mat* is next removed from the cone, small portions of stock added to strengthen any thin spots which may be detected, and it is rolled and worked in a piece of blanket. After a little manipulation, it is ready for the process of felting, which is done by experienced workmen, by constant rolling and dipping in hot water for several hours, for the purpose of farther thickening and fulling it; or, in other words, felting the fur and reducing the large cone to the proper dimensions for making a hat. After being properly sized or felted, it is passed to the shaving-room, where the outer surface is shaved with a sharp knife by a skilled workman, to remove whatever hair may yet remain in the fur. It is then returned to the kettle for a second sizing, to farther close up and strengthen the felt. After the farther operations of being stiffened, cleaned, blocked, colored, shaped, and pounced, the body is ready for the finishing process.

The great improvement of the perforated exhausted cone, with its attendant slotted blowing cylinder, is due to H. A. Wells, by whom it was patented April 25, 1846. Williams, in England, had previously employed a partially exhausted cone in connection with a carding-machine for making hat-bodies from tow or waste silk. See Blowing-machine, p. 307.

In this country, fur, mixed with a little Sea-Island cotton, is generally employed. The forming and sizing of the body are done in a way precisely similar to that of felt hats, but a much less quantity of stock, from 1 to 1¼ ounces, is used.

After sizing, it is dipped into a solution of shellac and alcohol, drawn over a block and the brim flattened. A thick stiffening is placed in the crown and on the brim, and the body again blocked, slightly moistened, and ironed into shape. The brim is ironed on the brim-board, sand-papered smooth, again ironed and coated with a sizing of fine glue.

After this two coats of shellac varnish are applied and the body is ready to receive its silk plush covering. The plush for this purpose is imported from France and Germany, the former of superior quality.

The material is cut into two pieces which form the upper and under surfaces of the brim, and other two which constitute the body and crown. The under brim in one circular piece is first put on, and afterwards the upper brim, sewed to the crown and side piece; the whole forming a sort of bag, which is drawn over the body. The operation of sewing requires great neatness, to conceal the seam, and neatness is also required to conceal the joint where the two ends of the piece forming the side unite. This is effected by cutting off the overlapping part very exactly at the joint and brushing the nap over it; the application of a hot iron unites the plush to the body. The hat-band conceals the junction of body and upper brim, and the binding that of the upper and lower brim pieces.

The hat is finished by rubbing with small wire hand-cards and stiff brushes, after damping with a sponge, and afterwards ironing it. This straightens and lays the nap, a mixture of camphor and alcohol is applied to soften any adhering dirt, and the hat is then placed in the *luring*-machine, — an apparatus similar to a lathe, — in which the hat on its block is caused to revolve against pads of stiff woolen plush; this removes all dirt and water stains. The final gloss is imparted with the hot iron, after which it is trimmed. From the hands of the finisher the hat passes to the trimmers and curler, where the finishing touch is given and the brims molded into the shape, as the style and fashion may dictate, bringing out the Hogarth lines of beauty in their curves and curls, and adapting them to the taste of the correctly dressed gentleman of the day.

Two kinds of bodies are employed for silk hats. One consists of stiffened muslin, and the other of felt or fur.

The muslin, or, as it is termed, the gossamer body, is said to be the lightest and most durable of the two kinds used, and is rapidly superseding the fur or felt body for general wear.

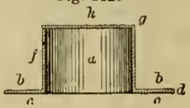
Silk-hat making is known to those connected with the trade as an art, and was styled by them in olden times, "the art and mystery of hat-making."

The parts of a hat are as follows: —

a, body or crown.
b c, brim.
b, upper brim.
c, under brim.
d, rim.

The banding-point, or break of the band, is at the junction of the brim and crown.
f, side crown.
g, square. *h*, tip.

Fig. 2420.



Hat.

A cap differs from a hat in the shape of its brim, which projects from one side only, and is called a *fore-piece* or *visor*. A bonnet differs from a cap in the angle at which the brim projects from the body.

Among the different kinds of hats may be cited, the

Cloth-hat.
Cork-hat.
Embossed-hat.
Felt-hat.
Fur-hat.
Leather-hat.
Paper-hat.
Silk-hat.
Spring-brim hat.
Straw-hat.

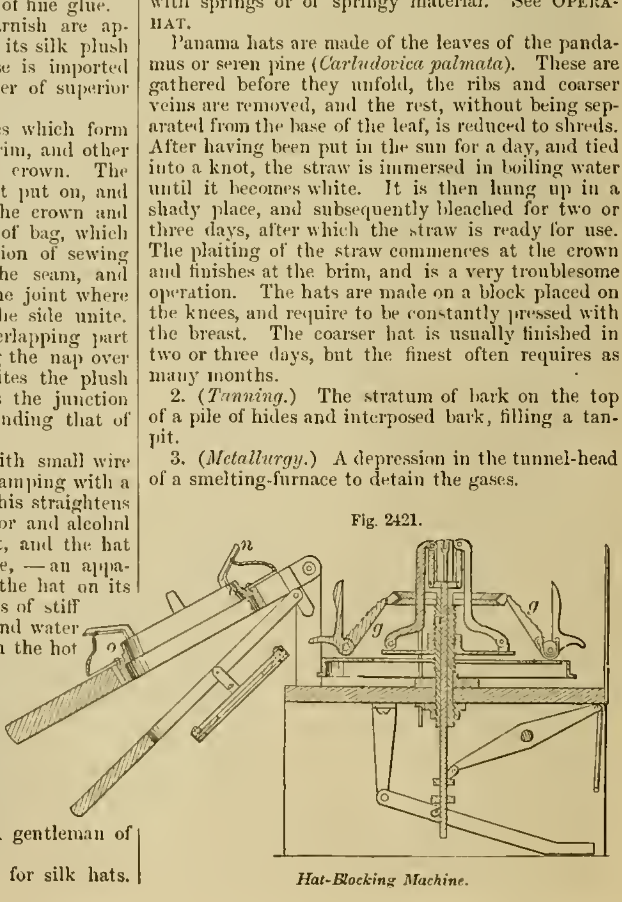
Collapsible hats, for opera or traveling, are made with springs or of springy material. See Opera-hat.

Panama hats are made of the leaves of the pandamus or seren pine (*Carludovica palmata*). These are gathered before they unfold, the ribs and coarser veins are removed, and the rest, without being separated from the base of the leaf, is reduced to shreds. After having been put in the sun for a day, and tied into a knot, the straw is immersed in boiling water until it becomes white. It is then hung up in a shady place, and subsequently bleached for two or three days, after which the straw is ready for use. The plaiting of the straw commences at the crown and finishes at the brim, and is a very troublesome operation. The hats are made on a block placed on the knees, and require to be constantly pressed with the breast. The coarser hat is usually finished in two or three days, but the finest often requires as many months.

2. (*Tanning.*) The stratum of bark on the top of a pile of hides and interposed bark, filling a tan-pit.

3. (*Metallurgy.*) A depression in the tunnel-head of a smelting-furnace to detain the gases.

Fig. 2421.



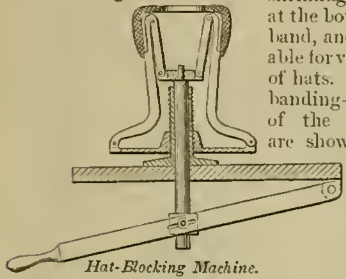
Hat-Blocking Machine.

Hat-block. A form upon which the hat is finished. It is usually made of five pieces, four outside segments and a square central or key-block.

In finishing the exterior, a *spinner* is used as a stand, being simply a flat oval table, the face of which corresponds to the curve of the brim. It is removed when the under brim is to be worked.

Hat-block'ing Ma-chine'. A machine for blocking hats, stretching out the crown by means of expansible framework, and stretching out the brim by clamps, which take hold of the brim, and are then raised from an inclined to a horizontal position. The expansible framework is raised and lowered by a screw stem, so as to adjust it to varying depths of hats. The ring serves several purposes, giving pressure to the clamps by means of springs, and forming a point of attachment for the inclined projections for giving the edge of the brim an extra stretch to overcome the shrinkage. The rim *o* at the bottom *breaks* the band, and is changeable for varying sizes of hats. Fig. 2421, the banding-ring and a part of the stretching-arm are shown as laid over away from the cone; it is brought into operation upon the hat-body by swinging over, bringing the stretchers *n n* between the part *g g* and the banding-ring *o*, upon the band of the hat.

Fig. 2422.

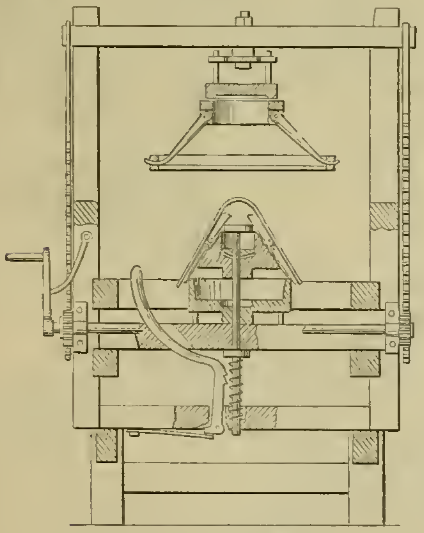


Hat-Blocking Machine.

Fig. 2422 shows the rubber over the crown stretchers to prevent undue corrugating of the body.

In Fig. 2423 the *cone* to form the body is placed upon the block *E*, which has two circumferential series of slanting ribs above it. When the carriage is raised so as to bring the cone within the hollow former above, the piston *D* expands the upper series of radial arms, distending the crown, which is thereby pressed against the sides of the block *T T*, and flattened against the crown-piece *H*; the crown and sides are then blocked. The brim is distended by the rising of the ring *L* against the inside edges of the lower and outer series of hinged arms, which are thus pressed against the under side of the brim and press the latter against and between the arms *V* of the former above.

Fig. 2423.

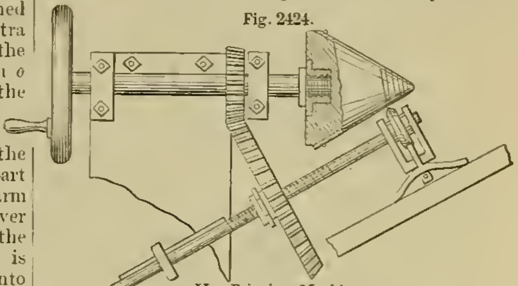


Boyden's Hat-Blocking Machine.

Hat-bod'y. The entire body in an unfinished state, as the *cone* from a forming-machine, or the *shell* or *carcass* upon which plush is attached to make a silk hat; or the beaver hat before napping; or a cloth hat before stiffening.

Hat-bod'y Print'er. A machine for printing a pattern on the exterior of a hat-body, to produce an ornamental effect or imitate a fabric. In the example, the block having the pounced hat-body thereon is screwed upon the end of a shaft, which is rotated in conjunction with a printing-roller, which may have more or less rapid feed given to it.

Fig. 2424.



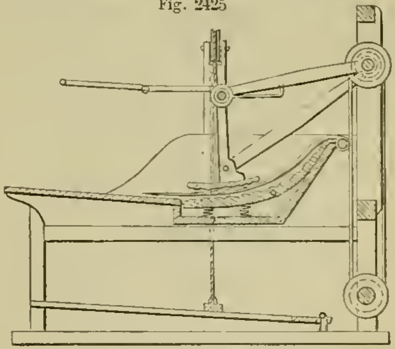
Hat-Printing Machine.

Hat-bod'y Siz'ing-ma-chine'. Sizing is a term synonymous with *hat-shrinking* and *hat-planking*. For hand process see HATTER'S BATTERY.

An operation for shrinking or reducing the hat-body to the proper size and form for making the finished hat. The apparatus consists of an elastic bed in a trough containing hot water, and a semicircular rocker, by which a kneading operation is performed on the body.

The elastic support of the corrugated bed sustains the lower end of the latter above the surface of the liquid, so that the roll of hats may be adjusted upon the bed without exposing the hands to the hot water. The handle, pivotal shaft, and impelling springs enable the machine to be operated by hand.

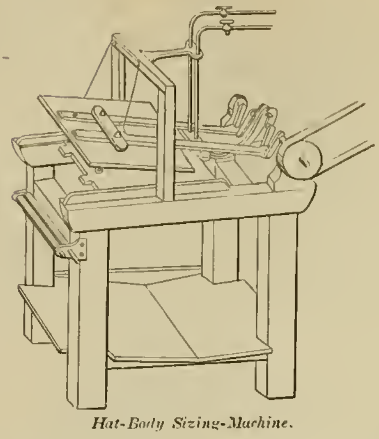
Fig. 2425



Hat-Body Sizing-Machine.

In Fig. 2426, the table has a simple horizontal reciprocation, and the platen an oscillating as well as a reciprocating motion, being rigidly attached to the pitmans. Jets of hot water or steam may be applied to the *hat* from pipes which end in a finely perforated box.

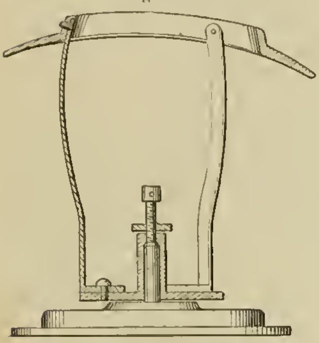
Fig. 2426.



Hat-Body Sizing-Machine.

Hat-brim Trim'mer. A pattern which determines the point at which the brim is to be trimmed. The operation is commonly performed by a *rounding-jack*, which is a curved knife carrying a gage which bears against the band point while the hat is upon the block, and, being moved around the body, cuts the brim of an equal width all round.

Fig. 2427.



Hat-Brim Trimmer.

Hat-brush. A soft, drawn brush, of horse or goat's-hair.

Hat-brush'ing Ma-chine'. A machine in which brushes are used to equalize and polish the nap, pile, or exterior fibrous matter forming the surfaces of hats. They sometimes rotate in contact with the body, or it is rotated while they are held in contact with it. After the forming operation, the brushing-machine removes the dust or liberated fiber.

Hatch. 1. A stop-plank falling in vertical grooves in a frame, and supporting a head of water in a weir. A *sluice*-gate. A *flood*-gate.

2. A grated weir for a fish-trap.

3. A breast-high or half door.

4. A shutter to cover a hatchway, or scuttle, in a ship's deck or warehouse floor.

5. A hatchway or opening in a deck or floor.

6. An opening into a mine.

Hatch-bar. (*Nautical.*) The bars by which the hatches are fastened down.

Hatch'el. (*Fiber.*) An instrument for cleansing flax or hemp from the *hards*. It consists of a number of teeth set in a board, upon which the bank of fiber is thrown and dragged through, so as to comb it straight and remove the coarser portions. A *hackle*.

Hatch'et. (*Carpentry.*) A one-handed chopping-tool.

Hatchets of the stone age have been found with eyes for the reception of the helve. No such perforation is found in any bronze axe or hatchet of the immense period during which the cutting tools were formed of this metal. Bronze was always cast, and it seems wonderful that no one thought of casting it with an eye. Natural holes in stones were utilized for eyes; two flint hatchets in the museum of Copenhagen are examples.

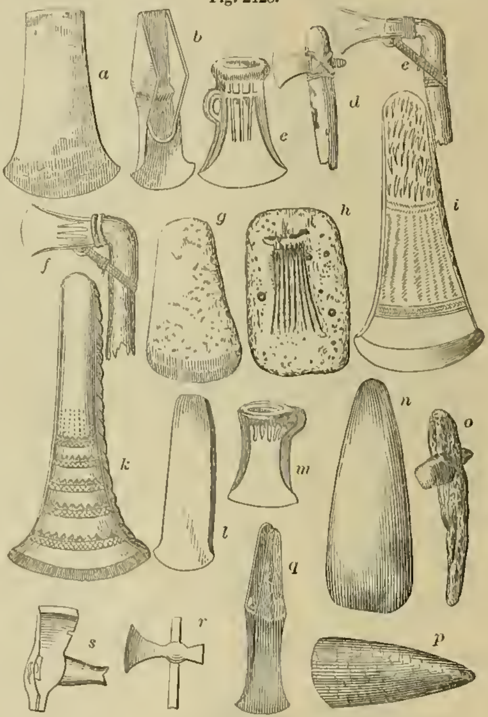
The early history of our race is written in the tools of stone, bone, and bronze. A few leaves from the chapters to be found in all our museums are transferred to these pages.

a is a copper celt from Waterford, Ireland, resembling in shape the earlier stone tools, such as axes, adzes, chisels, hoes, for the chase, war, carpentry, and agriculture.

b is a winged celt from Ireland, *c* a socketed celt from the same country.

d e f show the modes in which the celts *a b c* were stocked.

Fig. 2428.



Celts and Hatchets.

These celts vary in size from an inch to a foot in length. *g* is a stone celt.

h is a celt-mold from Ireland.

i is a decorated bronze celt from Ireland.

k l m are Danish celts of bronze.

n is a stone axe from Ireland.

o, a stone hatchet found in county Monaghan, Ireland, yet mounted in a pine handle 13½ inches long. Almost none of these weapons are found with holes for the handles. See AXE.

p is an ancient stone hatchet found at the stream-tin works, Morbihan.

q is a bronze hatchet from Morbihan.

r is the Roman *securis*. It had a single edge, or a blade and poll, as represented in the figure. When it had a blade on each side of the haft it was known as *bi-pennis*. See DOUBLE-BITTED AXE.

s is a shingling hatchet.

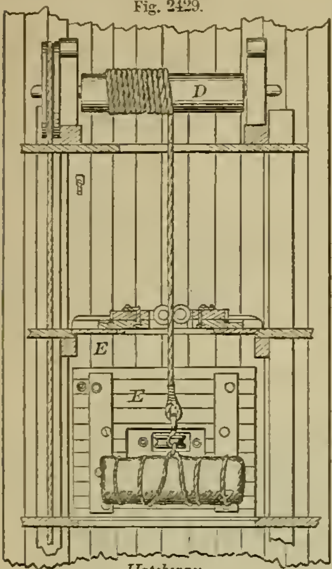
Hatch'ing. (*Engraving.*) A style of drawing or engraving in which the shading is performed by lines crossing at angles less than 90°.

Hatch'way. 1. (*Shipbuilding.*) One of the large square openings in the deck of a ship whereby freight is hoisted in or out, and access is had to the hold. The coverings are *hatches.* These are fastened down by *battens.*

There are four pieces in the frame of a hatchway. The fore-and-aft pieces are called *coamings,* and those athwart ship are *head-ledges.* The *head-ledges* rest on the beams, and the *coamings* or *carlings* extending between the beams.

The hatchways are *fore, main, after,* as the case may be, according to the size and character of the vessel.

Fig. 2429.



Hatchway.

2. An opening in the floor of a warehouse for the passage of goods. The illustration shows a part of three floors, the windlass *D* above, the hatch of the next floor closed, a floor yet lower has the hinged hatch *E* lifted and laid back against the wall.

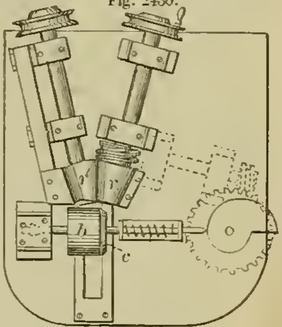
Hat-con-form'a-tor. A machine of French origin, by which the oval shape of the head is ascertained. It consists of a series of sliding arms, radially arranged in a frame, and carrying at their upper ends sharp points. When applied to the head as is a hat, the arms are thrust outward by contact with the head, and assume a position corresponding to the exact conformation thereof. While thus held an impression is taken upon a slip of paper pressed upon the points. This paper is trimmed to the form delineated by the points, and becomes a pattern by which an adjustable block is set for use in reshaping the form of a finished hat.

Hat-die. A block for holding a hat while pressing. Synonymous with Hat-mold (which see).

Hat-em-boss'ing. A means for beautifying the appearance of a hat, by producing a pattern upon its exterior by raising and depressing different parts of its surface. Generally done on a pattern-block upon which it is pressed. Dies are sometimes employed. A pressing tool, running in a lathe, is also used to impress a pattern.

Hat-felt'ing. A mode of forming hats by placing a disk of felting material between surfaces which by a rubbing and drawing action felt the fibers and cause the hat to gradually assume the required shape. In the example, the circular piece of felting material is placed between the disk *c* and *block b,* its outer portion being embraced between the conical rollers *r r'.* The parts being set in motion, the block is gradually slipped along its axis, causing the felt to assume the shape of the sides of the block. When the latter has been moved a distance equal to its length, the hat is formed, the remainder of it that is between the manipulators *r r'* constituting the brim.

Fig. 2430.

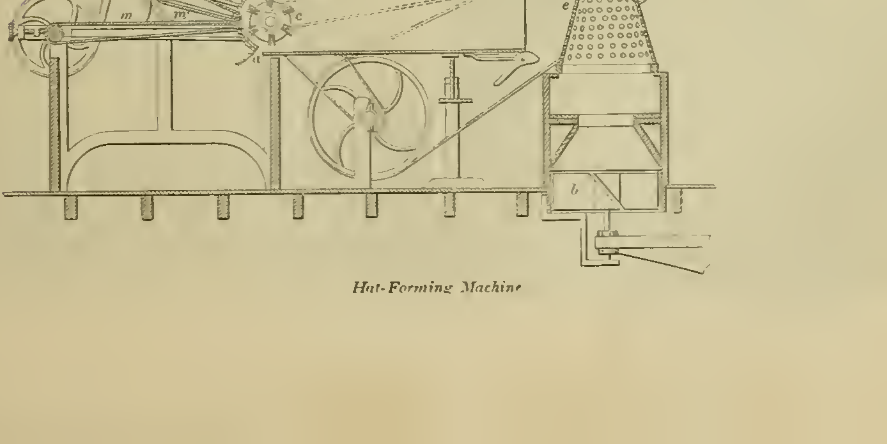


Hat-Felting Machine.

Hat-fin'ish-ing. The operations which complete a hat for market, — such as brushing to lay the nap, and ironing to smooth and impart a gloss to it ; or pouncing to even the surface ; or brushing to remove the dust ; or dyeing and trimming.

Hat-form'ing Ma-chine'. Slivers of wool are taken from the doffer of a carding-engine and wound

Fig. 2431.



Hat-Forming Machine

in different directions upon a cone, which revolves and traverses or vibrates to and fro, by which motions the filaments of wool are crossed at different angles, and perfect felting is accomplished.

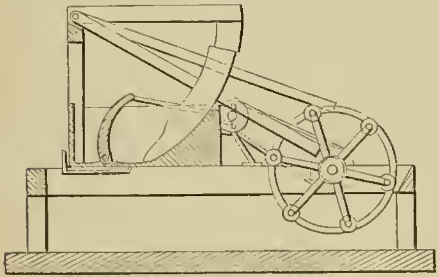
This class of machines is now superseded by that shown in Fig. 2431, which is a machine for loosening-up fiber and depositing it on a former, so as to form the hat-body. Various machines of this kind have been invented, embracing the same general principles, but differing in detail. That illustrated was patented by H. A. Wells, April 25, 1846. In this the fur, in regulated quantity, is supplied to the machine between a pair of feeding-belts *m m'*, and caught from the lips of the belts by a rotating brush or picker *c*, which separates the fibers and delivers them into the tunnel *d*, air being drawn through the aperture *a* by means of the draft caused by a fan-blower *b*, rotating with great velocity. The cloud of fur is drawn through the tunnel *d*, and deposited upon the revolving perforated cone *e*, from which the air is exhausted by the fan *b*. A vibratable deflector *f* hinged to the tunnel *d* governs the discharge of fur from the tunnel, so that an increased thickness may be given to the lower part of the hat-body.

When the charge or given quantity of fur to form a body has been deposited on the former, it is covered with a conical cloth or felt cap over which a metallic covering is placed and the whole removed from the machine, and immersed for a short time in a hot-water bath, to contract and compact the material. See also Blowing-machine, page 307.

The succeeding processes are those ordinarily employed in hat-making. See Hat; Felting.

Hat-full'ing Ma-chine'. The function of a fulling-mill in hat-making is to thicken or consolidate the body. It commonly consists of two or more sets of beaters or hammers, successively raised and dropped upon the mass of hats contained in the trough, where they are agitated or turned by mechanical means so as to constantly present new surfaces to the fulling-stocks. In the example the movement of the swinging side of the fulling-box causes the mass of hats to pass around regularly to insure equal action on all their parts.

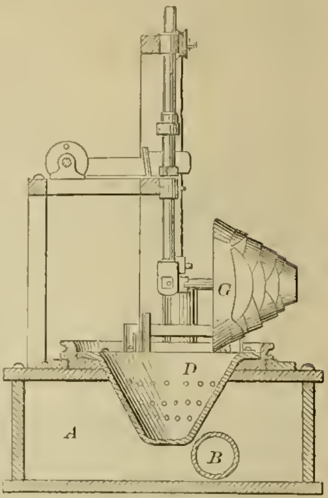
Fig. 2432.



Hat-Fulling Machine.

In Fig. 2433 the *bat* is laid over the basin *D* and the forming-block *G* brought over it. Steam is admitted through perforations in the mold, and also in the *former*, if desired. The mold and its rim rotate continuously. The *former* has an adjustable reciprocating rotary motion, and also an up-and-down vertical one; the shingles or curved lapping surfaces serve to crowd down and aid in fulling the bat. By an automatic motion of a weight outward upon the beam-lever, a blow of gradually increasing force is given to the falling cone *G* as the work proceeds. *A* is the steam-chamber, *B* the steam-pipe.

Fig. 2433.

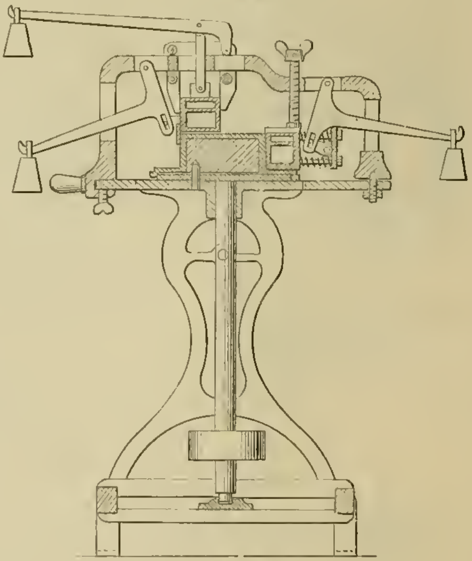


Hat-Fulling Machine.

Hat-hard'en-ing Ma-chine'. *Hardening* or *basoning*; a preliminary felting operation which converts the fibers into a fabric dense and tenacious enough to enable it to be handled and put through the felting process. In cones from the forming-machine, it is usually done by an auxiliary cone moved over that on which the body was formed. Other bodies are steamed and rolled up in cloths (basoning-cloths). Flat bats are hardened between a table and a flat platen having short, quick reciprocating motion. See Emmon's patent, April 19, 1853.

Hat-i'ron-ing Ma-chine'. A machine for performing the ironing formerly done by hand, by which the final operation of finishing a hat is accomplished.

Fig. 2434



Hat-Ironing Machine.

The block supporting the body rotates at a high speed, while hollow irons, heated by interior gas-jets, steam, or hot air flowing through, or by heated slugs introduced within them, are held against the whole surface by pressure of a weight or spring. The tip-iron usually has a lip on one side, which bears over the square.

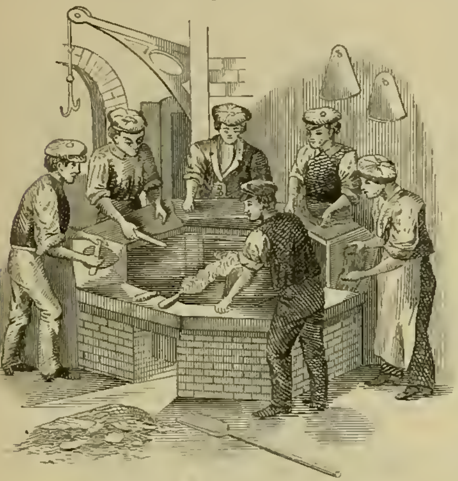
The under brim is either finished by hand or by inverting the block on the machine, so that an iron may bear upon it. In some instances the block is so supported on its spindle as to allow an iron to bear on the under brim at the same time that the crown is being treated.

In the example, the blocked hat revolves on a turn-table; the irons are pendent from an upper bridge-frame, and their pressure is regulated by levers and counterweights; the irons are heated by gas-burners.

Hat-mak'ers' Bat'ter-y. (*Hat-making.*) A large boiler with a surrounding set of benches for a number of workmen. The water has a small quantity of sulphuric acid to enable the fur to felt more readily.

At the battery the conical hat-body and the sheet of fur *napping*, each previously prepared, are united, so that the latter forms a fur covering to the former. The junction is accomplished by laying the napping on the body, pressing, rubbing, and rolling with a pin. Boiling-hot water is sprinkled over them from time to time, by means of a *stopping* brush, and when a certain degree of cohesion is obtained the conical hat is ready for *shaping*.

Fig. 2435.



Hat-Makers' Battery.

The effect of the manipulations is to drive the butt-ends of the filaments into the interstices between the fibers of the body (see Felt), and it is persevered in no longer than is sufficient to give the nap a good hold on the body.

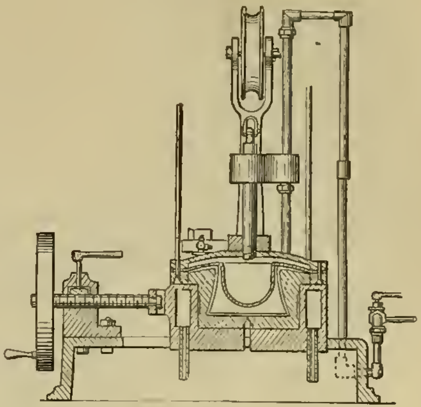
A wooden tool held in the palm of the workman's hand is the means of rubbing, and is held on by a string. It is called a *glove.*

Hat-meas'ure. A device by which the size of the oval head opening is ascertained. Usually a circular graduated ribbon, the ends of which slide in each other. See also Hat-conformator.

Hat-mold. The die in which a hat or bonnet is formed or shaped by pressing. In the example, the *hat* to form the hat is shown as being driven into the heated mold by means of the pressure of a liquid introduced above an elastic diaphragm above the hat. See Hat-pressing Machine.

Hat-nap'ping Ma-chine'. A felted body is dipped into boiling water and its nap drawn out or carded up by a small hand-card. The process of scalding in napping is described in English patent 7397 for 1837. Known also as *ruffing.*

Fig. 2436.



Hat-Mold.

Hat-per'fo-rat'ing Ma-chine'. A machine for cutting a multiplicity of fine holes in the hat-body to provide for ventilation.

Hat-plank'ing. A finishing felting operation. See Felting.

The hat-body being *basoned* or *hardened* is passed through a cistern containing a heated acidulated water with dregs of beer, or other planking liquor, and between two series of pressing rollers, by which the fibers are knitted together or consolidated into felt, when they are ready for the blocking.

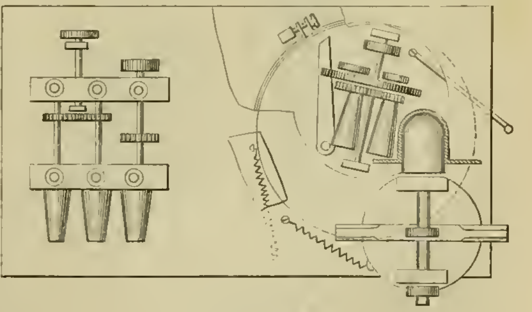
In hat-planking machines the bodies are repeatedly passed through a boiling acidulated bath and under pressure, being frequently *crozed.* See also Hat-body Sizing-machine.

Crozing or *crosing* is refolding a hat-body so that in passing many times through a felting-machine it may present new surfaces to be acted upon.

Hat-poun'cing Ma-chine'. A machine for evening or equalizing the surface of a felted hat. It consists of a roller covered with sand or emery paper, and rapidly revolved in contact with the surface, by which the projecting fibers are ground off until the surface fibers are of equal length.

In the example, the cones are covered with sand-paper, and are mounted on shafts which have their bearings in a revolving disk in connection with a swivel plate and an adjustable revolving block on which the hats are presented to the pouncers. By the combined action of the feed and pouncing rollers

Fig. 2437.

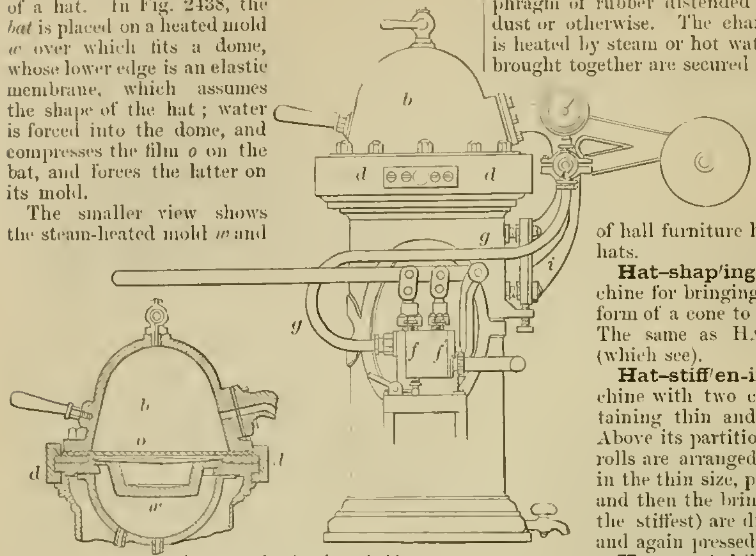


Hat-Pouncing Machine.

the brim is subsequently revolved automatically and operated upon by the pouncing cones.

Hat-press′ing Ma-chine′. A machine for bringing a *bat* or *cone* of hat-making material to the form of a hat. In Fig. 2438, the *bat* is placed on a heated mold *a* over which fits a dome, whose lower edge is an elastic membrane, which assumes the shape of the hat; water is forced into the dome, and compresses the film *o* on the bat, and forces the latter on its mold.

Fig. 2438.

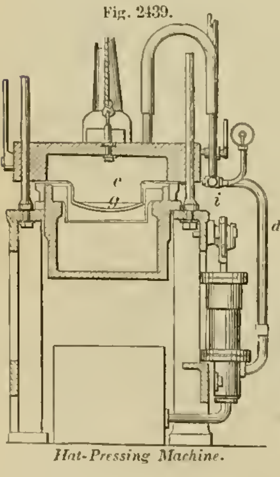


Simonet's Hat-Pressing Machine.

The smaller view shows the steam-heated mold *a* and dome *b* in section, while the larger view is a side elevation. *f f′* are the force-pumps by which water is forced into the dome *b* through the bent pipe *g* and trunnion-tube *c*, which is on an adjustable bracket *i*; the mode of connection allowing a vertical motion to the dome in closing and opening, and a horizontal motion when securing the foot of the dome in the ring *d* by means of a bayonet-joint attachment.

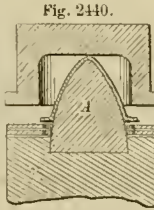
In Fig. 2439, the hat *g* is shown in process of extension downward to fill the hat-shaped mold. The pressure of water is at the first derived from a head, but as greater force is required, the cistern tap is closed and the force-pump is brought into action, injecting water through pipe *d* into the dome *c*; at *i* is a connection with a manometer which indicates the pressure.

Fig. 2439.



Hat-Pressing Machine.

Fig. 2440.



Hat-Press.

In Fig. 2440, *A* is a compressible block of rubber, which, under pressure, expands to fill the whole interior of the hollow die and press the hat-cone against the surface, while the brim is held between yielding surfaces which preserve its shape.

Fig. 2441 is a machine in which a paper, straw, or cloth hat is brought into the desired form in a hollow die, by means of a plunger formed of a diaphragm of rubber distended by packing with sawdust or otherwise. The chamber *C* behind the die is heated by steam or hot water, and the parts when brought together are secured by a bayonet-joint.

Hat-pro-tect′or. A cover approximating the shape of the hat, and applied to it to protect it in inclement weather.

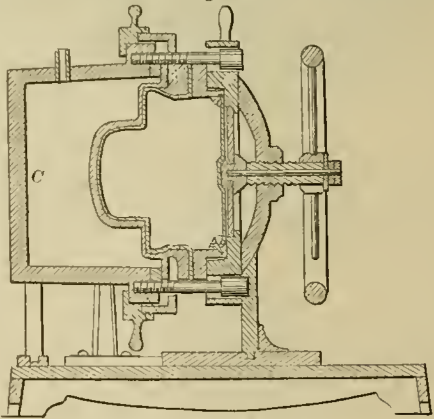
Hat-rack. A piece of hall furniture having pegs for holding hats.

Hat-shap′ing Ma-chine′. A machine for bringing the hat-body from the form of a cone to the hat shape desired. The same as HAT-PRESSING MACHINE (which see).

Hat-stiff′en-ing Ma-chine′. A machine with two compartments, one containing thin and the other thick size. Above its partition a pair of squeezing-rolls are arranged. The hats are dipped in the thin size, passed through the rolls, and then the brims (which require to be the stiffest) are dipped in the thick size, and again pressed.

Hat-stretch′ing Ma-chine′. A machine having a series of radially arranged arms, hinged to a head-block *b*, so as to be expanded. They stretch out the hat-cone, which is placed over them, and prepare it for blocking. In the example, Fig. 2442, the block is raised into contact with the stretched top of the hat, and then pushed up by means of a lever, so as to draw it up. The rubber bands fit on the body, and holds it when the stretcher-levers *B* are separated at their upper ends. The hat-cone *f* is shown as clamped to the conical system of levers by the band *T*.

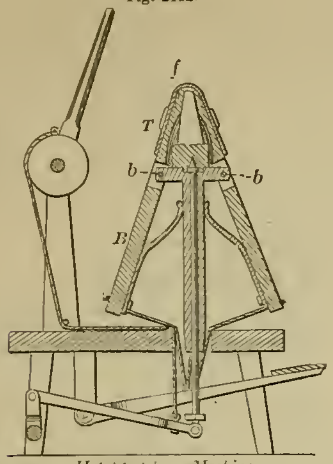
Fig. 2441.



Hat-Pressing Machine.

In Fig. 2443, the pieces *b d′ d′* are adapted to receive a cone supporting both the crown and brim portions; rising with the cone, they carry it against two other sets of ribs or rollers m^3 m^3 radially arranged, by which contact the body is crimped or stretched so as to have the requisite fullness to be

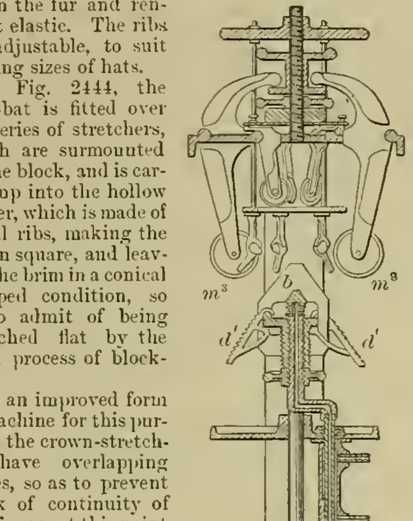
Fig. 2442.



Hat-Stretching Machine.

brought into the hat form over a block. Jets of steam are introduced through the spindle to soften the fur and render it elastic. The ribs are adjustable, to suit varying sizes of hats.

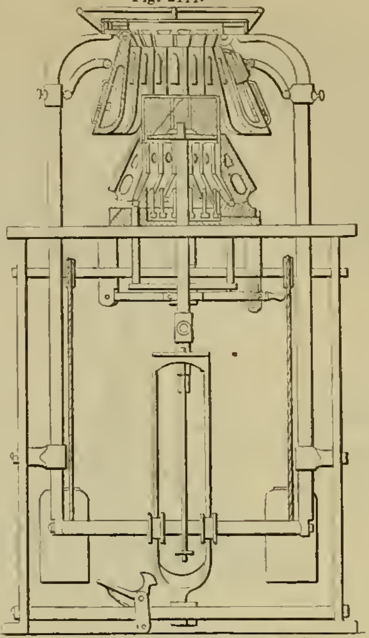
Fig. 2443.



Hat-Stretching Machine.

In Fig. 2444, the cone-bat is fitted over the series of stretchers, which are surmounted by the block, and is carried up into the hollow former, which is made of radial ribs, making the crown square, and leaving the brim in a conical crimped condition, so as to admit of being stretched flat by the hand process of blocking.

Fig. 2444.



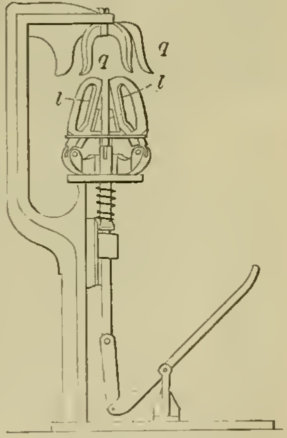
Hat Stretching and Blocking Machine.

In an improved form of machine for this purpose, the crown-stretchers have overlapping plates, so as to prevent break of continuity of the *former* at this point when the parts are distended. This is also accomplished by an india-rubber cap. When the brim-stretchers clamp the brim on arriving at a horizontal plane, they expand radially, drawing the body against the banding-ring, stretching the brim circumferentially, pulling material out of the side-crown, which is thereby stretched.

Hat-tip Press. One in which gold printing is performed on fabric for hat-tips. The type are of brass, and kept hot. The gold-leaf is laid on the type. The leather or fabric has an adhesive material applied to it, so that the gold will remain on the impressed part and the remainder may be brushed off.

Hat-tip Stretch′er. A machine adapted for stretching the tip of the cone, so that it may be blocked flat. The top is held by the clamp, so that when the treadle is depressed and the stretchers *l* rise, they reach the hat and then expand, passing between the pendent arms *q* and crimping the tips.

Fig 2445.



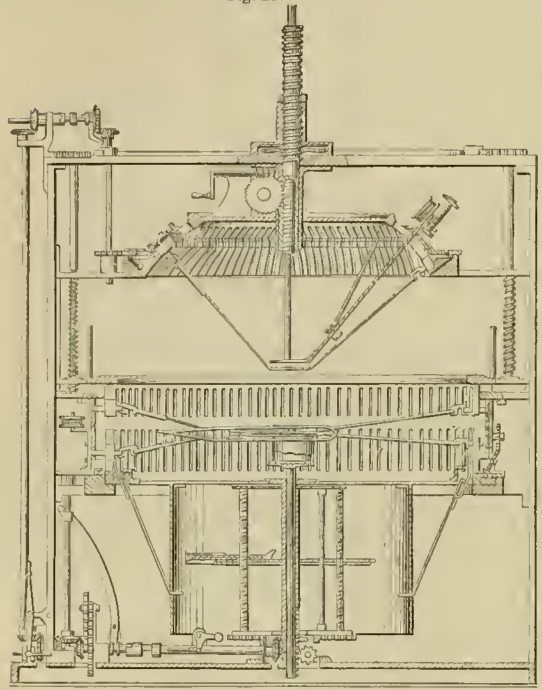
Hat-Tip Stretcher.

Hat-ven′ti-la′tor. A means for promoting a circulation of air through a hat while in wear.

The simpler form is an aperture at the top of the crown, frequently provided with a means for closing it up. An orifice extending wholly or partially around the head opening, and formed by a perforated block interposed between the *sweat* and the *body*, acts in conjunction with the *tip* opening. The simplest and most common form is a covered crimped wire sewed between the *sweat* and *body*. The side crown is frequently filled with fine perforations, and in one instance a stiff body pierced with large holes is covered with an open woven fabric, the pattern of which conceals the perforations.

Hat-weav'ing Loom. The warp strands for the hat are attached to carriers placed opposite each other in a circular series of partitions. The top of the crown is first woven, the warps being horizontal and moved to cross the path of the moving filling. When the top is completed the warp-carriers are removed to the upper series of partitions, and a circular or oval plate at the bottom of a follower gages the size of the crown; then, to weave the brim, the warp-carriers are removed to the lower series of partitions, the crown being fitted to a hat-shaped block. During the weaving, additional warps and warp-carriers are thrown into action automatically. The edge of the brim is finished by hand, after the hat is removed from the machine.

Fig. 2446.



Hat-Weaving Loom.

Haul. (*Rope-making.*) A bundle of three or four hundred parallel yarns ready for tarring. Being dipped in a tar-kettle, the haul is dragged through a *grip*, *gape*, or sliding nipper which expresses superfluous tar.

Haul-up Gear. (*Saw-mill.*) A machine for dragging up logs from a fore-bay, pond, or log-yard, to be placed upon the log-carriage.

Haunch. (*Architecture.*) The shoulder of an arch between the *crown* and the *springings*. The *flank*, *haund*, or *hance*.

Haut'boy. (*Music.*) A wooden musical instrument played with a reed, and resembling a clarinet. Called also *oboe*.

Haute-pace. (Or *half-pace.*) A raised floor in a bay-window.

Hav'er-sack. 1. A strong linen bag for containing the rations of a soldier on the march or detached duty.

The haversack of the Roman soldier was an osier basket with a long neck. Sometimes, as on the Column of Trajan, a wallet carried on the spear. Its contents were salt meat, cheese, onions, and olives, and it held sufficient for three days.

2. A gunner's case for carrying a charge from the chest to the gun. See Gunner's Haversack.

Hawk. (*Plastering.*) A piece of board ten inches square, and held by a handle at the bottom; it is used to hold a small quantity of plaster, and is grasped by the plasterer's left hand, while his right wields the trowel.

Hawk-bill. A pliers with curved nose, to hold pieces in blow-pipe soldering.

Hawk-bill-tooth Saw. A saw having a curving, hooked saw-tooth, somewhat resembling the upper mandible of the hawk.

Hawk'er. (*Nautical.*) A vessel built like a *pink*, but rigged like a *hoy*; that is, having a narrow stern and *sloop-rigged*.

Hawks-bill. (*Horology.*) A catch-piece attached to a vibrating arm, which acts as a detent in the rack of the striking part of a clock, and assists in effecting the proper number of strokes.

Hawse. (*Nautical.*) *a.* That part of a ship's bow in which are the *hawse-holes* for the cable.

b. The situation of a ship moored with anchors from each of the bows.

Hawse-bag. (*Nautical.*) A canvas bag stuffed with oakum, to stop a hawse-hole in heavy seas.

Hawse-block. (*Nautical.*) A block for stopping the *hawse-hole* when the cable is unbent and the ship at sea. Also called *hawse-plug*, *buckler*, etc.

Hawse-hole. (*Shipbuilding.*) A hole in the bow through which a cable or hawser passes. In iron ships it is a cast-iron tube having rounded projecting lips, inside and outside.

When the cable is unbent, the hole is stopped by a *hawse-block*, or *hawse-plug*.

The *hawse-holes* in large ships are four in number, the foremost pair being for the *bower-cables*, and the aftermost pair for the *sheet-cables*.

Hawse-piece. (*Shipbuilding.*) *a.* One of the cant-frames standing next to the knight-heads, and fitting close together, so as to form a solid mass of timber for the passage of the hawse-holes.

b. A wale on a ship's bow, which is pierced by the hawse-hole.

Hawse-pipe. (*Nautical.*) The tube lining a hawse-hole in a ship's bow.

Hawse-plug. (*Nautical.*) A Hawse-block (which see).

Haw'ser. (*Nautical.*) A small cable, used in warping and mooring.

A *clear* hawse is when two cables are down and diverge from each other.

A *foul* hawse is when they are twisted by the swinging of the ship at her moorings.

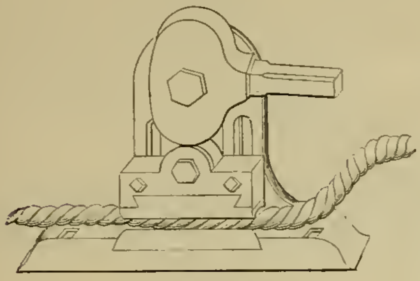
When simply crossed, it is called *cross*-hawse; another cross makes an *elbow*; another makes a *round-turn*.

Disengaging it is called *clearing hawse*. Slackening it is called *freshening hawse*.

Speaking generally, a hawser is not over ten inches in circumference. Above this it is a cable. The *laying*, however, is not to be disregarded.

Haw'ser-clamp. (*Nautical.*) A gripper for a hawser, to keep it from veering out. In the example, the lever is recessed so as to form a flange which acts as a cam upon a pin for the purpose of raising the guide with the movable jaw. The guide has a rib running in a slot in the upright bracket to which it is bolted. See CABLE-STOPPER.

Fig. 2447.



Hawser-Clamp

Haw′ser-laid. (*Rope.*) Rope made of three strands, of three yarns each, *laid up* into a rope. The twist of the strands is the reverse of the individual yarns.

Shroud hawser-laid has four strands.

Three *hawser-laid* ropes are laid up into a *cable*, the twist being again reversed.

Hay-band Ma-chine′. (*Husbandry.*) Hay or straw bands are useful in binding an occasional bunch or sheaf of straw or hay, or for throwing over a new stack to hold the cap on until it has time to settle. They are made by drawing and twisting, as in the more elegant and precise operations of spinning cotton and wool.

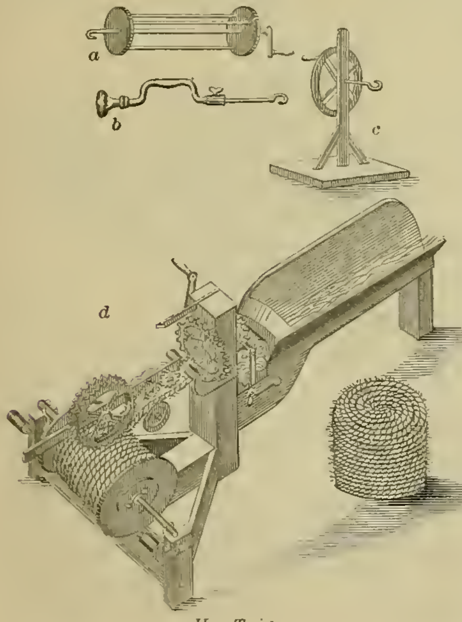
A common device for this purpose is a reel or lantern cylinder *a* held under the left arm, while the right hand turns the crank and the axis, on whose end is a hook to which a wisp of hay is attached. The operator walks away from the bunch of hay, or an assistant pays out the hay in the quantity required.

A brace and hook *b* answer the same purpose.

Instead of the brace and hook, another device *c* may be used, in which the axis of the twister is mounted in a stand. One person turns the wheel and another catches a wisp into the hook and then backs out, like a rope-maker.

d is a machine which makes hay rope and winds it up into a coil for transportation. Rollers draw the hay from the trough, and the twisting is effected by a planetary action of the rollers longitudinally. It is then coiled on the reel.

Fig. 2448.



Hay-Twisters.

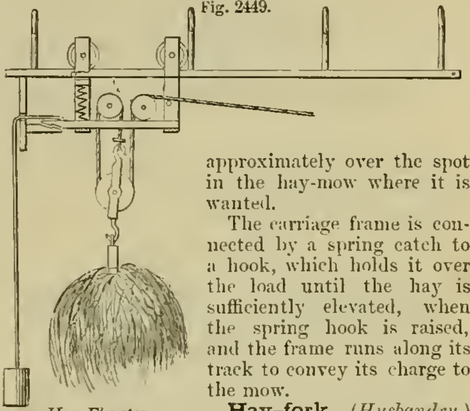
Hay-cap. (*Husbandry.*) A piece of canvas to lay on the top of a haycock to shed rain.

Hay-cut′ter. (*Husbandry.*) A box in which hay is cut into chaff. There are many forms: wheels with radial knives, which cut into each other's intervals, or against a cylinder of rawhide; guillotine knives with a shear cut; rotary shearing knives, which glance athwart the throat at which the compacted mass of hay emerges, and so on. See STRAW-CUTTER.

Hay-el′e-va′tor. (*Husbandry.*) A means for lifting a forkful of hay, and conveying it to a place approximately over the spot in the hay-mow where it is wanted.

The carriage frame is connected by a spring catch to a hook, which holds it over the load until the hay is sufficiently elevated, when the spring hook is raised, and the frame runs along its track to convey its charge to the mow.

Fig. 2449.



Hay-Elevator.

Hay-fork. (*Husbandry.*) 1. A hand fork, with two or three tines, for stirring or pitching hay.

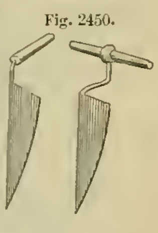
2. A fork elevated by a rope and horse, in unloading hay from a wagon to a mow, or *vice versa.* See FORK.

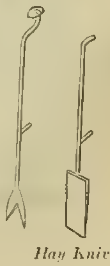
Hay-hook. (*Husbandry.*) An implement for pulling hay out of a mow or stack, instead of throwing it off the top, or cutting it off with a hay-knife. Such hooks are common in the Eastern States, but not in the West. Such a hook is described and pictured, page 893, Tome 5, "Encyclopédie de l'Agriculteur," Paris, 1861.

Hay-knife. (*Husbandry.*) The *hay-knife* has a straight blade, one edge, and a bent shank, so that the hand does not come in contact with the upright face of the stack. The same effect is obtained by placing the handle at right angles to the plane of the blade.

The hay-spade has a sharp blade, a handle, and a tread. One form has a re-entering angle with sharpened edges. It is said to be peculiarly efficient.

Fig. 2450.





Hay Knives.

Hay-load'er. (*Husbandry.*) A device attached to a wagon to collect or raise the hay from the swath, windrow, or cock, and deposit it on the wagon.

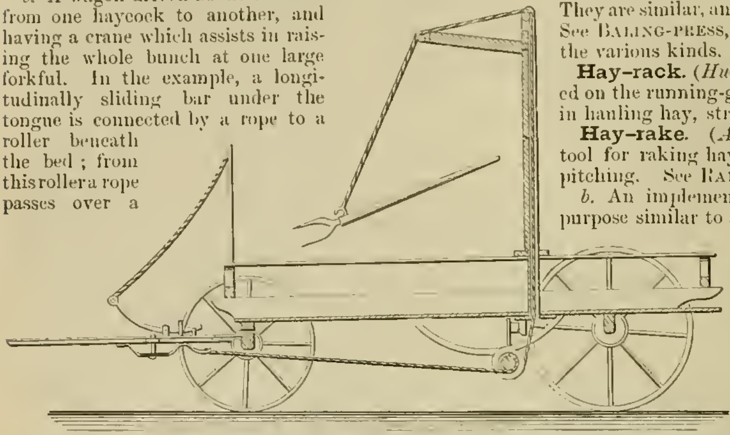
There are several forms : —

a. A rake trailing behind the wagon or alongside of it, and a traveling band with teeth carrying up the hay and dropping it into the wagon rack or bed. (See Fig. 2458.)

b. A drag-rake gathering the hay, and a crane on the wagon lifting it therefrom.

c. A wagon driven about the field from one haycock to another, and having a crane which assists in raising the whole bunch at one large forkful. In the example, a longitudinally sliding bar under the tongue is connected by a rope to a roller beneath the bed ; from this roller a rope passes over a crane to the loading-fork. The draft on the rope applies the rubbers to the wheels.

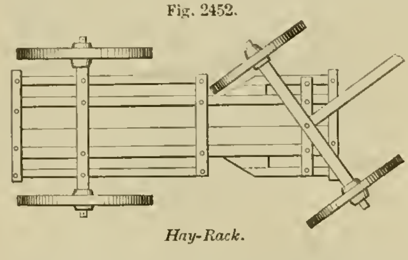
Fig. 2451.



Hay-Loader.

d. A crane on wheels or a sled. A mast or tripod on a sled.

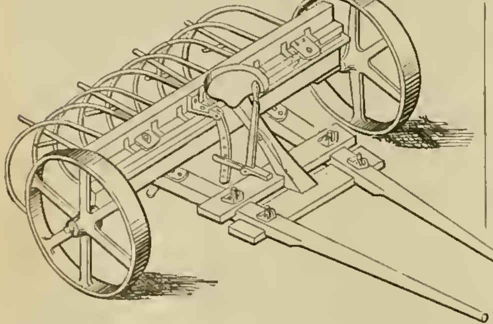
Fig. 2452.



Hay-Rack.

Hay-mak'ing Fur'nace. Mr. Mechi writes to the "London Times" that he shall hereafter arrange to make his hay by furnace-heat. The apparatus consists of a coke-furnace, and a fan by which the heat is driven through a small chamber filled with grass. In fifteen minutes the grass is converted into hay, sweeter and greener than can be made by sun-drying. The apparatus works in all weathers, and dries grain, corn, and roots as well.

Fig. 2453.



Horse Hay-Rake.

Hay-press. (*Husbandry.*) A press for baling loose hay for greater compactness in storage and transportation. The old form is the lever or screw ; latterly much ingenuity has been exercised in this direction, some machines being especially intended for baling hay, others for cotton. They are similar, and are considered together. See BALING-PRESS, in which place are cited the various kinds.

Hay-rack. (*Husbandry.*) A frame mounted on the running-gears of a wagon, and used in hauling hay, straw, sheaves, etc.

Hay-rake. (*Agriculture.*) *a.* A hand-tool for raking hay into windrow ready for pitching. See RAKE.

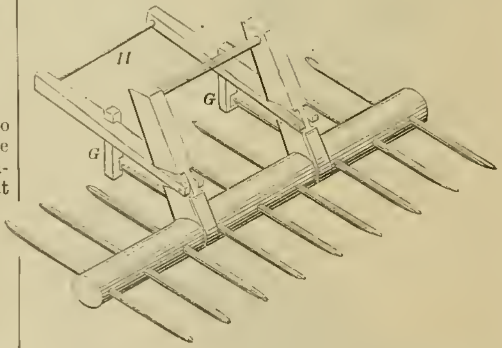
b. An implement drawn by a horse for purpose similar to above.

There are several typical forms : —

1. A series of curved teeth depending from a bar behind an axle supported on wheels. The points of the teeth trail along the ground and gather the hay, which collects in the bend of the teeth. To discharge the collected load, the teeth-bar is rotated on its axis, lifting the points of the teeth, while the clearer bars protruding behind the axle sweep the hay from the teeth. This motion of the teeth is by means of a lever which is conveniently placed for the driver.

2. Another type is that shown in Fig. 2454, in which the rake-head rests on the ground, the front ends being tipped down sufficiently to catch the hay as it lies in the swath. When a load has collected on the rake, the handle *H* is a little raised, causing the front ends of the teeth to catch in the ground and the rake to upset, the dependent catcher *G* slipping from the teeth, to allow the rake-head to rotate. The operator walks behind.

Fig. 2454.

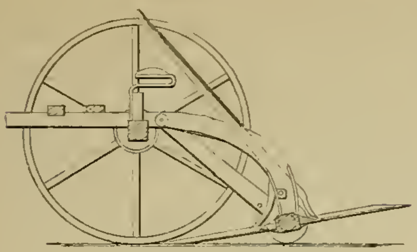


Flop-Over Hay-Rake.

Fig. 2455 shows a substantially similar rake mounted on wheels, so as to allow the person to ride and operate it.

Fig. 2456 is a form in which a frame, carrying a series of rakes on an endless band, trails behind a

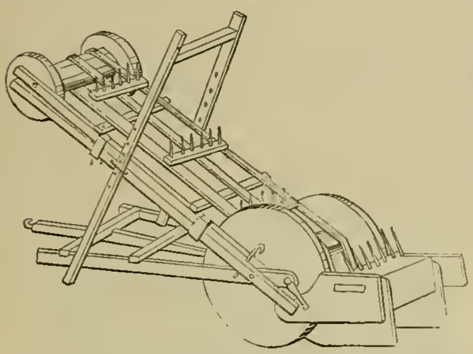
Fig. 2455.



Horse Hay-Rake.

wagon so as to rake up from the swath and discharge it on to the vehicle. After the wagon is loaded the raking-frame is detached and left in the field, or attached to another wagon. See also RAKE.

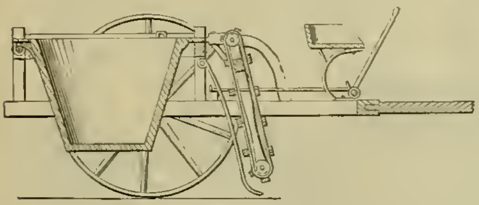
Fig. 2456.



Hay-Loading Rake.

Hay Rak'er and Cock'er. (*Husbandry.*) An implement for raking hay in the swath and cocking it. In the example, the hay is gathered by a rake, carried up by an endless elevator, and received in a conical receiver which is inverted when filled, leaving the haycock upon the ground.

Fig. 2457.

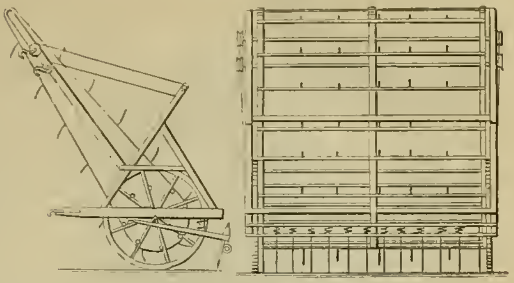


Hay Raker and Cocker.

Hay-rak'er and Load'er. (*Husbandry.*) An implement for raking hay in the swath and delivering it on to a wagon. It is usually attached to the hind axle of the wagon, and is dragged in the rear, a rake gathering up the hay in the swath as the wagon goes over the ground; a traveling apron with teeth lifts the gathered hay, carries it up, and discharges it on to the wagon. When the wagon is loaded the implement is detached.

Hay-spread'er. (*Husbandry.*) A machine for scattering cut hay to expose it to sun and air. A *tedder.* (See Fig. 2460.)

Fig. 2458.

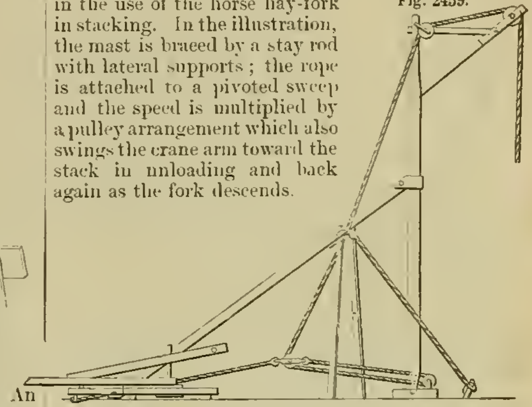


Hay Raker and Loader.

Hay'stack-boil'er. (*Steam.*) A tall form of steam-boiler introduced by Smeaton, and shaped like a kettle or a haystack, with flaring sides and rounded top.

Hay-stack'er. (*Husbandry.*) A portable derrick for the suspension of tackle in the use of the horse hay-fork in stacking. In the illustration, the mast is braced by a stay rod with lateral supports; the rope is attached to a pivoted sweep and the speed is multiplied by a pulley arrangement which also swings the crane arm toward the stack in unloading and back again as the fork descends.

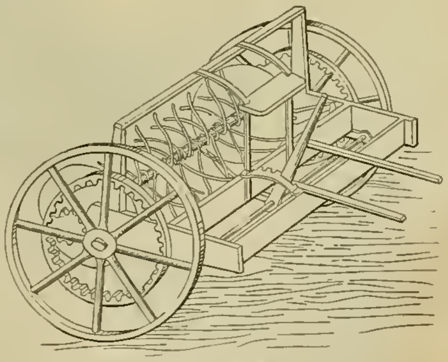
Fig. 2459.



Hay-Stacker.

Hay-ted'der. (*Husbandry.*) A machine to scatter hay to the sun and air. The hay-tedder was invented about 1800 by Salmon of Woburn, England, and is more useful in the humid climate of that country than in the United States. It consists of a pair of wheels supporting a reel consisting of an open cylindrical frame, formed by arms proceeding from it, and carrying bars set with curved tines, pointing outward. This reel may be lifted

Fig. 2460.

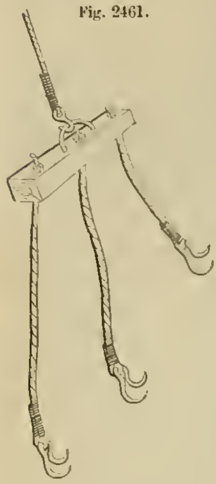


Hay-Tedder.

out of operative position when going to and from work in the field, and when at work is rotated by pinion connection to a spur-wheel in the hub of one wheel.

Hay-un-load'er. (*Husbandry.*) A device for bringing the power of a horse to bear in unloading a load of hay in stacking or mowing. The example shows a triple claw which may be made to grasp a bunch of hay, but the horse hay-fork is the usual implement. See Fork.

Fig. 2461.



Hay-Unloader.

Head. The upper end or portion of an object or of a mast, sail, page, column, etc. The other end is the *foot.*

The larger end of a thing, as of a nail, bolt, screw, cane, etc. The other end is the *point* or *tip.*

The effective portion or blade of a tool or weapon, as of a spear, axe, hammer, etc. The other end is the helve, stock, handle, according to circumstances. See Handle.

1. (*Machinery, Forging,* etc.) *a.* The striking portion of a hammer, as distinguished from the helve.

b. The *poll* of a hammer, as distinguished from the *claw* or the *peen,* as the case may be.

c. The upper or steel portion of an anvil. The surface is the *face.*

d. That stock of a lathe containing the *live-spindle.* A *poppet.* The other stock is the *tail-stock,* and contains the *dead-spindle,* — as it does not rotate. See Lathe.

2. (*Books,* etc.) *a.* The top of a standing book; sometimes gilded to allow the dust to be blown off. The lower end is the *foot.*

b. The upper end of a page or column.

c. A *sunk-head* is a blank portion at the beginning of a book or chapter.

d. The cross-beam of a printing-press.

3. (*Shipwrighting* and *Nautical.*) *a.* The forepart, *beak,* or *stem* end of a vessel, the after end being the *stern.*

b. A figure-head, or ornamental device on the prow. According to its character, it is known as a *billet-head, bust-head, family-head, fiddle-head, scroll-head,* etc.

c. The upper part of a timber in a frame. The other end is the *heel.*

d. The part of a mast between the *hounds* and the *top.*

e. The forward end of a bowsprit.

f. The top or *drum* of a capstan.

g. The flattish part of a *dead-eye* at the side of the channel or groove.

h. The upper edge of a sail. The lower end is the *foot.*

i. The fore-foot of the keel.

4. (*Carpentry.*) *a.* The top of a *door, window,* or *bay;* as a *circular* head.

b. The top-beam or ridge-beam of a bridge or trestle.

c. The square block which slips on the stem of a gage, and carries the scribe.

5. (*Founding.*) The *sprue, sullage-piece,* or *riser* on a casting, which is knocked off.

6. (*Mining.*) *a.* The end of *gallery* or *drift.* The *heading* is a passage excavated in the line of an intended tunnel.

b. The top part of a fuse, containing the priming.

7. (*Spinning.*) The system of rollers in a Drawing-frame (which see).

8. (*Hydraulics.*) *a.* The vertical hight or available fall of water from a dam, race, reservoir, standpipe, or forebay; or the difference between the hights of water inside and outside a dock-gate or lock-gate. The vertical pressure usually expressed in pounds.

b. The up-stream end of a canal-lock.

9. (*Architecture.*) The capital (*caput,* head) of a column.

10. The cover of an alembic or still.

11. (*Fortification.*) The salient or advanced portion of a work. A work covering the end of a bridge.

12. (*Coopering.*) That which closes the end of a cask.

13. The *obverse* of a coin or medal. The opposite side is the *reverse,* or *tail.*

14. The *cap* of a windmill.

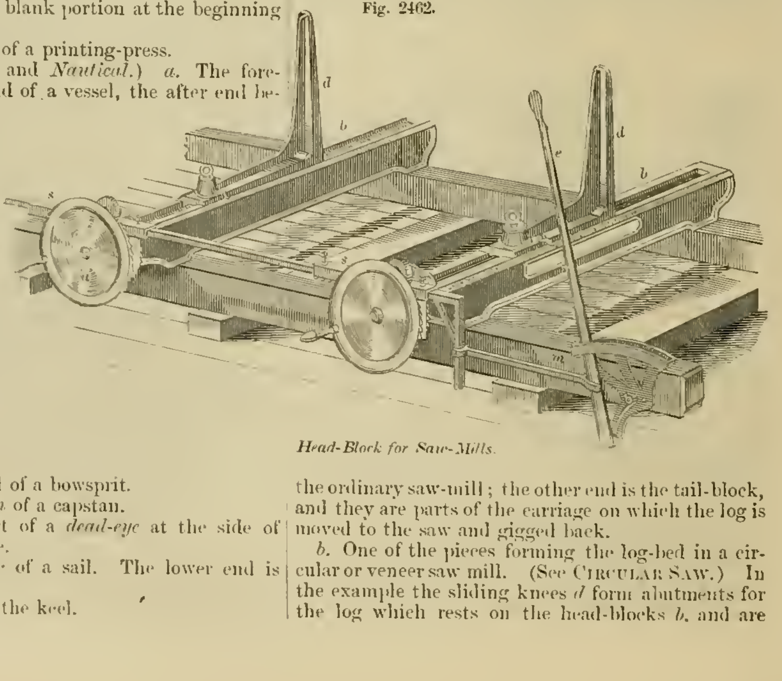
Head-band. (*Bookbinding.*) A strip of plaited silk over a mill-board core, or a projecting fillet of fabric which serves as a finish to the top and bottom of the sheets inside the back. It is only used in binding of superior character, as may be seen by comparing a fine calf binding with one in ordinary cloth.

Head-bay. (*Hydraulic Engineering.*) That part of a canal-lock between the upper pond and the head-gates of the lock. See Canal-lock.

Head-block. 1. (*Saw-mill.*) *a.* The block on which the head — or forward end — of a log rests in the ordinary saw-mill; the other end is the tail-block, and they are parts of the carriage on which the log is moved to the saw and gigged back.

b. One of the pieces forming the log-bed in a circular or veneer saw mill. (See Circular Saw.) In the example the sliding knees *d* form abutments for the log which rests on the head-blocks *b,* and are

Fig. 2462.



Head-Block for Saw-Mills.

moved by screws in the head-blocks. On the ends of the screws are the wheels *a*, which are moved simultaneously by the lever *c*, rod *m*, and racks *s s*.

2. (*Vehicles.*) A piece of wood attached below to the upper ring of the fifth wheel and above to the front spring, also having the front end of the perch mortised through its middle.

Head'er. 1. (*Bricklaying.*) A brick laid with its end or *head* in the face of the wall. It acts as a bond. Bricks laid lengthwise are *stretchers*. See BOND.

2. (*Husbandry.*) A form of reaper. See HEADING-MACHINE.

Head-fast. (*Nautical.*) A rope by which the *head* of a vessel is made fast to a quay or vessel alongside.

Head-gate. (*Hydraulic Engineering.*) *a.* One of the upper pair of gates of a canal-lock. See CANAL-LOCK.

b. A *crown*-gate, *flood*-gate, *water*-gate, by which water is admitted to a race, run, sluice, etc.

Head-gear. (*Harness.*) The bridle of a horse. The head-stall and bit.

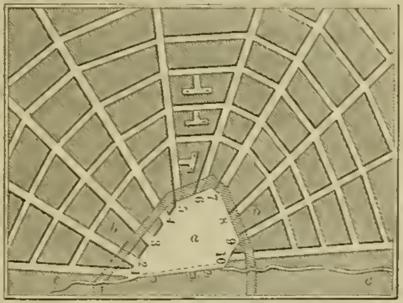
Head'ing. 1. (*Mining.*) *a.* The end of a drift or gallery, as "the *heading* is in solid rock and is *driven* by blasting and quarrying."

b. A *gallery*, *drift*, or *adit* in a mine; or in the line of an intended tunnel, especially one of relatively small size, which forms a *gullet* in which the workmen labor, and which is afterwards enlarged by extension sideways and downward to constitute a tunnel.

c. A horizontal passage between the shifts or turns of the working parties.

The illustration shows the headings driven into one of the submarine rocks which render the navigation of the East River, N. Y., so dangerous. *a* is the shaft; *b*, coffer-dam; *c*, shore line. The headings are all tunnels, and it is the intention to blow up the roof, all the rock to fall back into the cavity.

Fig. 2463.



Headings of Submarine Excavations (East River, N. Y.).

2. (*Coopering.*) The pieces which compose a cask-head. The central piece is called the *middle*, and the side pieces the *cants*.

3. (*Sewing.*) The extension of a line of ruffling above the line of stitch.

4. (*Fireworks.*) The device of a signal-rocket; such as a *star-heading*, a *bounce-heading*.

5. (*Masonry.*) A course of *headers*; the ends of the stones presented outward.

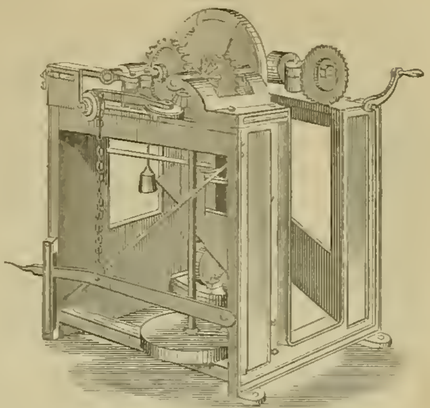
6. (*Books.*) *a.* An inscription at the head of an article, written or printed.

b. A running-title at the top of a page.

Head'ing-chis'el. A chisel for cutting down the head of a mortise. A mortise-chisel.

Head'ing-cir'cler. (*Coopering.*) A machine for cutting down and dressing the pieces to form the head of a cask. The heading stuff is clamped between two disks, trimmed circular by a saw, and dressed by revolving cutters.

Fig. 2464.



Heading-Circler.

Head'ing-course. (*Bricklaying.*) A horizontal course of bricks or masonry in which the pieces are laid with their heads in front; that is, across the thickness of the wall.

Head'ing-joint. 1. (*Joinery.*) A square or butting joint of two pieces, as of sections of hand-railing, floor boards, etc. The junction is secured by dowel, tongue, and groove, or otherwise.

2. (*Masonry.*) The joint between two voussoirs in the same course.

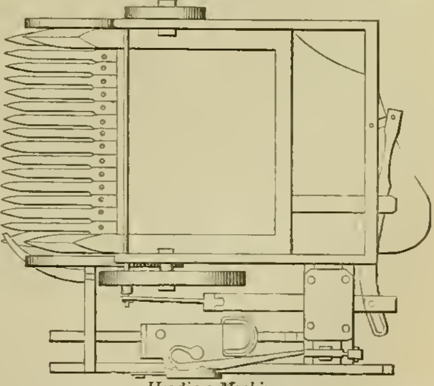
Head'ing-knife. 1. (*Saddlery.*) A round-headed knife used to cut out holes in leather, too large for the application of punches, and smaller than are conveniently made by the *round-knife*, which is the ordinary cutting-tool of the saddler.

2. The currier's knife with one straight and one cross handle, and a turned-over edge. It is used in scraping hides and reducing them to an even thickness. (Fr. *couteau à revers.*)

3. (*Coopering.*) A knife for cutting the chamfer of the head of a cask.

Head'ing-ma-chine'. 1. (*Agriculture.*) A machine for cutting off the heads of grain in the field, instead of harvesting the whole straw. The machine was tried awhile in Illinois, but its use is believed to have been abandoned except in California. The machine is now always associated with a traveling thrasher, the ripe heads of grain being cut off, thrashed, and bagged. These machines vary in their cutting apparatus; some have the reciprocat-

Fig. 2465.



Heading-Machine.

ing knife usual with reapers, a reel sweeping the heads into a well, from which they are raised by a conveyor to the thrashing-cylinder, and thence pass to the sieves and fan.

Another favorite form is a comb with long teeth of a lance shape; the comb presents its teeth towards the grain, the stalks pass between the teeth, and, reaching the narrow portion, the head is detained and torn off, or is cut off by a revolving brush, a rotating reel, or a traveling belt with scrapers.

The *header* is the oldest form of reaping-machine, and is mentioned by Pliny and Palladius. See Reaper.

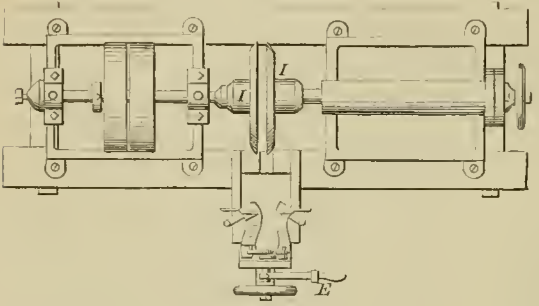
Clover-seed is also harvested in this way, the machine simply tearing off or cutting off the heads. See Clover-header.

2. (*Metal-working.*) A machine in which bolt blanks are headed by swaging between dies, or upsetting.

3. A machine for forming the heads of pins.

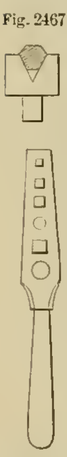
4. (*Coopering.*) A machine for making heads of casks. The *middle piece* and *cants* are jointed and doweled together and placed between two circular disks *I I*, so arranged upon lathe mandrels that the stock from which the head is to be cut is placed between the heads and clamped by screwing up the loose mandrel; when the heads are revolved, the heading passes between two adjustable arms, having the tools that cut the head to the desired diameter, and bevel the edge at the same time. These arms can be changed to cut heads of greater or less diameter by turning a graduating screw, or they can be expanded to work thicker stuff by oscillating a lever *E* that works a shaft, to which, on the opposite sides, are short levers pivoted to the arms.

Fig. 2466



Heading-Machine.

Fig. 2467.



Heading-Tools.

Head'ing-tool. (*Forging.*) A tool used in swaging heads on stems of bolts. The rod is run through the hole of the required form and size, and the projecting portion is *upset* or hammered down, forming a knob. This is brought to shape by a swage. A swage with an angle of 60° is used for making hexagonal bolt-heads. (See Fig. 2467.)

Heading-tools for nail, rivet, and brad forgers are made like nippers to open and release the nail, etc., after the head is swaged down.

Head-knee. (*Shipbuilding.*) A piece of compass-timber fayed edgeways to the stem and cutwater. A *check-knee.*

Head-ledge. (*Shipbuilding.*) One of those portions of the raised rim around the edge of a hatchway which run athwart ship. The parts running fore and aft are *coamings.*

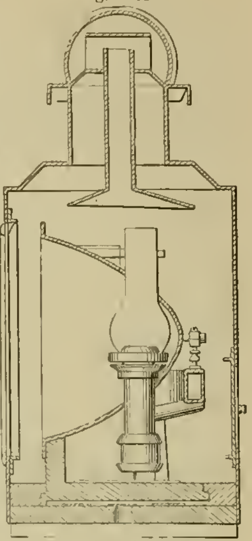
Head-light. (*Railway.*) The light carried at the front end of a locomotive, to illuminate the way and act as a signal. It has usually an oil-lamp, whose flame is in the focus of a parabolic reflector. In the example, the lamp is of the Argand variety, air being admitted to the center and around the tubular wick, while the heated air is received from the chimney by a flue above.

Head-line. 1. (*Printing.*) The top line of a page in which the running-title and folio are given.

2. (*Nautical.*) The rope at the head of a sail.

Head-mold'ing. (*Architecture.*) A molding over a door or window.

Fig. 2468.



Locomotive Head-Light.

Head-plate.

1. (*Artillery.*) The plate which covers the breast of the cheeks of a gun-carriage.

2. (*Saddlery.*) The plate strengthening the point or *cantle* of a saddle-tree.

Head-post. A stanchion by the manger, in a stable.

Head-rail. (*Carpentry.*) The upper rail, or horizontal piece of a door-frame.

Head-rest. A cushion or support against which to place the head in sitting in a car-seat or chair, or when having a portrait taken. The illustration shows a portable head-rest which may be attached to the back of a car-seat when required. The jaws of the clamp embrace the top of the seat back, and it is held in place by a strap which is passed around the back. The pad is adjustable on the bar, which is hinged to the clamp.

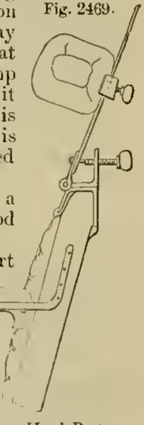
The photographic head-rest is a cushion vertically adjustable on a rod supported by a tripod.

Head-rope. (*Nautical.*) That part of a bolt-rope sewed to the head of a sail.

Heads. (*Roofing.*) Tiles which are laid at the eaves of a house.

Head-sail. (*Nautical.*) *Fore-sail.* For purposes of maneuvering ships, the sails are distinguished into *head* and *after* sails; *head-sails* comprehending all sails whose centers lie before the general center of effort of all the sails, and *after*-sails, all whose centers lie abaft that point.

Fig. 2469.



Head-Rest.

Head-stall. (*Menage.*) *a.* The bridle minus the bit and rein.

b. The halter minus the hitching-strap.

Head-stick. 1. (*Printing.*) A piece of furniture forming the margin at the heads of pages.

2. (*Nautical.*) A short, round stick, with a hole at each end, through which the head-rope of some sails is thrust.

Head-stock. 1. (*Lathe.*) That portion of a lathe which contains the mandrel or *live* spindle on which the work is chucked or to which it is dogged, in contradistinction to the *tail*-stock which contains the *dead* spindle. The *live*-head as distinguished from the *dead*-head.

2. The head which supports the cutters in a planing-machine.

Head-tim'ber. (*Shipwrighting.*) A crooked timber in the frame of a ship's head, to support the gratings. A *bracket.*

Head-valve. (*Steam-engine.*) The delivering valve. The upper air-pump valve.

Head'way. 1. The clear hight of a passageway, tunnel, gallery, doorway, arch, etc.

2. A gallery at right angles to the main passageway to the shaft of a coal-mine. A *heading.*

Healds. (*Loom.*) The harness for *shedding* the warp-threads in a loom. The *heddle.* The threads are doubled in pairs, and arranged in sets so as to shift the warp-threads as may be required for plain, twill, or figured weaving.

Heal'ing. (*Roofing.*) The covering a roof with lead, tin, slates, etc.

Heap. 1. (*Printing.*) The pile of wet paper to be fed to, or of printed paper delivered from, a press.

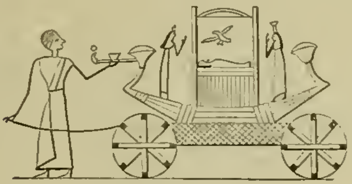
2. (*Mining.*) The refuse or sterile gangue thrown into a pile.

3. The pile of wood stacked for burning into charcoal.

Hear'ing-trum'pet. An acoustic instrument to collect a larger volume of sound and conduct it to the ear. See EAR-TRUMPET.

Hearse. A carriage for the conveyance of dead bodies. In the hearses of the ancient Egyptians we may see traces of the fabled "passage across the lake" which separated the land of life from the land of death, and from which the Greeks derived their Styx and Charon. The legendary custom was to hold an assize at the point where the corpse was embarked, to determine whether the deceased had by his virtues or atonement merited the land of rest. When the determination was favorable, the bier was placed on the boat, which bore his remains to the city of silence. In after times, — as it would seem, — when no lake intervened, the bier or body of the hearse was made to represent a miniature boat, with liliputian rowers, and was mounted on four wheels, or on runners. Instances of both occur in the sepulchral paintings, and the car is shown drawn by oxen or men, and sometimes by both. The Greeks preserved a portion of the legend, turned the practical into the mystical, as usual, in time forgot all about the moral, and degraded the grand assize into a morose old waterman, a great stickler for pennies, and not afraid of ghosts.

Fig. 2470.



Egyptian Hearse.

Hearses in England are not noticed till the time of James II. Previous to this time, bodies were carried on men's shoulders, on biers, or on horse-litters.

Heart. 1. The interior, as of wood. The solid portion divested of sap-wood or alburnum.

2. The central solid portion or core of a twisted column.

3. (*Nautical.*) *a.* A dead-eye of triangular shape, having but one eye, whose lower edge has *scores* for the lanyard which hauls taut the backstay occupying the outside *groove.*

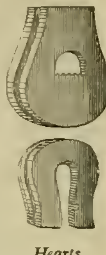
Collar-hearts are open at the lower ends; a double score is cut round the outside, and two grooves on each side for the seizing, which keeps the collar in the scores of the heart.

b. The inner part of a shroud-laid rope.

4. A heart-shaped wheel or cam used for converting a rotary into a reciprocating motion. See HEART-CAM.

Heart-bond. (*Masonry.*) A bond in which no header-stone stretches across the wall, but two headers meet in the middle, and their joint is covered by another stone laid *header* fashion.

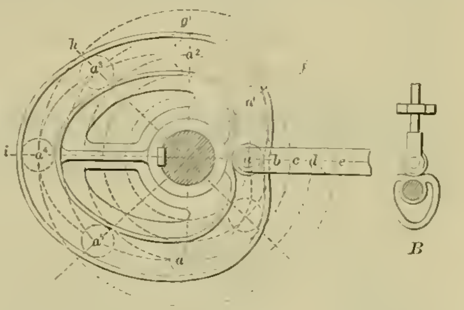
Fig. 2471.



Hearts.

Heart-cam. A form of cam which serves for the conversion of uniform rotary motion into uniform rectilinear reciprocating motion. The principle of its construction is, that for each successive equal part of one half revolution of the cam, the rod must have been moved by its periphery through a corresponding equal part of the entire stroke. If $a\ c$ represent the stroke required, then divide the same into any number of equal parts, $a-b$, $e-d$, $d-c$, and describe from the center of rotation circles passing through these points of division; divide half the circumference of these into as many corresponding equal parts, and draw radial lines through the points of division $e\ f\ g\ h\ i$, then $a^1\ a^2\ a^3\ a^4$ will represent the successive positions of the point of the rod as the cam revolves, and of course for the return stroke these divisions will recur in the reverse order. To lessen the friction, the rod is provided with a roller, to suit which two equidistant curves are made, forming a groove in which the roller runs.

Fig. 2472



Heart-Cam.

Hearth. 1. (*Metallurgy.*) The floor in a reverberatory furnace on which ore, metal, etc., is exposed to the action of the flame from the furnace. The hearth has a domed ceiling, and is divided from the furnace by a *bridge,* over which the flame passes. See REVERBERATORY-FURNACE.

2. The floor of a fireplace.

Hearth-brush. (*Domestic.*) A small hair broom for brushing up ashes and tidying around the hearth of an open grate.

Hearth-ends. (*Metallurgy.*) Particles of unreduced lead ore, expelled by decrepitation and the blast from the lead smelting furnace. This becomes mixed with lime and fuel used in smelting, and is collected from time to time, is washed to remove earthy particles, and then smelted.

Hearth-plate. (*Metallurgy.*) A cast-iron plate forming the sole of the hearth of a forge or refinery furnace.

Heart-wheel. This is one form of cam-wheel, which acts by a regular impulse and recession to reciprocate the object against which it impinges. (See HEART-CAM.) *B* shows a vertical bar or rod which is raised by the heart-wheel as the point of the heart ascends, and conversely, returning by gravity; keeping constantly in contact with the face of the cam.

Heat. (*Forging.*) *a.* The mass or piece of iron undergoing forging. Where it is made from the end of a rod or bar, the latter is called the *porter*, and forms the handle. When the mass is heavy, a long iron rod is welded to it in continuation of its axis. The mass is then swung from a traversing crane and is guided by the *porter-bar*.

b. A single exposure to the fire, as "to make a weld," or "to shape a horseshoe at a *single heat*."

c. Latent heat "is the heat which is absorbed by bodies in passing from one state to another, but it does not manifest itself by producing an increase of temperature, and is on this account called *latent* heat. . . . . A pound of water at 212° mixed with a pound of *water* at 32° gives two pounds of water at 122°, the mean of the two components; if, however, a pound of *ice* at 32° be mixed with a pound of water at 212°, we have two pounds of water at 51° only, ... the difference being equal to that required to raise two pounds of water through a range of 71° . . . . representing the heat required to liquefy one pound of ice." — BALFOUR STEWART'S *Treatise on Heat.*

It was discovered by Black, and was taught by him in 1762.

d. Specific heat is the quantity of heat required to raise the temperature of a body of a given weight 1°; the unit of measure being the quantity required to raise the same weight of water to the same temperature.

Degrees of heat are noted by the THERMOMETER or the PYROMETER (which see).

In practice the degree is frequently noted as *red* heat, *cherry-red*, *white* heat, *welding* heat, and so on. See FUSING-POINT.

Heat-en'gine. A thermo-dynamic engine in which motive power is produced by the development of heat. Such are steam and hot-air engines, and others which are effective by the explosion of gas, etc. See AIR-ENGINE; STEAM-ENGINE.

Heat'er. 1. A stove or furnace for warming a building, dry-house, or some portion of a machine, as a calendering apparatus in a paper-mill, etc. See list under STOVES AND HEATING-APPLIANCES.

2. A block of iron, made red-hot in a fire, and then placed in an urn or smoothing-iron.

3. A pan in which the juice of sugar-cane, or the water gathered from the maple, receives a preliminary heating before reaching the evaporating-pan.

Heat'ing-ap'pa-ra'tus. See specific list under STOVES AND HEATING APPLIANCES.

The various contrivances employed for warming buildings may be classed under: —

Methods of Warming independently of Ventilation.

1. By close stoves, the heating surface being either of iron, earthenware, or soapstone.

2. By hot-air flues, passing under the floors, or around inside the walls.

3. By a system of endless pipes heated by a current of hot water from a boiler, the circulation being caused by the cooling, and consequently greater weight, of the water in the lower or returning pipe.

4. By steam pipe and radiators.

5. By gas.

Methods of Warming combined with Ventilation.

6. By open fires placed in the several apartments.

7. By causing air, which has been previously heated, to pass through registers into the several rooms.

In the time of Seneca a large stove, or several smaller ones, was constructed in a cellar beneath the living-apartments, and the flue conducted into dining-room and bedchambers. It is probable that the plan resembled some of our green-house arrangements. It was originally used by the Romans in their baths, the *calidarium* being heated by the flues of the fire by which the warm baths were prepared. (See HYPOCAUST.) These caliducts were, no doubt, of various kinds, the architects and engineers of the Imperial City being very skillful and thorough; but it was no doubt true of Italy at that day, as it is at the present, that the provision of means for artificially heating apartments was lamentably deficient. Chimneys were almost unknown. The references to these are very scant and few. See CHIMNEY.

The Italian architect, Palladio, who wrote at A. D. 1560, thus writes of the heating arrangements of the ancient Romans: —

"The Romans were sensible that a continual flame and a great heat from live coals were hurtful to the eyes; they therefore went very wisely about finding out a remedy. They found how dangerous it was to carry fire about the house from one room to another. Stoves are an abominable invention: they cause a continual stench, swell the head, and make men drowsy, dull, and lazy. Most people that use them grow tender and weak: some cannot stir out of these rooms all the winter. The ancients used to light their fire in a small furnace under the earth. Thence they conveyed a great many tubes of different sizes into all the different stories and rooms of the house, which tubes or pipes were invisible, but laid in the thickness of the walls and ceilings, just like water-pipes. Each of these opened at that part of the furnace which joined to the wall of the house, and through these ascended the heat, which was let in whenever they had a mind it should, whether in dining-rooms, bedchambers, or closets, much in the manner as we see the heat or steam of water contained in an alembic to ascend and warm the parts most distant from the fireplace. The heat in that manner used to spread so equally that it warmed the whole house alike. It is not so with chimneys or hearths; for if you stand near, you are scorched; if at any distance, you are frozen; but here a very mild warm air spreads all around, according as the fire that warms the pipes laid along the wall opposite to the hearth is more or less burning. Those pipes which dispensed the heat did not open into the furnace itself, in order that neither smoke nor flame should get into them, but only a warm steam should enter, which they let out again; thereby creating a continual moderate heat. The fire needed not to be large, provided it was continual, to supply those confined and enclosed pipes with a sufficient power of warming. They dressed their meat at the mouth of the furnace; and all along the walls were disposed kettles, or other vessels, filled with hot water to keep the meat warm."

From this it would appear that the conduits were actually hot-air pipes, and not flues; the heated current in the pipes proceeding from a chamber around the furnace, but not contaminated by the gaseous and sooty results of the combustion of fuel.

In the partially exhumed city of Pompeii there are some traces of the conducting of heat by pipes from the bath-room to the triclinium and other private apartments. Heating by braziers was, however, the ordinary practice when artificial heat was needed, and there are many days in the year when the climate of even Southern Italy is anything but salubrious.

The Chinese call a stove which is heated by a furnace a *kang;* in the *ti-kang* the flue runs under the floor or pavement of the room; the *kao-kang* is used for heating their sleeping and sitting places. In the *tong-kang* the heating flue is carried along the floor, with openings from it at which the heated air and smoke ascend into the spaces of a hollow wall, thus nearly approaching the principle of the chimney.

A *tong-kang* was erected in 1761 by Sir William Chambers for heating the orangery at Kew Palace, near London.

In imitation of the Chinese method, he introduced heated air through an air-pipe or flue in contact with the heating flues.

The method of obtaining warmth in Persia is by means of a large jar, called a *kourcy,* sunk in the earthen floor, generally in the middle of the room. This is filled with wood, dung, or other combustible; and when it is sufficiently charred, the mouth of the vessel is shut in with a square wooden frame, shaped like a low table, and the whole is then covered with a thick wadded quilt, under which the family, ranged around, place their knees to allow the hot vapor to insinuate itself into the folds of their clothing; or, when they desire more warmth, they recline with the quilt drawn up to their chins. The immovable position necessary for receiving the full benefit of the glowing embers is inconvenient; and the effluvia from the fuel is nauseous and deleterious. The *kourcy* also serves for an oven, and the pot is boiled on its embers. This rude and unwholesome method is adopted in the noblest mansions of the cities, as well as in the dwellings of the poorer classes; only, in the former, a more agreeable fuel is burnt, and the ladies sit from morning till night under rich draperies spread over the wooden cover.

The palace of the Khalif of Cordova, A. D. 1000, was heated by hypocausts in the vaults below, the warm and perfumed air being conducted by earthen pipes or caliducts in the walls, and discharged into the apartments.

Heating by a circulation of hot water, proceeding from a boiler and returning thereto in a comparatively cool condition, was invented by Bonnemain in 1777. (See INCUBATOR.) In 1816 a conservatory at Brompton, England, was thus warmed. See CALORIFÈRE; HOT-WATER HEATING-APPARATUS.

James Watt, in 1784, heated his study by a steam box or heater made of sheet-iron, the plates 2½ by 3½ feet and 1 inch apart. This box had an air-escape cock, a steam-induction pipe, and a water-escape. It was supplied by the boiler of the establishment.

The experiment was repeated by a system of copper pipes, under Hoyle's patent, 1791. The steam ascended to the top of the building and passed downward.

Lee of Manchester erected a heating apparatus of cast-iron pipes, which also served as supports for the floor. This was constructed by Boulton and Watt in 1799.

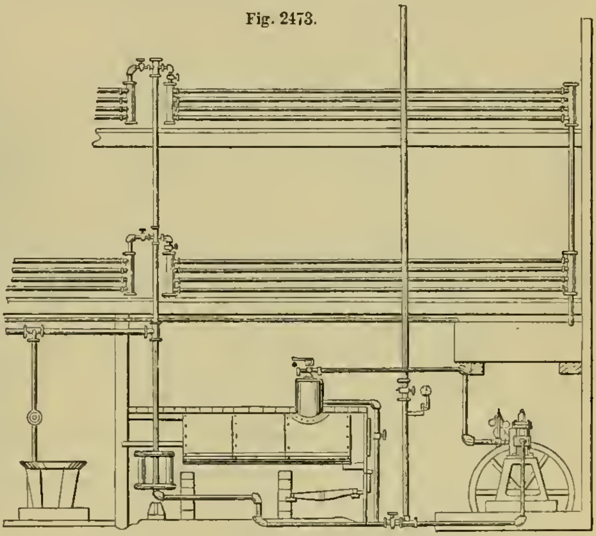
Fig. 2473 shows one form of steam-heating apparatus, in which exhaust steam from the engine is conducted to a heater back of the second fire bridge, and thence by a stand-pipe to the sets of pipes on the different stories of the building.

Gas has been used for warming, sometimes in connection with plates exposed to the jets, and sometimes has been adapted to the ordinary fireplaces where the perforated coil is disposed in a manner resembling grate-bars. Goddard's gas-heater, English, is of the latter description, and asbestus is spread over the bars so as to afford a mass of material capable of preserving incandescence, and affording radiation without consumption.

Warming apartments by hot air, as has been stated, was practiced by the Romans.

The modern mode is by a furnace in the basement story; air from the outside is admitted to a chamber around the furnace and conducted by pipes to the auditorium of the church or to the hall and apartments as the case may be.

Fig. 2473.



Steam-Heater.

The effectiveness of the hot-air current is materially interfered with by the opening of external doors and windows, the circulation depending upon the ascent of the rarefied air.

In the Reform Club House in Pall Mall, London, the circulation is secured by a large fan rotating in a cylindrical case and driven by a steam-engine of 5-horse power in the basement. 11,000 cubic feet of air per minute are forced through a tunnel and then through a cellular steam-heater, where it acquires a temperature of from 75° to 85° Fah. From a brick chamber it passes by pipes to the various apartments, where it is admitted by dialed registers. See HOT-AIR FURNACE; VENTILATION.

Dr. Arnott calculated the quantity of heat-radiating surface necessary to warm a room in winter to 60° when the external temperature is 22°, to be a foot square of surface heated to 200° for every six feet of glass, as much for every 120 square feet of wall or ceiling, and as much also for every six cubic feet of air escaping per minute by ventilation. See GRATE; FIREPLACE.

Heat'ing-pan. 1. A flat pan with stirrers, in which linseed meal is warmed before being bagged and pressed.

2. The first pan into which sugar-water of the maple, or the juice of the sugar-cane, is warmed before dipping or running into the evaporator.

Heat'ing-stove. The stove of Russia, Poland, and Northern Germany consists of a combustion-chamber and a number of reverting flues in which the heated current gradually parts with its caloric. The fire-chamber is surrounded by a good non-conductor of heat, and the heated products of combustion are retained within the stove as long as possible, in order to communicate the greater part of their heat to the stove, and thence to the air of the room.

This is effected by an arrangement similar to that shown at *A* (Fig. 2474), in which the lower space represents the fire-chamber, at the back of which is an upward passage *b* for the flame and smoke, which are successively diverted on their upward course by the partitions *d e f g c*, passing through their openings until discharged through the opening *h*, which is controlled by a damper.

These stoves are mounted on pillars, are made narrower toward the top, and are not placed in contact with the wall, so as to expose their whole heated surface.

In other cases they are built within partition walls, so as to heat two apartments at the same time. The fronts of these stoves are frequently quite ornamental, being built up into several stories of white porcelain in tasteful designs, and having polished brass doors.

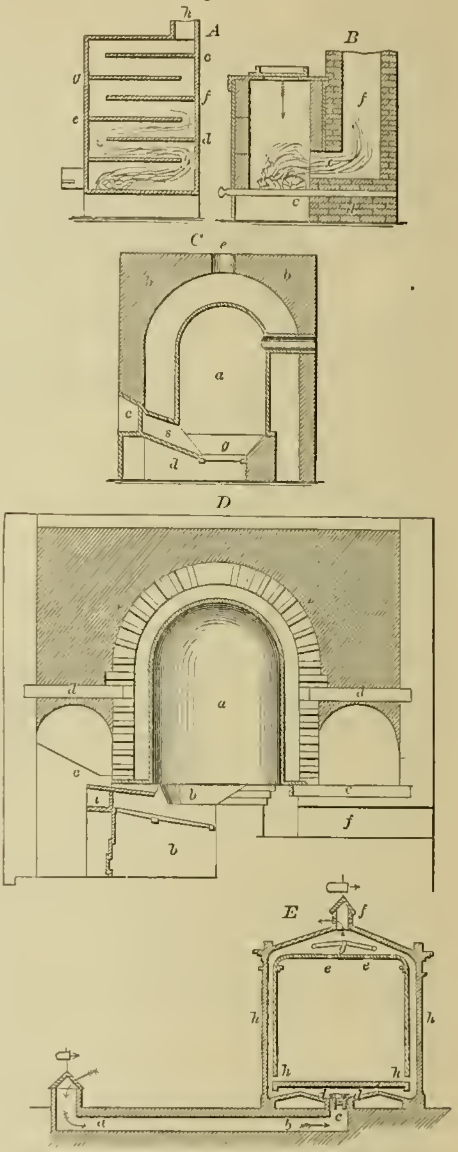
Beaumont's English stove (*B*) acts by a downward current. Two iron plates *e* are laid upon the foundation *d*, and between them is a sliding plate which covers the ash-pit. They are surmounted by a drum lined with firebrick and having a flue *x*. The drum is covered with a circular plate of cast-iron, having an opening for the admission of fuel and covered by a lid, pivoted to serve as a register. On lighting the fire this is slightly opened, and though the smoke at first tends to rise that way, the heat soon determines a downward current which deflects it through the flue *x* into the chimney *f*.

The Cockle stove *C* (Ger. *Kachel*, a tile; *Kachelofen*, a tile-stove), as made by Strutt, of Derby, England, has a cylindrical iron fire-chamber *a* with flat or dome-shaped head, around which is built, leaving a certain interval, a structure *b b* of brick.

The fuel is fed at *c*, sliding down the inclined plate *s* to the grate *g*. *d* is the ash-pit and draft-hole. The heated air between the stove and its casing is admitted into the room through one or more apertures *e*. This is also known as the "Belpre" stove, as the cotton-factories of the inventor in that town were warmed by it in 1792.

D is a stove erected by Sylvester for the Derby infirmary, on this principle. *c c* are the openings leading from the exterior of the building and supplying fresh air. The *cockle a* is cubical in form, and has a groined arch dome. It is made of iron plates riveted together. The smoke passes off by a narrow passage at the base of the cockle through the flue *f*. The brickwork surrounding the cockle is built with alternate openings between the bricks. Through these apertures are inserted pipes of sheet-iron, or porcelain, so as to extend within an inch of the cockle, by which means the air to be heated may be thrown near, or in immediate contact, with the surface of the cockle, if desirable. The horizontal partition *d d* cuts off the communication between the lower and the upper portion of the air-chamber, the arched openings in the lower half *c c* being the openings of the main air-flue leading from the exterior atmosphere. The fire-room and ash-pit are shown at *b b*, and the fuel is introduced by the opening at *i*.

Fig. 2474.

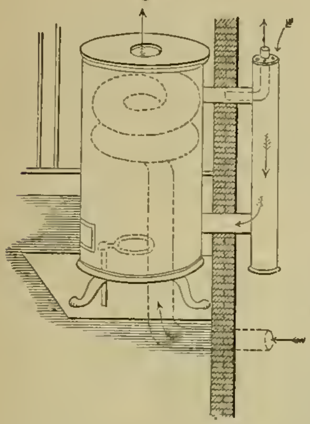


Heating-Stoves.

The air passing from the lower flues *c c* through the apertures beneath the horizontal partition, and coming in immediate contact with the surface of the cockle, finds its way into the upper air-chamber *e e* through the numerous pipes or openings of the upper division, by which circuit its velocity will be sufficiently retarded to obtain the necessary elevation of temperature from the heated cockle.

In the plan submitted by Sylvester, 1835, for warming and ventilating the Houses of Parliament (*E*, Fig. 2474), the fresh air was to be admitted through an underground channel *a b* to a cockle *c* beneath the floor of the building. It is thus heated about 15° in winter or cooled a like amount in summer. On passing through the cockle it spreads into the open space *d d*, and thence is distributed to all parts of the chamber through apertures in the floor. The ascending vitiated air, passing through openings *c c* in the ceiling, is discharged through the turn cap *f*, the opening of which is always opposite the wind. Heated pipes *g* near the roof were to insure a sufficient upward draft. When necessary to obtain a greater heat the apertures in the ceiling are closed, and the air escapes through openings in the walls *h*.

Fig. 2475.



Gas Heating-Stove.

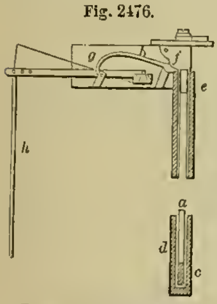
Fig. 2475 is a gas-heater. The cold air entering through the bottom is heated during its passage through the coil by annular gas-jets, and discharged into the room through the opening above. The products of combustion within the smaller drum are partly discharged through a small upward pipe, and the rest, in conjunction with a small quantity of cold air admitted through the apertures above the drum, is reverted, passing downward to aid in keeping the larger drum warm.

Heat′ing-sur′face. (*Steam-engineering.*) The fire-surface or amount of surface exposed on one side to fire and the other to water. The allowance is from 11 to 18 square feet per horse-power.

Heat′ing-tube. (*Steam.*) A water-tube in a steam-boiler surrounded by flame and connecting at each end with a water-space.

Heat-reg′u-la′tor. A device invented by Bonnemain, to keep up an equable heat in his INCUBATOR (which see). An iron rod *a* is tapped at its lower end into a brass nut *c*, inclosed in a leaden box *d*, terminated above by a brass collet *e*. The greater expansibility of the lead causes it, when the heat rises to the desired point, to elevate the collet *e*, which presses against the shorter arm of the bent lever *f g*, to the longer arm of which is connected a rod *h*, and serves to open or close a register that admits air to the fire. The instrument is provided with a dial graduated to indicate if there is an excess or deficiency of heat. See THERMOSTAT.

Fig. 2476.



Bonnemain's Heat-Regulator.

Heave. (*Nautical.*) *a.* To careen a vessel and expose the hull below the water-line, for the purpose of cleaning or repair. Known as *heaving-down* or *heeling*.

b. To haul on a rope or cable.

c. To cast the lead in sounding.

The term is frequently compounded; as, —

To *heave in stays;* to bring a ship's head to the wind. To *heave down*, to careen.

To *heave astern;* to draw the vessel aft.

To *heave and set;* to ride hard.

To *heave short;* to bring the ship above the anchor.

Heav′er. (*Nautical.*) A handspike.

Heck. 1. (*Weaving.*) A device through which the yarns pass from the warping-mill to the reel on which they are wound in order for transference to the warp-beam of the loom. The *heck-box* slides vertically on a bar as the reel rotates, and thus disposes the warp spirally on the reel.

The *heck* consists of a series of steel pins with eyes, through each of which one thread passes. The *heck* is in two parts, one a little raised from the other. The eyes of the parts being alternate, by raising one of them a little, the *bands* of the warp are separated; when the other part of the *heck* is raised, the position is reversed, the former upper band becoming the lower. This produces the *lease*, which is tied up, to form a guide for setting in the loom.

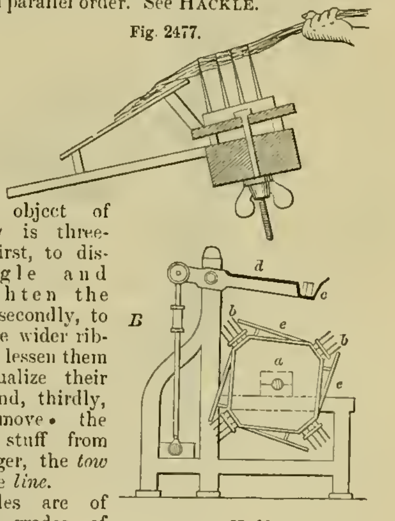
2. The *fly* of a spinning-wheel.

3. A fish-trap.

Heck-box. (*Weaving.*) A box suspended between the *travers* on which the bobbins of warp yarn are mounted, and the warping-frame on which the yarns are wound. Its duty is to divide the warp threads into two alternate sets or *leas*, one set for each *heald* or *heddle*. Also called a *jack*. See WARPING-MILL.

Heck′le. A board with sharp steel wires over which flax or hemp is combed, to clean, split, and arrange the fibers in parallel order. See HACKLE.

Fig. 2477.



Heckle.

The object of *heckling* is threefold: first, to disentangle and straighten the fibers; secondly, to split the wider ribbons, to lessen them and equalize their size; and, thirdly, to remove the shorter stuff from the longer, the *tow* from the *line*.

Heckles are of various grades of fineness, but the finer have shorter and more slender teeth; the grades are known as the *ruffer*, *common* 8, *fine* 8, 10, 12, 18; in allusion to the number of pins in a row. The pins are driven through a tin-covered board, which is clamped to the bench in a backwardly slanting position, as shown in the illustration. The bunch of flax, known as a *strick*, is thrown upon the *heckle* and drawn towards the operator, a sloping board at the back preventing its penetrating too far. One end being dressed, the *strick* is reversed in the hands of the operator, and the other end is *heckled*.

From 100 pounds of well-cleaned flax, 45 to 50 pounds of *heckled line* are obtained by hand labor of twelve hours.

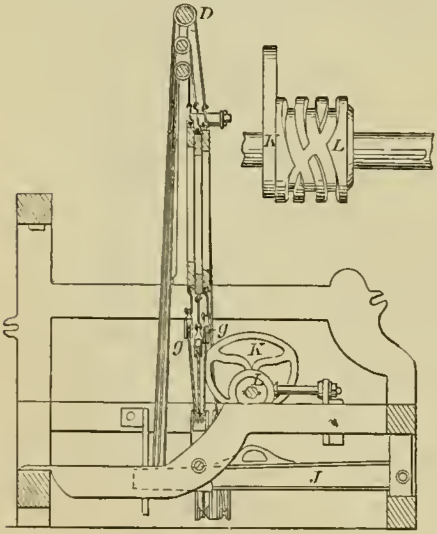
Heck'ling-ma-chine'. A machine for *heckling*, that is, separating the fibers of flax. The illustration (*B*, Fig. 2477) shows one of the earliest forms, designed to imitate the process of hand-heckling. It consists of a rotating square *a* with truncated corners, at which the heckles *b* are fixed. A *strick*, about four ounces of flax, previously slightly straightened and dressed, is fixed in the holder *c* on the arm *d*, which is oscillated while the heckle-carrier is being rotated. The separated fibers which collect on the heckles are removed by hand, and the strick, when thoroughly heckled on this, is again heckled on a similar machine with finer teeth. *e e* are back-boards limiting the depth of penetration.

A machine in which the strick of flax was made to vibrate over fixed teeth, so as to heckle the two sides at once, has also been employed.

Machines in which the strick was held over an endless band provided with heckle teeth, or drawn between two such bands, have been used to a considerable extent. The machine now in general use consists of an exterior drum, at the periphery of which are placed removable holders; this has a slow rotary motion, while rapid revolution is imparted to a toothed drum within; the flax hanging down from the holders is, when sufficiently heckled on one side by these teeth, removed, turned, and heckled on the other side.

Hed'dle. (*Weaving.*) One of the sets of parallel knotted cords forming loops for the warp-threads; and by whose vertical reciprocation the warp-threads are shifted so as to make the *shed* for the passage of the shuttle. The heddles, with their appliances for moving, constitute the harness. See HARNESS.

Fig. 2478.



Heddles.

Heddles are a necessary integral feature of all looms, having sets of strings for separating the warp-threads into two or three groups, between which the weft is passed. This is called *mounting the loom*, and consists in dividing the warp among the *leaves of healds* or *heddles*.

In *plain weaving* but two heddles are required, which raise and depress alternate threads; but in twills the *heddles* are equal in number to the number of threads contained in the interval between two intersections of the warp and weft. In *blanket twill* every third thread is crossed. In finer fabrics the threads intersect each other at intervals of 4, 5, 6, 7, or 8 threads. In full satin twill there is an interval of 15 threads. With the Jacquard the devices rise to the highest order of merit. See JACQUARD.

In the illustration, the twilling-cam *K* depresses such one of the set of levers *J* as is beneath it for the time being. The cam *K* is attached to a circumferentially grooved hub L, which slides on the shaft *y* and is controlled in its motions by a switch, so that the motions of the heddles *g g* follow in proper sequence. The heddles are suspended by cords which pass over a roller *D* and down to the levers.

Hed'dle-eye. (*Weaving.*) The loop in a heddle through which the warp-thread is passed.

A glass ring in the eye is known as the *mail of the heddle*.

Hed'dle-hook. (*Weaving.*) A hook used in heddling the warp-threads.

Hed'dling. (*Weaving.*) Drawing the warp-threads through the *healds* or *heddles*; a weaver's harness.

Hedge-bill. (*Husbandry.*) A cutting-tool used in making stakes for repairing and for trimming hedges. See BILL-HOOK.

Hedge-clip'per. (*Husbandry.*) A favorite device for dividing land into fields, especially where lumber and stone are scarce. For obvious reasons, the thorn has been a favorite for this purpose; Micah (vii. 4) says, "Sharper than a thorn hedge." It is yet the ordinary fence in Palestine.

The relevancy of the subject here arises from the fact that tools and machines are made for planting, training, and trimming hedges.

Thorns for hedges were used by the Greeks 1000 B. C. Homer represents Ulysses as finding Laertes digging, and preparing to plant a row of quick-sets.

"The art of clipping trees," says Pliny, "was invented by C. Martius, a friend of the late Emperor Augustus, within the last eighty years" (A. D. 79). He had not seen the beautiful gardens of Egypt.

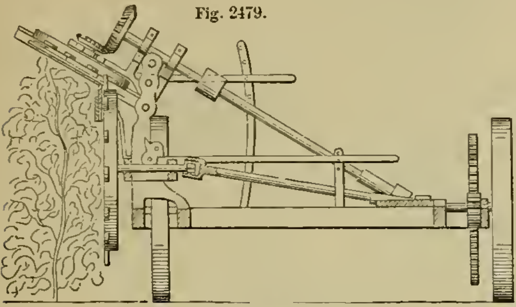
In some of the principal apple counties of England, the hedges are made of apple and pear trees trimmed to the proper proportions. In Brecknockshire, hazel is much used; blackthorn and hawthorn are also common; the latter is more used than any other hedge shrub.

The osage-orange (*Maclura*), honey-locust, and some varieties of thorn, are used in the United States for hedges. Hawthorn is the favorite in England, but does not stand our climate. Ornamental hedges are made in this country of privet, althea, spruce, arbor vitæ, rose, and occasionally a pear or other trees and shrubs. In England, the laurel, laurustinus, arbutus, Portugal laurel, bay, and other beautiful evergreens are used, but they do not so well suit this climate.

Hedges are planted in single or double rows, the latter from eight to twelve inches apart. The plants about the same, except that in single row they are at a distance of six inches. The maclura or osage-orange is the favorite, and has a great tendency to run up. It must be clipped savagely to make it spread below, allowing it an extra three inches of hight at each of the three clippings during its first year's growth. In succeeding years it may be allowed to advance about a foot a year, and at the end of five years it should be five feet broad at bottom and five feet high, slanted on each side to a central ridge. A first-rate fence is horse-high, pig-tight, and bull-strong.

Planted in a single row, six inches apart, a mile of hedge will take 10,560 plants. A double row — the plants eight inches apart in the rows — will take 15,840 plants. A fence eight rails high, staked and double-ridered, will, for the same distance, take 7,680 rails. Board fence, five boards high and the posts six feet apart, will take 1,173 posts and 13,200 feet of lumber, the boards being six inches wide and one inch thick. To this latter calculation add the value of the nails; and in each mode of fencing consider the first cost of putting in order and the subsequent wear and tear, and the cost of renewal of the rail and board fences, and of clipping the hedges.

Fig. 2479.

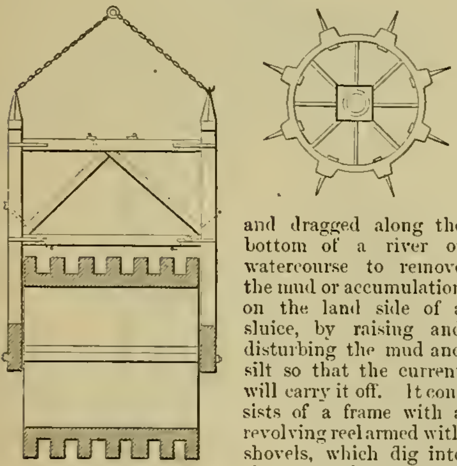


Hedge-Clipping Machine.

Hedge-clipping tools are usually shears (see HEDGE-SHEARS); but machines are made which pass alongside the hedge and, by their revolving cutters, trim it to the shape to which the cutting apparatus is adjusted, as in Fig. 2479.

Hedge'hog. (*Hydraulic Engineering.*) A machine attached to the stern of a steamboat or barge, and dragged along the bottom of a river or watercourse to remove the mud or accumulation on the land side of a sluice, by raising and disturbing the mud and silt so that the current will carry it off. It consists of a frame with a revolving reel armed with shovels, which dig into the mud and spade it up as it is dragged along.

Fig. 2480.

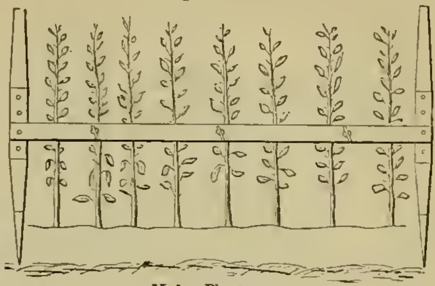


Hedgehog.

The frame is of 4 × 6 oak scantling, braced, and diagonally bolted. The spades are 4 inches wide, 7 inches long, and 7 inches apart. In some cases it is hauled by capstan and tackle, or moved by the current.

Hedge-plan'ter. (*Husbandry.*) A frame for holding plants in order as to distance and position while being set in the furrow prepared for them. The plants are clamped and supported at their proper relative distance between adjustable bars which engage perforated plates in the posts.

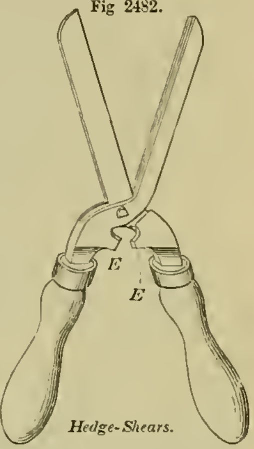
Fig. 2481.



Hedge-Planter.

Hedge-shears. (*Husbandry.*) A large scissors for trimming the rampant growth of hedges. In the example, the blades are for the shearing action, and a more powerful cutter *E E* is provided for stray stalks.

Fig 2482.



Hedge-Shears.

Hedg'ing-tools. (*Husbandry.*) The implements for hedging are thus enumerated by English authority. The items may be useful.

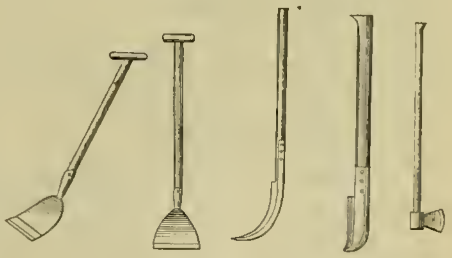
A scuffle hoe; blade 7 inches long, handle 5 feet long.

A hedging spade 3¼ feet long, blade 6 inches wide.

A hooked cutting-tool; blade 9 inches long, 1½ inches broad; shaft 2¼ feet long; weight, 2¼ pounds.

A heavier bill-hook for cutting stems; blade 7 inches long, 2½ inches broad; handle 2½ feet long. Tool weighs 6 pounds.

Fig. 2483.



Hedging-Tools.

A light axe weighing 3 pounds; helve 3 feet long.

Heel. A term as opposed to *toe.*

1. (*Shoemaking.*) A block built up of pieces of leather, and serving to elevate from the ground the rear portions of the boot or shoe.

Heels are usually made of several thicknesses of leather, called *lifts* or *taps*, which are fastened together and to the *insole* and *quarter* by pegs or nails.

Other materials are used for heels, such as, —

Wood.
Vulcanite.
Cast-iron.
Metal. Plated

Brass shells filled with wood.

Shell of leather, filled with composition of saw-dust, waste-leather scraps, and glue or resin.

Pieced heels are made of scraps approximately fitted together in a mold having movable sides, and then compressed so as to bring them to close conjunction and the required form. See Bigelow's patent, in which the *blank-heels*, built up in readiness for attachment to the boot, are punched while in a state of compression, and have the nails partially inserted ready for the final driving which fastens them to the boot. In some cases, as a substitute for the shaved *rand*, the upper lift is made basin-shaped by compression. The punching is done by a gang of awls. See also Ellis's patent of December, 1863, reissued, for punching the lifts of boots and shoes.

After the blank-heel has been made, it is placed in the socket of a machine against the boot in position, and a plunger drives the whole gang of nails at once through the insole and counter, and clenches them against the anvil which rests on the insole of the boot. Or, nails are forced through the inner sole into the heel from within; also, from the outer or wearing surface down through the heel-lifts by means of rods arranged to pass through nail-plates.

Julius Cæsar wore high-heeled shoes to increase his apparent stature. The shoe covered the foot.

2. A term as opposed to *head*.

(*Nautical.*) *a.* The after end of a ship's keel.

b. The lower end of a spar or timber, as the heel of a *mast*, of a *boom*, of the *bowsprit*, of the *stern-post*, of the rudder, of a *shore*, of a spar when used as a *jib* or *shear-pole*, etc.

c. The lower end of a timber in a frame; the other end is the *head*

(*Carpentry.*) The lower end or foot of a *rafter* where it rests on the wall or plate.

(*Fire-arms.*) The upper end of the butt-end of a musket when in firing position.

The tail of a gun-lock hammer.

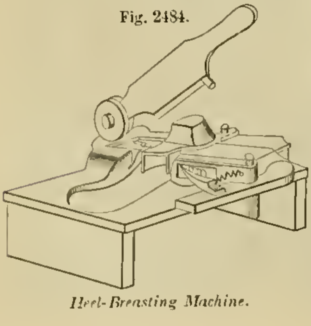
3. A lean or inclination.

(*Nautical.*) *a.* The inclination laterally of a vessel as she careens under a press of sail. Allowance for the heel is made in laying guns, a pendulum being used for the purpose.

In careening the "Royal George," 120 guns, at Spithead, 1782, to get at a water-pipe which discharged below the water-line, the vessel was sunk at her moorings.

> "They made the vessel heel
> And laid her on her side."

Fig. 2484.



Heel-Breasting Machine.

b. Said of a ship when deep in the water aft. *By the heel*, in contradistinction to *by the head*.

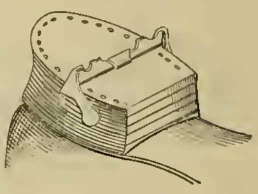
Heel-blank. (*Shoemaking.*) A set of *lifts* fastened together in readiness for attachment to a boot. A *blank heel*.

Heel-breast'ing Ma-chine'. A machine for cutting down the straight front face of a boot or shoe heel, as in the example, which has two adjustable jaws as a means of holding the heel, and a cutter and gage-plate combined with the said jaws, and a lever with pawl and rack operating on one of the jaws.

Heel-bur'nish-ing Ma-chine'. See HEEL-POLISHING MACHINE; BURNISHING-MACHINE.

Heel-calk. (*Shoemaking.*) A roughing for a heel, to prevent the slipping of the wearer on ice or slippery pavement. In the example, it consists of a strip of metal fastened to a heel by making two holes on either side of the heel. It is armed with points, and easily removable on account of its elasticity.

Fig. 2485.

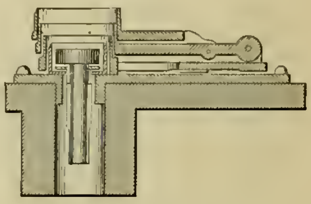


Heel-Calk.

Heel-chain. (*Nautical.*) A chain for holding out the jib-boom.

Heel-cut'ter. (*Shoemaking.*) One for cutting out the lifts which form the heel. In the example, the cutters are various in size, and are hinged to the frame, so that they can be let down over each other. The heel-lifts are cut to graduated size, and merely require beveling after attachment. The leather is placed on the cutters and forced down by blows of a wooden mallet.

Fig. 2486.



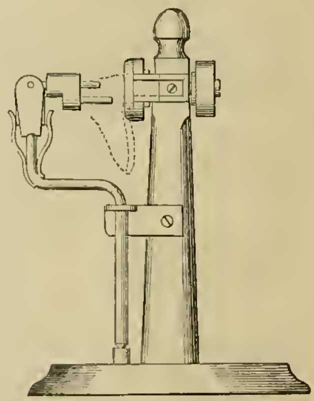
Boot-Heel Cutter.

Heel-face Dress'er. (*Shoemaking.*) One for rasping and dressing off the lower face of the heel. The boot is held by a clamp, the guides of which enter the rand, and so hold it parallel to the rotary disk-wheel which trues the face, and a burnishing-wheel which polishes the side.

Heel-i'ron. (*Shoemaking.*) A plate on the lower surface of a boot or shoe heel, to increase the durability. Sometimes put on to make a clattering, as in some fancy dances, perhaps the *cracovienne*.

Heel-ma-chine'. (*Shoemaking.*) The series of machines for this purpose are for cutting out *lifts*, or making them up of pieces and compressing them to shape; building up blank-heels by fastening together in proper order as to size the several lifts of which a heel is composed; trimming or burnishing the heels to give the required curve; *breasting*, that is, cutting down the front; cutting the seat for the heel; laying on and securing the *rands*; fastening the heels

Fig. 2487.



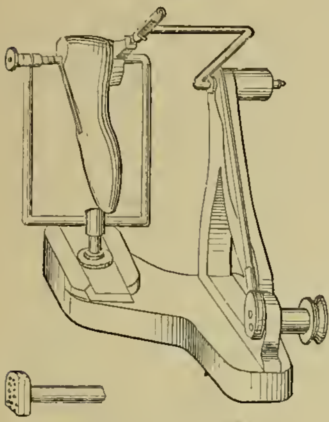
Heel-Polisher.

to the boots; dressing the heel-faces; polishing the heels; giving the stitch-marks on the upper surface along the edge. These operations are usually done by separate machines, and with great rapidity.

Heel-plate. The plate on the butt-end of a gun-stock.

Heel-pol'ish-ing Ma-chine'. (*Shoemaking.*) One for smoothing the surface of a heel after it is shaped and trimmed. There are several modes.

Fig 2488.



Reciprocating Burnisher-Machine.

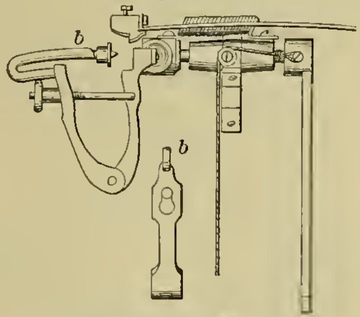
1. In the Ellis and Glidden machine, trimming and burnishing devices, actuated by a lever, move around the surface of the heel, guided by a plate having the form of the finished heel.

2. The boot is jacked and is revolved against a rotating burnisher, as in Fig. 2487.

3. The boot is clamped to the sliding frame, and the polisher reciprocated over the surface of the heel by an eccentric, whose rod is connected to the oscillating arm. (Fig. 2488.)

4. The boot is jacked, the arm *b* (Fig. 2489) reaching down the boot-leg and holding the heel to its seat. The heel is held up to the polisher, and the edge of the heel against the polisher-flange, which prevents the outer lift from spreading away at its edge while the jack is being rocked to bring the whole edge of the heel under the action of the stationary polisher.

Fig. 2489.



Stationary Burnisher-Machine.

Heel-post. 1. (*Shipbuilding.*) The post which supports the outer end of a propeller shaft.

2. That stile of a gate to which the hinges are attached.

3. The post to which a gate or door is hung.

4. The quoin-post of a lock-gate.

Heel-ring. (*Husbandry.*) The ring which is tightened by wedges and confines the scythe-blade to the snath.

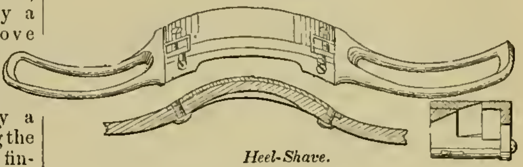
Heel-rope. (*Nautical.*) A rope for hauling on the heel of the bowsprit to run it out.

Heel-seat Cut'ter. (*Shoemaking.*) One employed to cut out the concavity in the heel to fit upon the convexity caused by the filling piece of the shank. The invention combines with a reciprocating gouge-like shank means for relative adjustment between the knife and heel-holder, adapting the same machine to cut heel-seats to fit upon different shanks.

Heel-shave. (*Shoemaking.*) A hand-tool like a *spoke-shave*, to shape the heel after the lifts of approximate shape have been fastened together.

The attaching screws of the curved blade pass through slots in the bridge-piece and allow adjustment of the blade. The guard-piece is removable, to admit sharpening of the blade.

Fig. 2490.

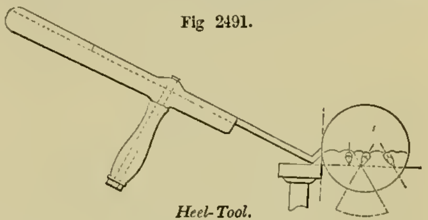


Heel-Shave.

Heel-tap. (*Shoemaking.*) One of the pieces or thicknesses of leather of which a heel is built. A *lift.*

Heel-tool. (*Metal-turning.*) A form of metal-turning tool in which the *heel* of the tool is supported on the rest. The helve has one piece which rests on the shoulder, and a handle whereby the cutting edge is adjusted as to presentation to the work.

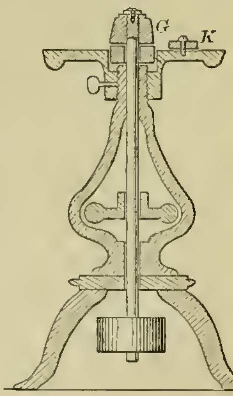
Fig 2491.



Heel-Tool.

Heel-trim'mer. (*Shoemaking.*) *a.* A machine in which the edges of the lifts are pared down so as to bring the heel to symmetrical shape. In the example, the collar limits the depth of cut made by the bur. The adjustable table board adapts the bur cutter to the varying depths of the boot-heels, and the stud or roller steadies and supports the heel while being trimmed. The shape of the rotary cutter *G* determines the contour of the heel, which is oscillated on the roller *K* to bring each part of its surface to the cutter.

Fig. 2492

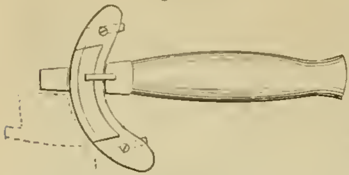


Heel-Trimming Machine.

See also HEEL-POLISHING MACHINES, which differ but slightly in construction, the principal variance being in the surface of the roller.

b. A hand-tool for shaping the curve of the heel.

Fig. 2493.



Heel-Trimmer.

A curved knife set in a shank whose lower end by contact with the lower surface of the heel forms a guide.

Heer. (*Weaving.*) The length of two cuts or *leas* of linen or woolen threads.

Hel′i-cal Spring. A spring whose coils have a gradually decreasing diameter, as the mainspring of a watch. It may lie in one plane like a fake of rope, one layer of rope as coiled up; or it may be like the architectural helix or the helix of a shell, and assume a conical form.

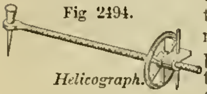
A spiral spring is a coil whose rounds have the same diameter.

A helical spring whose coils are in the same plane is used by alternately expanding and contracting in that plane, as with the pendulum spring and mainspring of an ordinary watch.

When the spring is more or less conical, it may be used either in the way just stated or by compression in the line of its axis.

Hel′i-co-graph. An instrument for describing helices. The small wheel rotates on the screw-shaft and revolves around the fixed point, moving towards or from the said center, according to the direction of its revolution; the pencil describing a helix, the distances between the intersections of an ordinate with the spiral are equal to the *pitch* of the screw.

Fig 2494.



Helicograph.

Hel′i-con. (*Music.*) A form of wind-instrument of metal, resembling a French-horn, but having keys and valves. They are made *en suite*, that is, of various sizes and compass. See Horn, *c*.

He′li-o-chrome. (*Photography.*) The name given by Niépce de St. Victor to the products of his process for photographing in the natural colors. A consummation devoutly to be wished, often announced with a flourish of trumpets and a new name, but not yet seen. Some indications yet afford a hope.

He′li-o-chro′mo-type. (*Photography.*) A sun-picture in the natural colors: long desired, partially obtained, but always fugitive — so far.

He′li-o-graph. (*Photography.*) 1. A sun-picture. *Heliography* is the name given to the art of taking *sun-pictures* by Nicéphore Niépce, who was the first to take a permanent picture. He used the bitumen of Judea on tin and pewter plates. He commenced in 1814, thus preceding Daguerre, who worked upon silver plates with the vapors of iodine and mercury. In 1829 they became associated, and thereafter they worked together. See Photography.

2. An instrument constructed by De la Rue for obtaining photographs of the sun. It is mounted equatorially. The image of the sun, 0.466 inches in diameter at the focus, is enlarged to nearly 4 inches by means of a secondary object-glass, and this image is received on a photographic plate. The sun's light is so intense that not only has the aperture to be cut down to 2 inches, but an instantaneous apparatus of peculiar construction has to be employed. When the picture is about to be taken, an opening, $\frac{1}{16}$ of an inch wide, flashes across the axis of the secondary object-glass, and the rays from the different parts of the disk pass through it in succession and are depicted on the collodion plate. — Brande.

He′li-o-graph′ic En-grav′ing. (*Photography.*) The process of Niépce de St. Victor was to coat a plate with bitumen; expose it with an engraving over it, the bitumen being, by the joint action of light and oxygen, rendered insoluble by the usual solvent. The solvent then removes the parts protected by the lines of the engraving, and the bare metal is etched by an acid.

Fox Talbot coated the plate with gelatine and bichromate of potash, and exposed it under a positive. The gelatine became insoluble where the light acted; where the film had been protected by the lines of the engraving it was washed away by water, and the lines were *bit in* by bichloride of platinum, or perchloride of iron, the other parts of the plate being protected by the film.

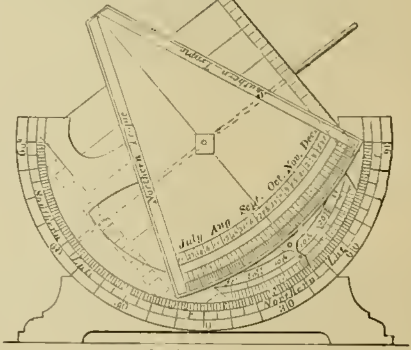
Salmon and Garnier produced another process, in which a brass plate was subjected to the action of iodine vapor and then exposed under a negative. Being then rubbed with wadding charged with globules of mercury, the latter is found to adhere only to the parts corresponding to the blacks of the negative. An ink-roller being passed over it, the amalgamated parts refuse the ink and form lights on a black ground. The variations in the process, and also those incident to the different proceedings thereafter, to fit it to be used as a copper-plate by etching, or in the manner of a lithographic stone, cannot be here detailed. See Sutton's Dict., "Photography."

He′li-om′e-ter. 1. (*Optics.*) A double object-glass micrometer (see Micrometer), called a heliometer from its being originally used for measuring the angle subtended by the sun. The telescope, in whose field it is placed, is usually of large size and mounted equatorially; that is, having two axes of motion at right angles to each other; one parallel to the axis of the earth and the other to the equator.

The instrument was suggested by Roemer about 1678, and brought into use by Bouguer about 1748. G. Chambers credits its application or improvement to De Charmères, a French naval officer of the last century.

The object-glass is divided diametrically, and the parts are capable of motion in their own planes, and through considerable intervals by means of screws, and thus their optical centers can be separated. Each half-glass forming a separate image of any object, the two images will be at an angular distance, dependent on the amount of separation of the centers of the two half-glasses. Dolland called it "a *divided object-glass* micrometer."

Fig. 2495.



Heliometer

2. A form of dial. An instrument for ascertain-

ing the solar time in all latitudes, and for ascertaining the latitude when the apparatus is set at noon according to the date. Also for ascertaining the date and length of day, sunrise and sunset, other conditions being established. Also, the differences of time between two places, the position of the earth's axis in relation to the level at the point of observation, etc. It does not admit of a brief description.

He'li-o-scope. (*Optics.*) The name given by Scheiner (1625) to an instrument of his own invention for observing the sun without hurting the eye.

Such instruments have a semi-opaque medium; shut off the greater portion of the rays; or have reflectors which transmit but a small portion of the rays.

Huyghens, in making a comparison of the intensities of the solar light and that of Sirius, employed upon the former a tube having a very small aperture at one end, into which was inserted a minute globular lens, which allowed only $\frac{1}{27664}$ part of the solar disk to be seen. He found this portion afforded a light equal to that of Sirius, and concluded that Sirius was 27,664 times more distant than the sun.

He'li-o-stat. (*Optics.*) An instrument invented by Gravesand, 1719, by which a sunbeam may be steadily directed to one spot during the whole of its diurnal period. Improved by Malus, Foucault, and Dubosq.

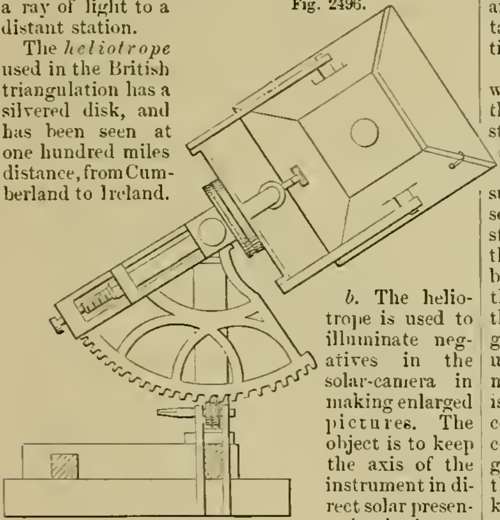
The object of the instrument is to make a sunbeam apparently stationary for purposes of experiment, obviating the inconvenience arising from the continual change of direction of the solar rays.

It consists of a plane metallic mirror, having a vertical and horizontal movement, and of a clock, the index of which moves in a plane parallel to that of the equinoctial. The extremity of the index is connected by a rod attached behind the mirror in the line of its axis. See HELIOTROPE; SOLAR-CAMERA.

He'li-o-trope. (*Optics.*) *a.* A geodetical instrument used to reflect a ray of light to a distant station.

The *heliotrope* used in the British triangulation has a silvered disk, and has been seen at one hundred miles distance, from Cumberland to Ireland.

Fig. 2496.



Heliotrope.

b. The heliotrope is used to illuminate negatives in the solar-camera in making enlarged pictures. The object is to keep the axis of the instrument in direct solar presentation by instrumental means. In the example, the optical axis of the instrument is brought parallel with the sun's rays, and kept coincident therewith by the adjustments described, a motor and a pendulum, or other time-keeper.

c. The ancient Greek *polos* or *heliotrophion* was a basin in the middle of which was a perpendicular staff or finger, whose shadow indicated on lines the twelve parts of the day; so it was a kind of dial.

He'li-o-type. (*Photography.*) Speaking generally: any process for obtaining pictures by the actinic power of the sun's rays on a prepared surface, from which to print in fatty inks. Specifically, the Edwards process developed step by step in the following way.

The action of hot water on gelatine is to dissolve it; the action of cold water is not to dissolve it, but to fill up the pores and swell it up, just as in the case of a sponge. As, after exposure to light in presence of a bichromate, hot water will no longer dissolve gelatine; so, after exposure, cold water will no longer expand it, — can no longer penetrate the pores. The light has had the effect of closing the pores, and thus rendering the gelatine water-proof. If a plate be covered with bichromated gelatine, and exposed to light under a negative, certain pores will be *completely* closed; the medium-tones will have the pores partly closed; and in the unlighted parts the condition of the gelatine will be unchanged. If this plate be steeped in cold water, some portions of it — those where light has not acted — will absorb water, and others will refuse to do so, having been water-proofed by light. On rubbing grease over the plate, the result will be that where the pores are full of water — that is, where the light has not acted — the grease will not touch the gelatine; but where the light has acted, the pores are closed, there is no water, and grease attaches itself readily; where the light has partly closed the pores, the small quantity of water absorbed does not prevent a small quantity of grease attaching itself. Lithographic ink is simply grease to which coloring matter has been added; and a lithographic roller charged with such ink, and rolled over such a plate, speedily reveals the light-produced image.

This method was discovered by Poitevin, and patented by him, as early as 1855. The process was not immediately successful, owing to the spongy and delicate nature of gelatine, the difficulty of obtaining intensity in the inking of the depressed portions, and the lack of sharpness.

Du Motay and Marechal used a very thin film in working by the Poitevin method, but failed to make the gelatine withstand the pressure. They also substituted alkaline trichromates for acid bichromates, and proposed the addition of reducing agents.

Herr Albert of Munich next produced some results by a similar method. His plan of working is somewhat as follows: instead of a lithographic stone, a glass plate is employed, of considerable thickness. On this is placed a layer of gelatine and bichromate, which, when dry, is hardened through the glass from the back, by exposure to light. On the top of this is placed a second thin coating of gelatine and bichromate; and this is exposed to light under a negative, and then hardened by chemical means. In this manner a compound printing film is obtained, having the necessary thickness to stand a certain amount of wear and tear, whilst, from its construction, the difficulty of the swelling of the gelatine is to a great extent got over; the plate is then inked and printed in the usual way. This is known as ALBERTYPE (which see.)

Edwards added to the known data, producing a film which is movable. By the addition of alum, more especially chrome alum, to the gelatine, a film can be produced consisting of a tough, tawny, insoluble substance, like leather or parchment, capable of standing an apparently unlimited amount of rough usage. Edwards discovered that gelatine might be converted into this substance, but that it still retained its property of being acted on by light in presence of a bichromate, and of receiving and refusing greasy ink. The practice is to produce by light on a sheet of bichromatized gelatine, by means of a photographic negative, the same result that is produced in lithography by drawing on a stone with a greasy ink; that is to say, where the light has acted, just as where greasy ink has been used, water is repelled; where light has not acted water is absorbed and grease repelled, and where light has partly acted, as in the half-tones of a negative, water is partly absorbed and grease partly repelled. Ordinary gelatine is dissolved in warm water, and a sufficient quantity of *bichromate of potash* is added to render it sensitive to light, and of alum to make it very hard and durable. This is poured on a level plate, previously rubbed over with wax, and is dried in the dark by means of heat. As soon as dry, or when required for use, the sheet of gelatine is stripped from the plate, and printed under a photographic negative; the side of the gelatine which has been next the glass, and which is consequently free from dust, etc., being that on which the image is obtained. When the picture appears sufficiently plain, the sheet of gelatine is taken from under the negative, and made to adhere to a metallic plate. The method of adhesion used is that of atmospheric pressure. The sheet of gelatine and the metallic plate are put together under water; as much of the water as possible is got rid of from between the two surfaces, the gelatine absorbs the remainder so that a vacuum is created, and the picture is thus attached to the plate by the weight of the atmosphere. The superfluous chemicals are soaked out with water, and the plate, with the printing-surface of gelatine attached, is placed on an ordinary platen printing-press, and inked up with ordinary lithographic ink. As in lithography, it is necessary after every impression to damp the plate with water. A mask of paper is used to secure white margins for the prints, and the impression is then pulled and is ready for issue. Two or more inks are sometimes used in the production of one picture, as it is found that where the light has acted deeply a stiff ink is required, but where it has acted not so deeply — that is, in the half-tones — a thinner ink may be used. So that a stiff ink is first used for the shadows, and a thinner ink afterwards for the half-tones. In this manner several inks may be used in printing one impression. The effect of India or other colored tint is obtained by using, instead of ordinary water for dampening the plate, water with some color in it. The paper absorbs a certain amount of water out of the plate, and with it the desirable amount of color. The ordinary rollers are not found to be satisfactory, and a mixture of gelatine, glycerine, and castor-oil is used.

Edwards's process is worked in the United States by James R. Osgood & Co., publishers, of Boston, who own the patents.

He′lix. 1. A curve generated by winding a line around in a coil of gradually increasing radius, and maintaining the same plane; or by winding the line on a cone on which it ascends in winding.

The flat watch-spring, or the *fakes* of rope in a *tier*, are instances of the *flat helix*.

The *conical helix* is shown at *w x* (Fig. 1143), and is common as a spring in bed-bottoms and upholstery.

2. (*Architecture.*) The volute under the abacus of the Corinthian capital.

The words *helix*, *coil*, and *spiral* should not be used as if they were mere synonyms. Preferably, *coil* is the generic word, and signifies a winding; a *helix* is a flat or conical coil, as just described; a *spiral* is a coil which advances in the direction of the length of its axis, like a wire which is wound around a cylinder maintaining contact therewith throughout the length of the wire so wound, and progressing in the length of its axis; the spiral is seen in the chronometer-balance (Fig. 532) and in the car-springs *m* to *v* (Fig. 1143).

Hel-len′o-type. (*Photography.*) A picture in which two finished photographs are used. One is taken very light, the paper made translucent by varnish, tinted on the back, and laid the stronger print, so that there is a combination of effects.

Helm. (*Nautical.*) The rudder and its operative parts; such as *tiller* or *wheel*.

"The ships . . . . are . . . . turned about with a very small *helm*, whithersoever the governor listeth." — James iii. 4.

When the helm is *a-starboard* the tiller is over to the right side, the helmsman looking forward.

A-port; it is to the left side.

Up; it is to the weather side.

Down; it is to the lee side.

Helm-port. The opening in the counter through which the head of the rudder passes.

Hel′met; Helm. *a.* Defensive armor for the head. *Casque*, *head-piece*, *morion*, are other names for the same thing. It was anciently formed of skins, leather, brass, iron, and still survives in the metallic and leather helmets of European armies.

Dr. Abbott's collection in New York has the helmet of Sheshonk or Shishak, with his cartouche upon it.

Herodotus states that "the Carians were the inventors of three things, the use of which was borrowed from them by the Greeks; they were the first to fasten crests on helmets, to put devices on shields, and handles on shields."

Herodotus describes (Book VII.) the following head-dresses of the nations forming the motley army of Xerxes: —

"The Assyrians had helmets of bronze or iron." Layard found some of the latter metal at Nineveh.

The Scythians had "tall, stiff caps, rising to a point." They were probably of felt.

The Ethiopians "wore upon their heads the scalps of horses, with the ears and mane attached; the ears were made to stand upright, and the mane served as a crest."

The Paphlagonians had leather helmets.

"The Thracians wore skins of foxes upon their heads."

"The Chalybes had brazen helmets, and above these they wore the ears and horns of an ox fashioned in brass. They had crests on their helms."

"The Milyæans had skull-caps of leather."

The Moschians and Colchians, wooden helmets.

The Mares had plaited leather helmets.

The Persians, soft caps.

The Lycians, hats with plumes.

Some of the Assyrian contingent wore fillets round the head, — perhaps turbans.

b. A diver's helmet is made of thin sheet-copper, furnished with eye-holes, the glass of which is protected by brass wire. It comes well down over the breast and back, and is fastened by rivets to a water-proof canvas jacket, so tightly that no water can penetrate.

To the helmet are attached the elastic tubes by which vital air is supplied to the diver and the exhausted air removed. The supply-pipe communicates above with the barrel of an air-pump, and the fresh air from above is made to impinge upon the inside surface of the glasses so as to evaporate the moisture condensed from the breath of the diver. See Armor, Submarine Diver's, page 714.

Helve. 1. The handle or shaft of a chopping-tool, such as an axe, adze, or hatchet. See Handle.

2. A tilt-hammer, used for shingling the balls as they come from the puddling-furnace.

Helve-ham'mer. A ponderous blacksmith's hammer, tripped by the helve and oscillating on bearings. A *trip-hammer.*

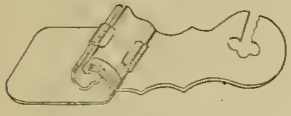
Hem'a-drom'e-ter. (*Surgical.*) An instrument for measuring the velocity of the blood in the arteries.

Hem'a-dyn'a-mom'e-ter. (*Surgical.*) An instrument for measuring the force of the current of blood in the arteries, by ascertaining the hight to which it will raise a column of mercury.

Hem'i-spheres of Mag'de-burg. Devised by Otto Güericke, 1654, to illustrate the pressure of the atmosphere. See Magdeburg-Hemispheres.

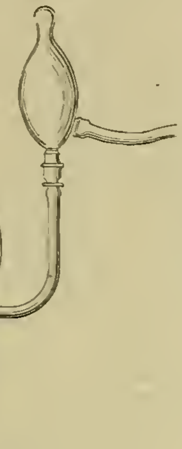
Hem'mer. An attachment to a sewing-machine for turning over the edge of a piece of fabric or a garment, in order that the flap may be stitched down. As the fabric is fed along, the edge is turned over in a curved path, and is then flattened by the presser-foot ready for stitching by the needle.

Fig. 2497.



Hemmer.

Fig. 2498.



Hemorrhoidal-Syringe.

Hem'or-rhoid'al-syr'inge. (*Surgical.*) A form of injection-syringe for the treatment of piles. In the example, the nipple on the bulb enters the rectum, and a stream of cold water is passed through the bulb, and circulates within the closed portion within the rectum.

Hemp. Hemp is not mentioned in our translation of the Hebrew Scriptures, and but sparingly in the Greek classics.

Hesiod and Homer make no mention of hemp. It is first mentioned by Herodotus: —

"Hemp grows in Scythia; it is very like flax; only it is a much coarser and taller plant; some grows wild about the country, some is produced by cultivation. The Thracians make garments of it, which closely resemble linen." — Herodotus, IV. 74. He elsewhere states that they buy it of the Northern people.

Hesychius says the Thracian women made sheets of hemp. The people of that country yet wear tunics of hemp, and some are employed in towing the boats on the Danube between Pesth and Vienna.

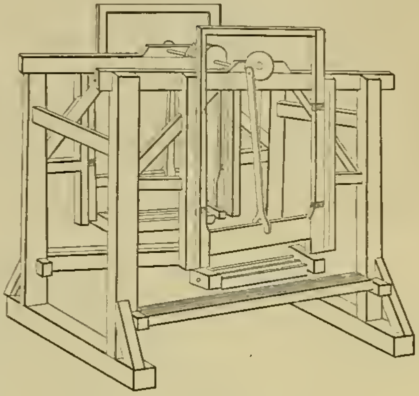
Hempen ropes were used on board the "Syracusia," built for Hiero, as recorded by Moschion. There are many other notices of hemp by later authors. It was imported in the hank or bale from the country of the *Rhodaunus*, which empties into the Vistula. The Greeks and Romans used tow for calking the seams of their vessels, but did not cultivate it before the Christian era.

Hemp was known to the Roman naturalists, but does not seem to have been used as a fiber plant. It was known to the Anglo-Saxons, and the mode of preparing and beating it is given by Strutt. Hempen cloth became common in Middle and Southern Europe in the thirteenth century.

For specific list of appliances in the treatment and manufacture of hemp and other fiber, see Cotton, Flax, Wool, Hemp, etc., Appliances.

Hemp-brake. A machine in which rotted and subsequently dried hemp-stalks are beaten to remove the bark and cellular pith from the fiber. Among the forms of the machine may be noticed the simple sword or slats driven between two slats set edge up; the hemp is laid crossways of the slats, and is violently bent by the blow, cracking off the scale of bark and powdering the pith.

Fig. 2499.

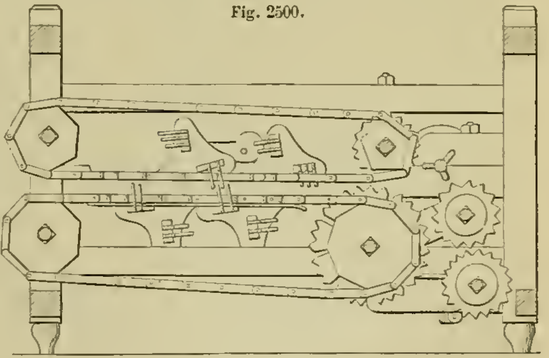


Hemp-Brake.

In Fig. 2499 the slats of the reciprocating portion and of the bed are arranged in gangs, to break the stalks which are laid crossways between them. The brake is in a gate which moves in guides by means of a pitman from a wheel above.

Other forms of brakes have rotatory motion. A series of fluted rollers whose projections interlock like cogs. Slatted interlocking cylinders. Planetary systems of fluted rollers, operating on beds of fluted rollers. In the example, the hemp is passed between braking rollers and thence is carried forward by and between endless slatted carriers, where it is broken by the action of oscillating beaters above and below, whose teeth strike it in concert between the bars of the carriers.

Fig. 2500.

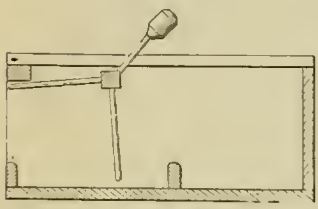


Hemp-Brake.

Hemp-har′vest-er. (*Agriculture.*) A reaping-machine for hemp. Hemp-harvesters resemble those for corn in their adaptation to operate upon tall top-heavy stalks, but as the stalk of the hemp is the valuable portion, the machine is made to cut low. One form of the machine is a puller which grasps the stalks near the ground and uproots them. Among the varieties of machines may be cited a low platform on wheels, with a cutter-bar in front, a reel to gather them to the knife and direct them over into a cradle where they are collected in a bunch. In another form, the stalks are caught by an arm till a shock is collected. In another, the stalks fall on an obliquely traversing apron which conducts them laterally and discharges them upon the ground out of the way of the horses the next time round. A stalk-puller consists of a pair of revolving disks on axes set at an obtuse angle with each other, so as to grip the stalks which are conducted between them at the lowest part of their revolution, and then open as they rotate and allow the stalks to fall into a cradle or on to the ground.

Hen's-nest. A box which furnishes a place for a fowl to lay her eggs. Contrivances have been suggested more curious than useful, and some so complicated that only well-trained hens could be expected to occupy them, and not then if in a hurry. The example has a pivoted or suspended door, counterpoised and arranged in such a manner that but one hen can enter and sit upon the nest at once. The object is to prevent hens laying eggs in the nests of setting hens, and also to prevent one hen from driving another off the nest.

Fig. 2501.



Hen's-Nest.

Her-ba′ri-um. A collection of dried plants.

Aristotle is considered the founder of the philosophy of botany, 347 B. C. The "Historia Plantarum" of Theophrastus was written about 320 B. C. Authors on botany were numerous at the close of the fifteenth century. The Botanic Gardens of Padua, Leyden, and Leipsic were established respectively in 1545, 1577, 1580; the Jardin des Plantes, in Paris, in 1624; Oxford, 1632. The system of Linnæus was made known in 1750; and Jussieu's system, founded on Tournefort's, and called the "natural system," in 1758. The latter is now accepted by such authorities as Lindley and London. The Linnæan was founded upon sexual differences, the classes being determined by the number of stamens, the orders by the number of pistils. The natural system of Jussieu is founded upon modes of growth and fructification. At the death of Linnæus, the number of species described was 11,800. The number of species now recorded is probably nearly 100,000. See Loudon's "Encyclopædia of Plants," 1829.

Amateur collectors may be interested in hearing the statement of a German naturalist, that the catalogue of useful plants has risen to about 12,000, but that others will no doubt be discovered, as the researches yet made have been completed only in portions of the earth. Of these plants there are 1,350 varieties of edible fruits, berries, and seeds; 108 cereals; 37 onions; 460 vegetables and salads; 40 species of palms; 32 varieties of arrowroot; and 31 different kinds of sugars. Various drinks are obtained from 200 plants, and aromatics from 266. There are 50 substitutes for coffee, and 129 for tea. Tannin is present in 140 plants, caoutchouc in 96, gutta-percha in 7, rosin and balsamic gums in 387, wax in 10, and grease and essential oils in 330; 650 contain dyes, 48 soap, 260 weaving-fibers; 365 fibers used in paper-making; 48 give roofing-materials, and 100 are employed for hurdles and copses. In building 740 plants are used, and there are 615 poisonous plants. Some of these groups are evidently underestimated.

Her′is-son. (*Fortification.*) *a.* A beam armed with iron spikes and used as a barrier to block up a passage.

b. A barrier of the nature of a turnstile.

Her-maph′ro-dite. (*Nautical.*) A form of vessel having the forward mast and bowsprit of a brig and the after mast of a schooner, each with its proper proportions, station, rig, and sails.

Her′ni-al Sup-port′er. See TRUSS.

Her′ring-bone. 1. (*Masonry.*) Rows of stone or paving-blocks sloping in different directions in alternate rows. See MASONRY.

2. (*Building.*) Strutting-pieces between thin joists, diagonally from the top of one to the bottom of another, to prevent lateral deflection.

3. (*Sewing.*) A cross-stitch in which the threads are laid diagonally in rows.

Her-schel′i-an Tel′e-scope. A form of reflecting telescope having no second mirror, but a speculum placed in an inclined position so as to bring the focal image near the edge of the tube, where it is viewed directly by the eye-piece, without materially interfering with the light entering the telescope from the object observed.

The magnifying power is equal to the focal length of the object-mirror divided by that of the eye-glass. See TELESCOPE.

Herse. 1. (*Fortification.*) (From French *herse*, a harrow.) *a.* A gate with cross-bars and spiked, and serving to obstruct a passage-way, on occasion. A *portcullis.*

b. A frame with spikes, acting as a *cheval-de-frise*, to impede an advance. A *hersillon.*

c. An openwork gate which obstructs passage along a ditch or watercourse, or a sally-port traversable by boats.

2. A rectangular frame made of four bars, and having pegs on which are wound the straining strings attached to the edges of a skin which is stretched in the frame, to remove its wrinkles and hold it while being scraped. Skins for parchment are thus stretched for fleshing, scraping, and grinding. See PARCHMENT.

Her′sil-lon. (*Fortification.*) A beam, frame, or plank set with spikes to stop a breach or way. A *herse*; a *cheval-de-frise.*

Hesp. (*Weaving.*) The length of two hanks of linen threads.

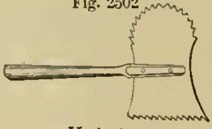
Het′e-rod′ro-mous Lev′ers. The windlass, capstan, winch, crank, crane, etc.

Hewn-stone. Stone blocks in which the faces are hammer-dressed to shape.

Hex′a-chord. A musical instrument with six strings.

Hey's Saw. A saw invented by the celebrated surgeon whose name it bears. It has one curved and one straight serrated edge. Used in making exsections, operating on the cranium, and removing carious bones from deep-seated places.

Fig. 2502



Hey's Saw

Hide. A flayed skin of an animal. For specific index see LEATHER.

The ancient Scythians made quiver-covers of the skins of the right arms of their enemies. The nails were left hanging to them. "Now the skin of a man is thick and glossy, and in whiteness surpasses almost all other hides. Some even flay the entire body of the enemy, and, stretching it upon a frame, carry it about with them wherever they ride." — HERODOTUS, IV. 64.

Cambyses killed and flayed a venal judge, afterwards cutting his skin into strips for a chair-seat, as a reminder for the son, the subsequent occupant of the chair and office. See CHAIR.

The skin of the Silenus Marsyas, flayed by Apollo, as the Phrygian story goes, was hanging in the market-place of Celænæ in the time of Herodotus. It was still shown there in Xenophon's time.

The sides of hides are the *flesh* side; and the *grain* or *hair* side.

Depilation is known as *unhairing*.

Piling is unhairing by hanging in a damp heat.

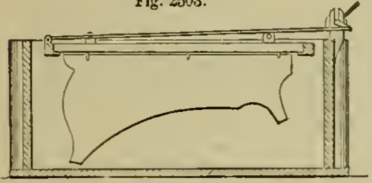
Fleshing is paring to a smooth surface by removal of fat and integuments.

Swelling is puffing it out by stuffing, etc.

Dressing embraces a number of operations in preparing the tanned hide for the use of the shoemaker, saddler, etc. See list under LEATHER.

Hide-hand′ler. A machine or vat in which hides are moved in the liquor to expose them to the liquid in circulation, and sometimes alternately to the air and the liquor.

Fig. 2503.

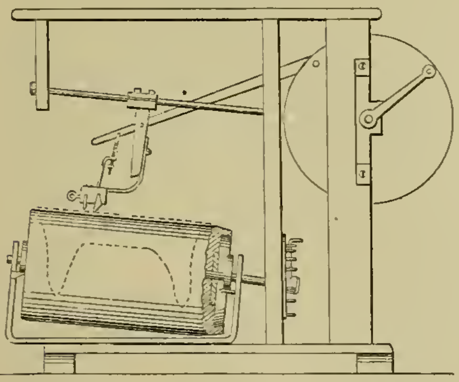


Hide-Handling Vat.

Hide-rope. Rope made of strands of cow-hide plaited. It is used for wheel-ropes, traces, purchase-ropes, etc. See RAWHIDE.

Hide-scrap′er. (*Leather.*) One to perform by machinery the business of scraping the flesh-side of hides. In the example, below the reciprocating scraping-knife is a drum, upon which the hide to be scraped is secured. The drum may be vertically adjusted to the knife by means of eccentrics, and is partially rotated after each movement of the knife to bring a fresh portion of the hide into the proper position to be scraped.

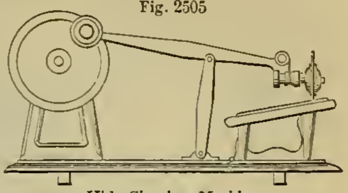
Fig. 2504.



Hide-Scraper.

Hide-shav′ing Ma-chine′. (*Leather.*) A machine having a cutting, shaving, or scraping-tool which reciprocates above an inclined table on which the hide is stretched. In the example, the tool has also a rotary motion imparted to it by means of a band.

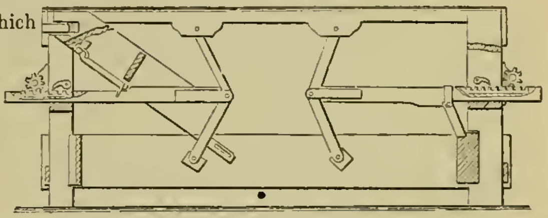
Fig. 2505



Hide-Shaving Machine.

Hide-stretch′er. (*Leather.*) A frame on which a hide is stretched to bring it to shape and remove wrinkles. In Fig. 2506, the hide is laid over a beam, and the edges of its depending sides are depressed by clamps and toggles, which are operated by rack-bars and pinions, the adjustment of the latter being maintained by pawls.

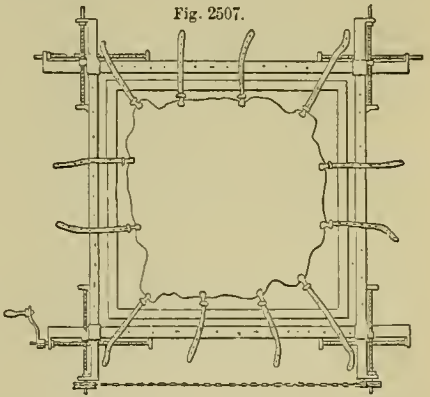
Fig. 2506.



Hide-Stretcher.

In Fig. 2507, the pivoted nippers are tightened on the hide by the straps that suspend it within the frame. The latter is expanded by screws at the corners.

Fig. 2507.

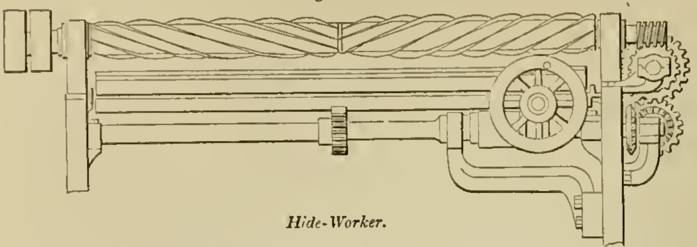


Hide-Stretching Frame.

Hide-work′er. A machine for performing that part of the currying operation which consists in evening the thickness by means of knives, which, in the hand-operation, are applied to the hide while lying upon a slanting post called a *beam*. See CURRYING.

In the machine (Fig. 2508) the table moves in a frame and is covered successively with cork or vulcanized rubber, felt, and cow-hide ; it passes under a roller armed with two sets of spiral blades which commence at the middle of the roller and extend to its ends.

Fig. 2508.



Hide-Worker.

High-fur'nace. (*Metallurgy.*) A smelting-furnace of full hight, in contradistinction to a certain smaller furnace known as the *half-high furnace.*

High-press'ure A-larm'. The object of this device, as the name indicates, is to give notice and prevent an explosion of a steam-generator. It consists mainly of two classes : 1. Fusible plugs in the side of the boiler, which give way when a certain heat is attained, and allow the steam to escape. 2. Valves which open when the pressure becomes excessive, and allow exit to steam, which blows an alarm-whistle. The first depend upon temperature, the second upon pressure. Pressure and temperature bear a certain ratio to each other.

1. Ashcroft's patents of March 19, 1850, and February 18, 1851, refer to methods for the protection and insulation of the plug which is destined to give way at a certain temperature and relieve the boiler.

The patent of C. Evans, May 8, 1834, describes the use and operation of the fusible plug, which is composed usually of lead and tin, with the addition, in some cases, of bismuth. The ingredients are so proportioned as to melt at the heat at which it is desired that notice shall be given. It is used as a low-water detector, as well as to indicate high pressure, and for protection of the boiler may be placed at that portion which is most likely to be unduly heated when the water is low. See FUSIBLE ALLOYS, p. 62.

2. The alarms acting by pressure are of the nature of the *safety-valve ;* the noise of the escaping steam or its impingement upon a whistle causing an audible alarm. See LOW-WATER ALARM ; SAFETY-VALVE.

High-press'ure En'gine. (*Steam.*) A steam-engine, condensing or non-condensing, in which the safety-valve is loaded with a weight equivalent to a boiler-pressure of, say, fifty pounds to the square inch. In England, above twenty-five pounds to the square inch is sometimes considered as *high* pressure. This is but an indefinite definition, but customs vary. Low-pressure engines are usually *condensing,* high-pressure engines on locomotives, saw-mills of moderate size, and Western steamboats, are *non-condensing ;* but the question of condensing is not necessarily one of pressure. Things took their names early, and it is not easy to bring modern forms under an old nomenclature. All the engines of Newcomen and the early ones of Watt were single-acting and condensing, and steam much over a temperature of 212° Fah. was considered high pressure ; the use of steam being merely to expel the air from below the piston, in order that the atmospheric pressure may be availed when the steam is condensed. This was all the use of steam in the Newcomen period and the early patents of Watt, which concerned the separate condenser, parallel motion, four-way cock, puppet-valves, and some other features of the engine now known as the CORNISH (which see). Watt subsequently used actual pressure of steam, was the first to use it expansively by cutting off at a part of the stroke, and also invented *double*-action engines in which the steam was admitted to alternate sides of the piston, making both motions effective. He made drawings for this in 1774, and exhibited it in 1782. He called it a "double-engine," which must not be confounded with the double-cylinder engine of Hornblower of Penryhn, patented in 1781, revived by Woolf, and much improved by Worthington. See plate opposite page 763.

Oliver Evans of Philadelphia has hardly had sufficient credit for his part in the matter, but he struggled for many years to make his townsmen believe that the high-pressure, double-acting engine was to be the engine of the future, both on roads and boats. He was active in the running of his hobby from 1787 to 1803, and in the former year obtained a patent from the State of Maryland for steam-carriages on common roads. His townsmen thought him crazy, and he could obtain no patent in Pennsylvania. He exhibited his engine running in 1803, sawing wood and stone, and grinding plaster. He put it on wheels and made it move itself to the Schuylkill, put it on board a scow, and made it drive a stern-wheel, working down the river to the junction with the Delaware, and then up the latter to the city of brotherly love but weak faith. This was some years before Fulton. He had no backers, and, having spent all his money, he, at the age of fifty, turned his excellent talents into a more lucrative channel, and was rewarded with success in business. He does not seem to have been such a fretful genius as Fitch and some others of his contemporary inventors ; his portrait shows a comfortable and genial man, who retired from the unequal contest before he lost his own self-respect and became a bore. "The time" was "out of joint," and he could not convince the folks against their will. Seventy years afterward the "Pennsylvania" steamed down the river, but the intervening time might count for centuries if measured by the progress made. It may be remarked that Evans used a cylindrical flue-boiler.

Next, perhaps, we should state the work of the man who has done more than any other one man to make the locomotive what it is : Richard Trevethick of Merthyr Tydvil, in South Wales. He had not got over the idea of the necessity for something more than the weight of the engine to give tractional adherence to the rails, and used a cog-wheel and rack rail. (See LOCOMOTIVE.) He used a blast of exhaust steam in the chimney, patented his locomotive in 1802, and it was in use on the Merthyr Tydvil Railway in 1804.

Trevethick and Vivian patented the application of high-pressure steam to engines. Trevethick is described in the Catalogue of the South Kensington Museum, London, as "the inventor and constructor of the first high-pressure steam-engine, and of the first steam-carriage used in England." Blackett improved on Trevethick, and used smooth wheels on a plate-way.

The multitubular boiler is stated to have been used by Rumsey, and subsequently, in 1790, in England. It was used by John Cox Stevens of New Jersey, 1791–1807; English patent, May 31, 1805. He used a Watt engine, cylinder 4½ inches diameter, 9 inches stroke. Boiler 2 feet long, 15 inches wide, and 12 inches high, with 81 copper tubes 1 inch in diameter. Boat, 25 feet long, 5 feet beam; tried in May, 1804; velocity, 4 to 8 miles per hour.

Not desiring to anticipate what should be said under Locomotive and Steamboat, suffice it to say that William Hadley's locomotive "Puffing Billy" was built in 1813, and had a long career of usefulness. Stephenson's first locomotive was built after seeing Trevethick's, as improved by Blackett for Lord Ravensworth's colliery, in 1814, and had grooved sheaves to increase adherence. Locomotives on Stephenson's plan were used on the Stockton and Darlington Railway, opened in 1825. Stephenson's "Rocket" was successful over three other competitors in the trial on the rails of the Liverpool and Manchester Railway, 1829. It used the multitubular boiler by the suggestion of Mr. Booth of that railway company, also the exhaust-blast in the chimney, invented by Trevethick. Hackworth's "Sanspareil" had a cylindrical flue-boiler on the Evans plan, and a very effective exhaust-blast in chimney. The "Rocket's" competitors broke down at various points in the trial. Stephenson was an excellent workman. The very insincere book called the "Life of Stephenson" ignores most of these facts, and pettifogs the whole case; it is about as one-sided an affair as Abbott's Life of Saint Napoleon, but has done much less harm, as it is only ungenerous and unfair, and does not debauch the judgment of the rising generation.

High-re-lief′. The projection of a sculptured figure, half or more, from the plane surface. Called also *alto-rilievo.* See Rilievo.

Hight. 1. (*Hydraulic Engineering.*) The *fall* of a body of water. The *head.*

2. (*Shipwrighting.*) The distance between decks.

Hight-board. (*Carpentry.*) A carpenter's gage for *tread* and risers of a wooden stairway.

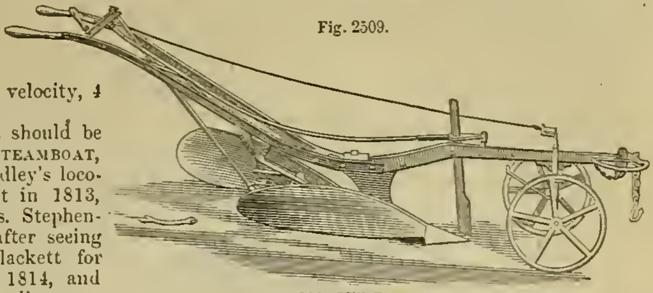
Hight-staff. (*Shipbuilding.*) A rod having marked upon it the hights above the keel of all the frames at the beam-line of the ship.

High-warp Loom. (*Weaving.*) A tapestry loom in which the warp-frame is vertical and the weaver works standing, thus being able to constantly inspect his work as it proceeds, an advantage which he does not possess in the *basse-lisse* or low-warp tapestry loom in which the warp is horizontal.

Hill′o-type. (*Photography.*) A process invented by L. L. Hill, of Westkill, New York, and much debated in the photographic journals of twenty years ago and since. He claimed — see "Photographic Art-Journal," October, 1852 — to have discovered "a method of heliotyping the colors of objects truthfully, brilliantly, and imperishably." The correspondence is voluminous, some of it acrimonious; the colors certified to have been produced heliotypically in the pictures are rosy, red, blue, green, orange, violet, buff. The process is not explained in these articles. Niépce worked long at this object, and called the products *heliochromes.* And yet we wait.

Hill′side-plow. (*Husbandry.*) One which has a turning share, so as to plow on side-hill or sidling places, returning in the last-made furrow and throwing down hill each way. The plow shown in the example is turned at the headland or end of the furrow, and by the movement of a lever the share is turned over and one *breast* is put into its proper position for work while the other is raised and carried clear on the land-side. The colter is moved by a separate lever. Such plows in England are called *turn-wrest* plows.

Fig. 2509.



Side-Hill Plow.

Hind-car′riage. (*Vehicle.*) The rear part of the running-gears of a four-wheeled vehicle. The hind wheels and axle, with or without the coupling.

Hinge. A means of connecting a door, casement, or leaf, with its frame or an object, so that it will swing thereon.

The ancient Egyptian hinges were crude affairs, and were similar in construction to those made in our early Western log-cabins. A pin projecting from the upper edge of the door was socketed in a vertical hole made in a bracket attached to the wall, and a similar pin on the lower edge of the door was stepped into a socket in the floor or threshold. The illustration *a* (Fig. 2510) is from a model house found by Mr. Salt in Egypt, and now in the British Museum. When found, it contained a supply of grain in the little store-room, but this was eaten by a rat when the model was at the Lazaretto in Leghorn, on the route for England. The grain remained in apparent good order for over 3,000 years, and was then consumed by a modern rat while the little house was in quarantine. The doors of Egypt were either single or double, and were secured by bars and bolts, as seen in the figure. The hinge-pieces were made of bronze in many cases. The accompanying figures *b c* show the upper and lower door-pins and the sockets in which the edge of the door is received, and in which it is secured by bronze pins. The projection on the upper piece was to keep the door from striking against the wall.

o shows the general form of a door in remains of stone, marble, wood, and bronze. *p* is a bronze hinge in the Egyptian collection of the British Museum. *q* is the plan of the threshold of an ancient temple with the arrangement of the folding-doors. *r s* are four Roman hinges of bronze now in the British Museum.

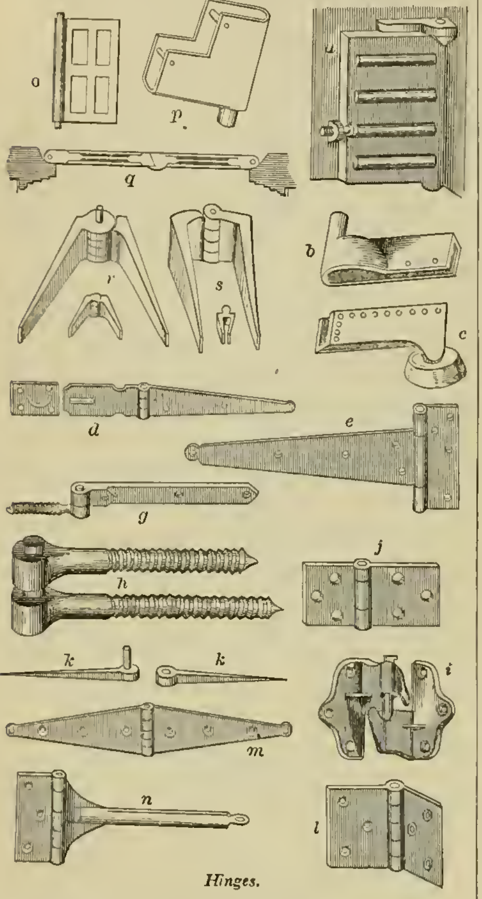
The term *cardo* (Lat.), a pivot or hinge, was applied to the North and South poles, on which the earth was supposed to turn. *East* and *West* being added, made the *quatuor cardines orbis terrarum,* the term yet surviving in our *cardinal points.*

Several bronze hinges, remains of ancient Egypt, are in the British Museum. One of them is 7 inches high and 11 inches long. The basalt socket of the lower one is also in the same museum. They are from the granite sanctuary of the great temple of Karnak.

The doors of the temple of Solomon had hinges of gold. The temple seems to have been remarkable rather for lavish expenditure of gold and ornaments than for architectural beauty. Of the contemporary styles, the Egyptian and Doric, the former is the more likely to have been copied, as the Israelites are not supposed to have originated any. They had been for several centuries in a state of transition from a nomadic to a settled life. The popular representations of the Corinthian order in the temple are anachronisms, for the temple was built 560 years before Callimachus.

There are several beautiful examples of hinge constructors in the natural world. Among them we may cite the mason-spider of the tropics and of Southern Europe. The subterranean cell of this animal is tapestried with silk and closed by an earth-kneaded door, hung upon a silken hinge and self-closing with an elastic spring, after each entrance and exit of the cavern's occupant.

Fig. 2510.



Hinges.

Hinges are known by purpose, as, —

Blind-hinge (*i*).
Carriage-hinge.
Chest-hinge.
Door-hinge.
Gate-hinge (*g h k*).
Hasp-hinge (*d*).
Reaper-hinge.
Table-hinge (*j*).

Or by some structural peculiarity or shape, as, —

Back-flap hinge.
Butt-hinge (*l*).
Cross-garnet hinge (*n*).
Dovetail-hinge.
Hook and eye (*k k*).
Loose-joint hinge (*i*).
Screw and strap (*g*).
Screw hook and eye (*h*).
Self-shutting hinge (*i*).
Spring-hinge.
Strap-hinge (*m*).
T-hinge (*c*).

The *knuckle* receives the pin.

The leaves are *straps*.

The *rising* hinge has a spiral groove winding round the knuckle so as to lift the door when it is swung open, and thus clear the carpet.

Hinge-joint. A junction of parts allowing a flexure and extension in a certain plane. The parts are usually connected by a pintle or ligature.

Hinge-mak'ing Ma-chine'. In the Evrard and Boyer machine the sheet-metal is placed in the machine in coils, there being two coils of sheet-brass for the two halves of the hinge-body, and a coil of wire to supply the connecting bolt or rivet. The material is drawn off from the coils as it is wanted, the wings of the hinge are stamped out by punching dies to the proper shape, the salient parts, which are to form the tube for the connecting bolt, are formed upon the wire itself which is to furnish the bolt, and this is then cut off to the proper length. Before the hinge is dismissed, the screw-holes, by which it is to be secured to the wood, are formed and countersunk to the form of the screw-head. The machine completes a hinge every second.

Butt-hinges are usually molded on *match-plates.*

Hink. (*Agriculture.*) A reaping-hook.

Hip. (*Building.*) 1. The external angle formed by the meeting sides of a roof.

2. A truncated gable. See HIP-ROOF.

3. A timber which forms the angle of a hipped roof, and against which the rafters are laid.

Hip-knob. (*Building.*) The finial at the apex of a gable, or on the top of the hips of a roof.

Hip-poc'ra-tes Sleeve. A strainer bag made by folding a square of flannel diagonally, and sewing it along the meeting edge, so as to make it of a funnel shape. Or, —

By uniting the opposite angles of a square piece of cloth.

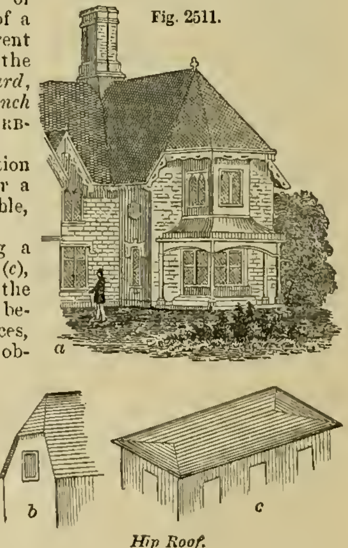
Hip-raft'er. (*Carpentry.*) The rafter at the angle of a roof. Its two outer edges are sloped to range with the rafters on each side of the roof.

Hip-roof. (*Roof.*) An obtuse angle formed by the meeting of two portions of a roof of different slant, as in the case of a *Mansard*, *curb*, or *French* roof. See CURB-ROOF.

A short portion of a roof over a truncated gable, as at *a*, *b*.

One having a double slope (*c*), the rafters at the exterior angles being in two pieces, meeting at an obtuse angle.

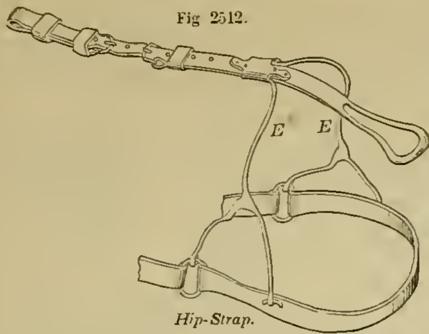
Fig. 2511.



Hip Roof.

Hip-strap. (*Harness.*) One (*E E*) which crosses the buttocks of a horse and supports the breeching *B*, or the traces merely, according to the style of harness. It gives the name to one form of harness, called hip-strap harness, having no *breeching*. It is used for lead harness, in which the horses are not

Fig 2512.



Hip-Strap.

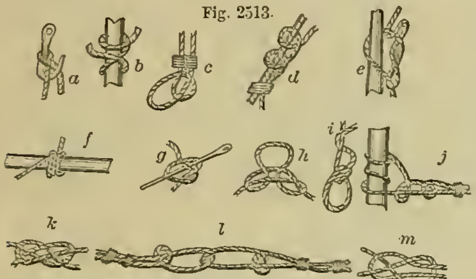
called on to hold back in descending hills, or to back the wagon.

Hip-tile. (*Roofing.*) A saddle-shaped tile to cover a hip. A *corner tile.*

Hirst-frame. (*Forging.*) The frame of a tilt-hammer.

Hitch. 1. (*Nautical.*) A species of knot by which a rope is bent to a spar or to another rope. There are various kinds knows as : —

Fig. 2513.



Hitches.

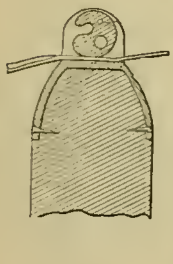
a, Blackwall-hitch.
b, clove-hitch.
c, half-hitch.
d, two half-hitches.
e, timber-hitch.
f, magnus-hitch.
g, marlinspike-hitch.
h, harness-hitch.
i, midshipman's-hitch.
j, rolling-hitch.
k, carrick-bend.
l, hawser-bend.
m, sheet-bend.

2. (*Mining.*) A small slip where the dislocation does not exceed the thickness of the vein.

Hitch'er. (*Nautical.*) A boat-hook.

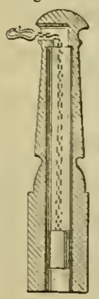
Hitch'ing-clamp. (*Menage.*) A device for holding the strap of a bridle or halter. In the example, the strap is held beneath a turning cam, so as to bind the tighter the harder the horse pulls upon it.

Fig. 2514.



Hitching-Clamp.

Fig. 2515.



Hitching-Post.

Hitch'ing-post. (*Menage.*) A post with convenient means for the attachment of the strap of a horse's halter or bridle. In the example, it has a weight to take up the slack, but allows a certain freedom of motion, as the weighted tie-chain travels in the hollow post. The weight forms a stop to arrest the extraction of the chain from the post.

Hive. (*Husbandry.*) A box or basket for a swarm of bees to live in. See Beehive ; Apiary.

Hoard; Hoard'ing. (*Building.*) A temporary screen of boards enclosing a building-site, where erections or repairs are proceeding.

Hob. 1. The flat, iron shelf at the side of a grate.

2. A hardened, threaded spindle, by which a comb or chasing-tool may be cut. A *hub.*

Hob'by. The old English name of the velocipede. "Every one rides his own hobby."

Ho'bit. (*Ordnance.*) An old form of mortar of six or eight inches' bore, mounted on a carriage.

Hob'nail. A short, thick nail, with a pointed tang, a large head, and with pendent claws, which pierce the boot-sole.

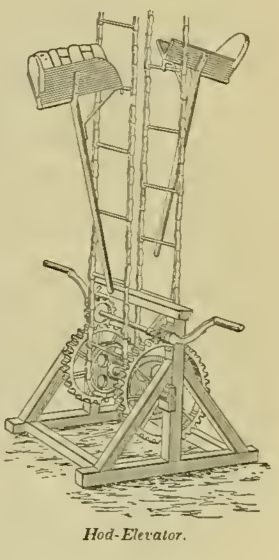
The *caliga*, or coarse shoe, of the Roman soldier, was thickly studded with hobnails.

Hod. (*Bricklaying.*) 1. A box with two sides and an end, set on edge, and with a handle by which it is carried, a padded cushion resting on the shoulder.

2. A coal scuttle or box. A coal-hod.

Hod-el'e-va'tor. A hoisting device to raise hods loaded with bricks or mortar to the building hight on a building, and return the empty ones. In the illustration, it is a traveling ladder which runs over a drum above, — not shown, — and is driven by a winch below. The hods are hooked on to the rounds.

Fig. 2516.



Hod-Elevator.

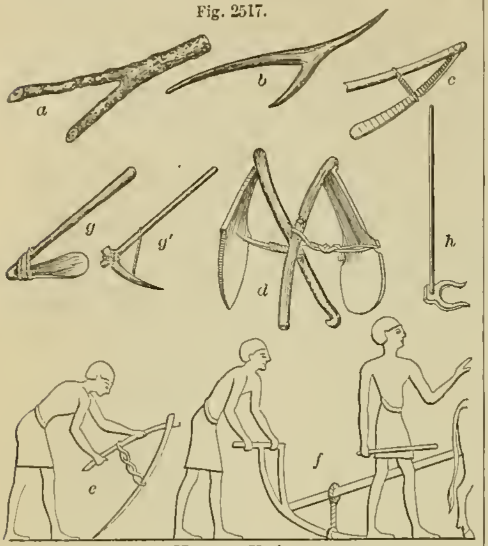
Ho-dom'e-ter. A way-measurer. See Odometer.

Hoe. 1. (*Agriculture.*) A tool with a flat, thin blade used to cut weeds or stir the earth around plants. In its ordinary sense, it is the familiar tool attached at a convenient angle to a straight handle, and whose duty is defined above. In England, hoes are attached to machines, but the function remains the same, for the hoes follow in the balks between the rows of plants. The same devices are here denominated *shares.*

The hoe may be fairly assumed to have been the first implement of the husbandman, in its form of a pointed stick for stirring around the roots of a plant. Next comes the crotch *a* sharpened to a point, as at *b*, in which form it might be used as a hoe or plow, according to size. *c d e* represent the hoes used by the ancient Egyptians, the two former being drawn from actual hoes which have been preserved in the tombs, and the latter (*c*) being a copy of a picture at Beni Hassan. Their hoes were made of wood, the handle was about three feet long, the blade being mortised thereto at the junction and bound by a twisted rope or thong, as clearly shown in *d*, which represents two hoes in the Berlin collection. One is also to be seen in the Abbott collection, New York. *f* shows the Egyptian plow, and is introduced to exhibit the similarity in shape of the hoes *b c* and plow *f*, a crotch of a tree being the original of each. The team being hitched to the long end of the crotch *b*, the shorter end forms a share or tusk, and the back portion projects for a handle. See Plow.

With their wooden hoes the peasants of Egypt covered the seed which was scattered broadcast over the surface of the land yet glistening with the mud left by the retiring Nile. Plows were also used for this purpose, and not unfrequently the seed was buried by driving herds of sheep or goats over the land.

Fig. 2517.



Hoes and Hoeing.

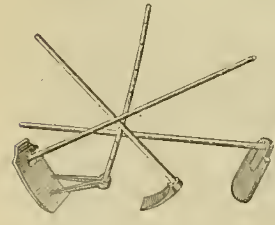
The *bidens* or two-pronged hoe was a common tool in Roman agriculture. It was also common in Greece in the form shown at *h* (Fig. 2517). Homer describes Laertes as hoeing when found by Ulysses.

The Romans hoed their grain crops, wheat, spelt, and barley. Once in early winter, a second time in spring, before jointing. The wheat was sowed on the top of ridges made by a double mold-board plow, and was consequently in rows. It was not uncommon to hoe up the earth to the young plant at the first hoeing.

g g′ (Fig. 2517) are the hoes of Pacific coast Indians. *g* is a scapula; *g′* a walrus tooth.

Fig. 2518 shows four Japanese hoes in the collection of the Smithsonian Institution, Washington. The clumsiness of the two larger ones is something fearful to contemplate. The hoe or mattock is the usual implement for cultivating the land in Japan. The plow is also used.

Fig. 2518.



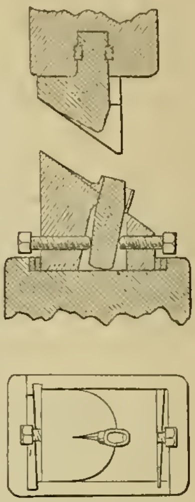
Japanese Hoes.

The hoes of Polynesia, when first discovered, were the shells of the oyster or a large kind of *pinna*; a bone from the back of a turtle; or a plate of tortoise-shell. The hoe was used with a thrust motion, like our Dutch hoe.

The hoe of the Fegee-Islanders is a blade of tortoise-shell or the valve of a large oyster. These may be considered a type of maritime substitutes for metal. Obsidian, flint, hard wood, and various other substitutes have been employed, the latter by the ancient Egyptians.

The Feejees are very ingenious in finding substitutes for metal. A hard stone ground to an edge forms an axe. A blade of tortoise-shell attached to a handle is their knife. The spines of echini are their boring-tools. Rats' teeth set in wood are gravers and chisels. The mushroom coral answers for a file, and pumice-stone for sand-paper. The axes and hatchets of America, and the knives and chisels of England, are fast superseding their primitive tools. They can now cut up their *bakolo* or long-pig — as they term the edible human body — with more civilized implements.

Fig. 2519.



Hoe-Swage.

The broad and thin metallic blade is quite a modern contrivance, and was never well made until made in the United States. It is now a scientific tool, sharp, light, and shiny. Hoes should be selected for covering or cutting; the latter have a less angle with the handle. Clean your hoes always before putting them away, and you may always resume your work in good-humor.

Hoes were formerly made by forging, but now they are more often cut out as blanks and then struck in dies.

The blade being extended and the eye formed by hand, the heated blank is placed on the anvil and secured with the pin; the drop being released falls thereon, shaping and finishing the face of the hoe.

Hoes are made in specific forms for various purposes.

a is a hoe for marking out fine drills.

b a hoe for marking small ridges.

c a hoe for working two sides of small plants.

d a hoe for drawing a pair of parallel ridges.

e a combined hoe and rake, a very common implement in the Netherlands, and used in the United States by amateur gardeners.

f has a serrated blade; *g* a sectional one.

h i j k are *Dutch* hoes, known as *scuffle* or *thrust* hoes, operated by pushing instead of striking or pulling. They are useful in extirpating weeds under bushes, and loosening the soil around growing plants.

l shows a mode of attaching the blade to the tang.

m of wedging it in a ferrule.

n o have means of adjusting the angular presentation of the blade.

p has a reversible blade.

2. (*Dentistry.*) A dentist's excavating instrument, having a blade attached to a shank and shaped like a miniature hoe.

Hoe′ing Ma-chine′. (*Agriculture.*) An implement for tending drilled or dibbled crops. It was invented by Jethro Tull, the introducer of the system of drilled crops into England, and was designed to diminish the expense of cultivation by substituting horse labor.

Tull's implement was comparatively rude, and it was successively improved by a number of inventors, among whom we notice the names of Blackie, the two Wilkies, Weir, Hayward, Grant, Ganett, Howard, and others in Britain.

The history merges into the history of *cultivators*, in the United States our husbandry being different.

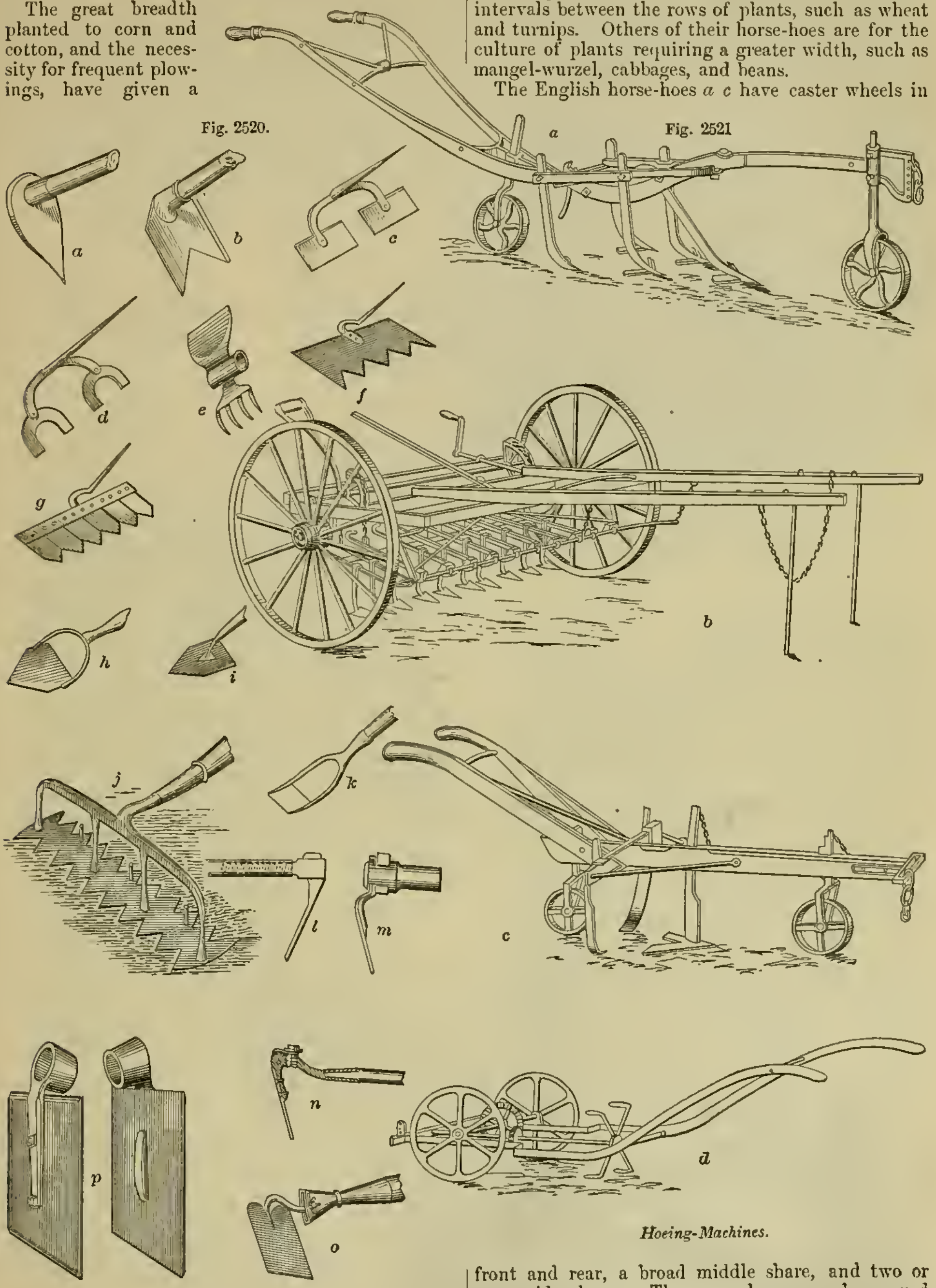


Fig. 2520.

Hoes.

Fig. 2521

Hoeing-Machines.

The great breadth planted to corn and cotton, and the necessity for frequent plowings, have given a different form to the tool, as the distance between the rows renders it convenient for the horse, implement, and man to follow the balk, going twice in a row, tending the crop to his right hand each time. This is very different from the hoeing of wheat, and also from the hoeing of turnips.

The horse-hoes (*b*) of Britain have a range of shares spaced like the drills, so as to work in the intervals between the rows of plants, such as wheat and turnips. Others of their horse-hoes are for the culture of plants requiring a greater width, such as mangel-wurzel, cabbages, and beans.

The English horse-hoes *a c* have caster wheels in front and rear, a broad middle share, and two or more side shares. The rear share may be curved or flat, as shown at *c* and *a* respectively. It is what we should call a cultivator, but there is more of it than we regard convenient. If the tool be well proportioned, and the animal hitched to it rightly, it needs no wheel. For turning at the end of a row of corn or potatoes it is too long. A man would need 12 feet of ground to come out on to turn, and it is not necessary to withdraw so large a marginal strip of the field for such a purpose. See CULTIVATOR.

Bucknalls's horse-hoe *b* (English) has a gang of 10 shares in a frame, adjustable by a lever as to hight, and also as to angular presentation of the shares to the ground. It is intended for hoeing wheat.

An implement used for chopping gaps in drilled rows of plants was described by Skirving of Fifeshire, Scotland, in 1778, and constructed by Huckvale some 25 years since (*d*, Fig. 2521). It was designed for turnip culture, and is also used in cotton culture. In each case the seed is sown somewhat abundantly in drills, and requires to be thinned after having attained such size as to bear culture. The practice with cotton has been to cut gaps in the rows with a hoe, leaving the plants in square bunches, which are afterward thinned out to a few plants, and eventually, when the contingencies of insect enemies are overpast, leaving the most likely plant in full possession of the hill.

This *horse-hoe* is designed for chopping gaps in the rows, and has a set of revolving hoes on a shaft parallel with the line of draft, and driven by bevel gearing from the main axle of the machine. As the machine advances, the hoes chop transversely across the row of plants, making intervals therein equal to the lengths of the blades. See COTTON-CHOPPER.

Hog. 1. (*Paper-making.*) A revolving stirrer in a chest of paper pulp which agitates the pulp so as to keep it of uniform consistence as it flows to the paper-making machine. See PAPER-MAKING MACHINE.

2. (*Nautical.*) A scrub-broom for scraping a ship's bottom, under water.

Hog-chain. (*Shipbuilding.*) A chain in the nature of a tension-rod passing from stem to stern of a vessel, and over posts nearer amidships; designed to prevent the vessel from drooping at the ends.

Hog-el′e-va′tor. A hoisting device used in large slaughter-houses for raising hogs which have been killed, scalded, and scraped, to the position for gutting and cleaning.

Hog-frame. (*Shipwrighting.*) A fore-and-aft frame, forming a truss in the main frame of the vessel to prevent vertical flexure.

The term "hog-frame" has been adopted into carpentry and engineering in some forms of trusses for roofs and bridges.

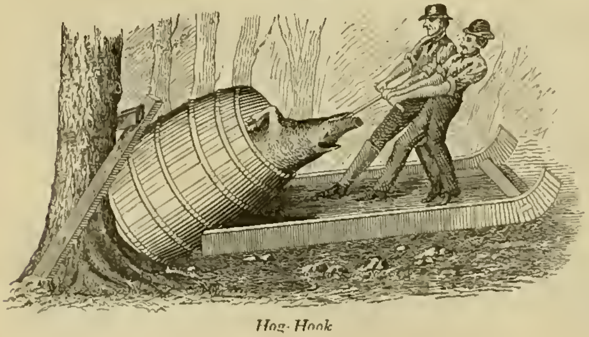
Hog′ger-pipe. (*Mining.*) The upper terminal pipe with delivery hose of the mining-pump.

Hog′ger-pump. (*Mining.*) The top pump in the sinking-pit of a mine. The lower is the *sump-pump*.

Hog′ging. (*Nautical.*) Said of a ship's shape when the head and heel of her keel are drooped; the middle portion curving upwardly. *Sagging* is the opposite curvature.

In other structures than nautical the term has the same relation, as the drooping of the ends of a truss, or the ends of a pivot bridge or table.

Fig. 2522.

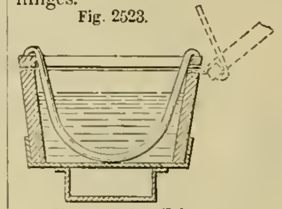


Hog-Hook.

Hog-hook. One used in handling hogs in scalding.

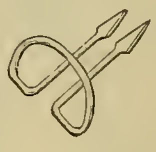
Hog-scald′ing Tub. (*Domestic.*) A means for scalding hogs, consisting of a large boiler and furnace, or a tub (Fig. 2522) to hold heated stones which are thrown in to raise the temperature of the water to scalding heat. In the example (Fig. 2523) the hog lies in a cradle within the tub, whose contents are heated by the furnace below. The hog is removed and tipped out on to a bench, by vibrating the cradle on its hinges.

Fig. 2523.



Hog-Scalding Tub.

Fig. 2524.



Nose-Ring.

Hog's-nose Trim′mer. A pair of cutting forceps or nippers, to remove the protuberant cartilage from a hog's snout to discourage him from rooting.

Hog-ring. A ring, or wire bent into other form, clasping the snout cartilage of a hog. In the example, the pivoted extensions of the ring penetrate the hog's snout, and, turning back, clinch round the ring.

Hoist. 1. The term applied to the elevating machinery of a factory, mine, or hotel.

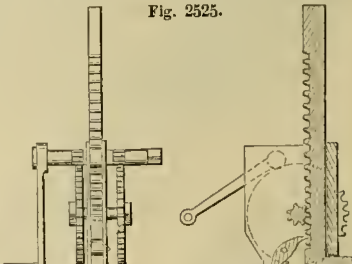
2. The perpendicular hight of a flag; the length from the spar outwards is the *fly*.

Hoist-bridge. A form of drawbridge, in which the leaf or platform is raised. See BASCULE.

Hoist′ing-en-gine. A steam-engine for hoisting at a mine, or in a warehouse, factory, etc.

Hoist′ing-jack. A contrivance by which hand-power is applied to lifting an object by working a screw or lever. A list of the different kinds is given under JACK. Several varieties are described under CARRIAGE-JACK, WAGON-JACK, JACK-SCREW, etc.

Fig. 2525.



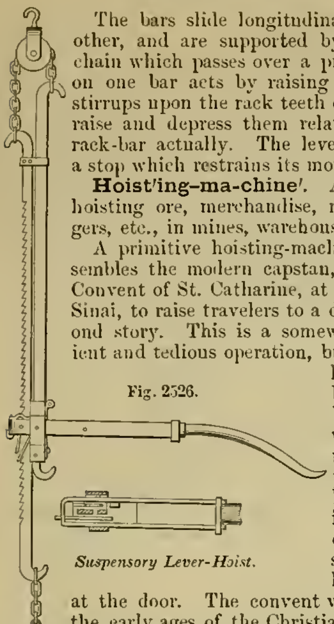
Hoisting Jack.

One form here shown operates by crank, pinions, cog-wheel, and rack.

The other is a suspensory jack, depending from an eye-bolt in a ceiling-joist and used to lift an object a short distance, so as to get it on to a store truck.

The bars slide longitudinally upon each other, and are supported by a connecting chain which passes over a pulley. A lever on one bar acts by raising and returning stirrups upon the rack teeth of the other to raise and depress them relatively, and the rack-bar actually. The lever is locked by a stop which restrains its motions.

Fig. 2526.

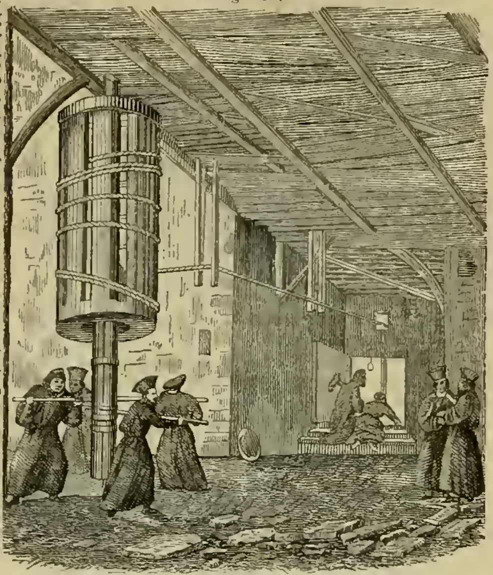


Suspensory Lever-Hoist.

Hoist'ing-ma-chine'. A machine for hoisting ore, merchandise, miners, passengers, etc., in mines, warehouses, hotels, etc.

A primitive hoisting-machine, which resembles the modern capstan, is used in the Convent of St. Catharine, at the foot of Mt. Sinai, to raise travelers to a door in the second story. This is a somewhat inconvenient and tedious operation, but is used in a land where robbers go on horseback. It is also worthy of remark, that the people of the land have no idea of the value of time, and so set six men to help another in at the door. The convent was founded in the early ages of the Christian Church, and the chapel was built by Justinian in the sixth century. It is a vast, straggling building, surrounded by a high wall, and is believed by its residents to occupy the place whereon the Lord appeared to Moses in a burning bush.

Fig 2527.



Hoisting-Machine, St. Catharine's Convent, Mt. Sinai. (*From Harper.*)

The obelisks in ancient Egypt may have been raised by gradually lifting the apex and scotching up by introducing earth beneath them.

The Stonehenge blocks were probably raised in the same way.

The blocks were moved from the quarries on rollers by animal or man power. They were perhaps raised, at the pyramids, for instance, by a rocking motion on midway blocks, a rather thicker block from time to time, at each rock. Or they may have been raised on an incline of earth, afterwards removed.

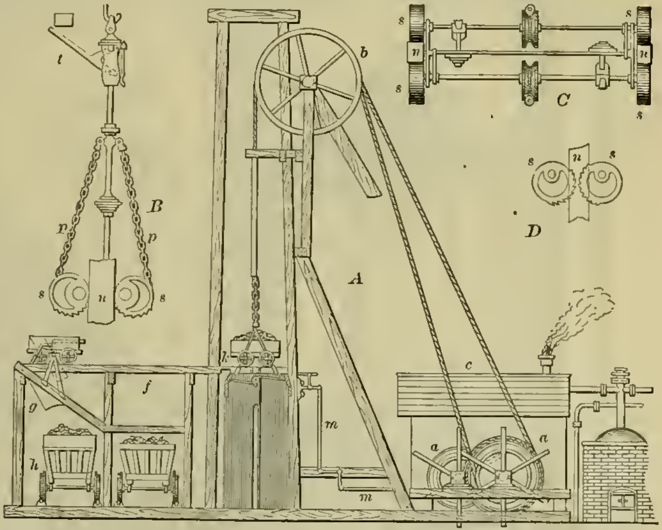
When Chersiphon built the Temple of Ephesus, in the time of Amasis of Egypt, he raised the architrave by surrounding the columns with bags of earth, which served as an inclined plane.

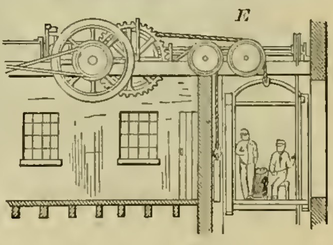
Fig. 2528 shows forms of hoisting-machines for coal-mines and factories.

A is a general elevation of the machinery for hoisting, screening, and loading coals, which will be readily understood by merely citing the parts. *a a* are the rope-drums, driven by the engines in the house *c*; *b* the pit-head pulley; *k* the cage which lifts the folding boards of the hatchway, and then, allowing them to drop, rests upon them. The car is then run out upon the track *f*, its load dumped upon the screen *g*, and received in the wagons *h*. On the return of the empty car on to the cage, the hatches are lifted by the engine-man by means of the rods *m m*.

B, *C*, *D*, show the safety apparatus, by which, if the hoisting-rope break, the cage is prevented from falling by the biting of the toothed eccentrics *s* upon the wooden conductor *n*. The eccentrics are connected with spiral springs, which tend to rotate them, and bring the toothed part against the conductor *n*; but so long as the rope remains intact, the working faces of the eccentrics are

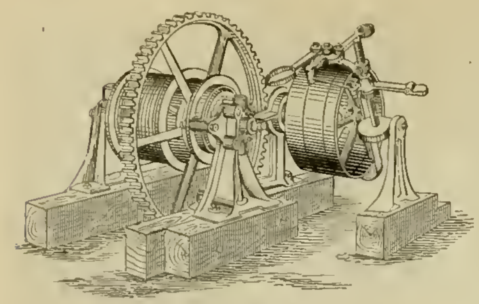
Fig. 2528.





Mine and Factory Hoists.

Fig. 2529.



Sellers's Hoisting-Machine.

firmly held by the chains *p* from contact with the conductor. *t* is a trigger which releases the cage in case of overwinding.

E is a factory-hoist like the modern elevator so much used in hotels. It is known in the North of England as a *teagle* (? *tackle*).

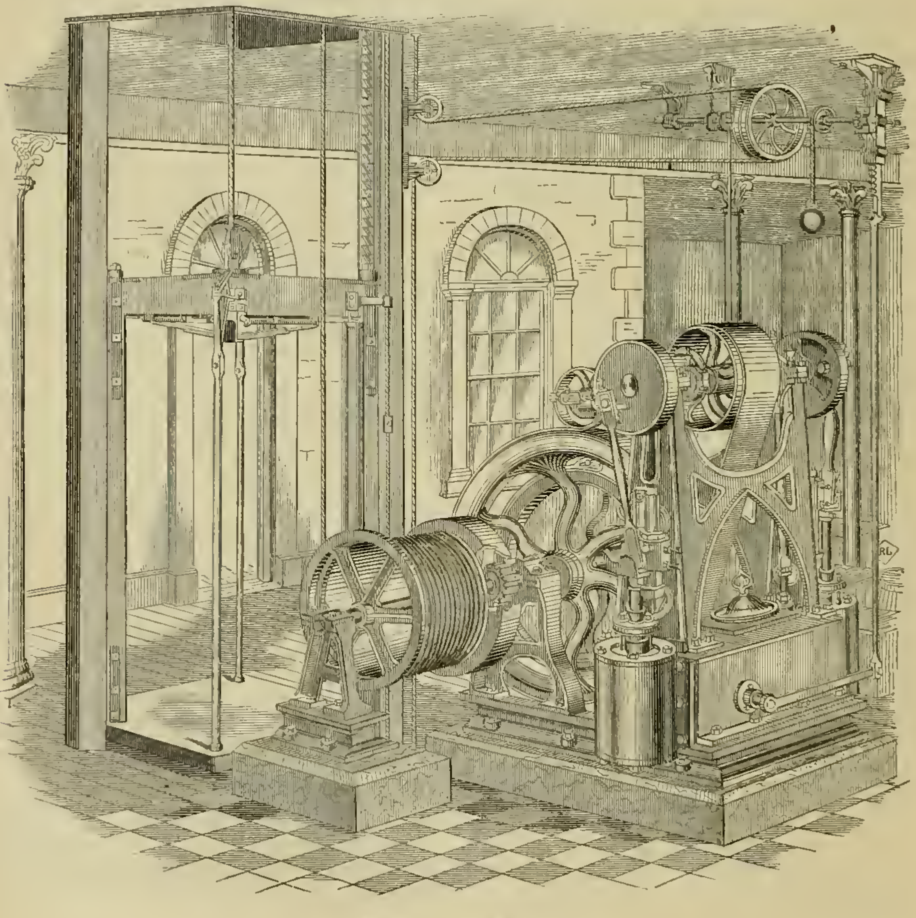
Sellers's hoisting-machine for warehouses or hotels is shown at Fig. 2529. It exhibits the wire-rope drum together with the up-and-down pulleys, and the middle loose pulley.

Fig. 2530 exhibits the hoisting-machine with the steam-engine by which it is driven. This is a double-cylinder, and reverses by a single movement of the valve-lever at the front. The platform moves at a speed of from 10 to 150 feet per minute, and has safety-ratchets which instantly lock it to the standards if the rope break. The drum on which the wire rope is wound has a spiral groove in which successive coils of the rope are kept separate. The car stops automatically at certain limits, or by hand at intermediate points. See ROPE-ELEVATOR.

See also under the following heads: —

Balance-crane.
Barton.
Block.
Bracket-crab..
Brake.
Brick and mortar elevator.
Bricklayer's hoist.
Bucket.
Cage.
Can-hook.
Cant-hook.
Capstan.
Cargo-jack.
Catadrome.
Cat-head.
Cat-tackle.
Check-hook.
Chevrette.
Chinese windlass.
Claw for suspending tackle.

Fig. 2530.

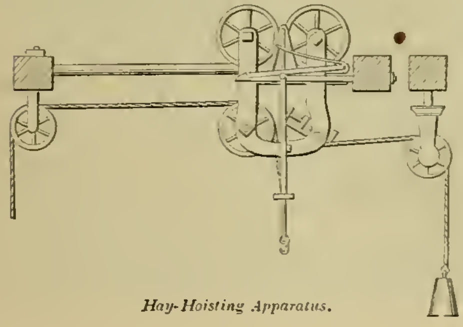


Miller's Hoisting-Machine.

Cog and round.
Cotton-elevator.
Crab.
Crampoons.
Crane.
Cuddy.
Davit.
Derrick.
Differential windlass.
Dolly.
Draft-engine.
Drop.
Drop-table.
Elevating-block.
Elevating-clutch.
Elevating-screw.
Elevator.
Field-derrick.
Fork.
Foundry-crane.
Furnace-hoist.
Gibbet.
Gin.
Gipsy-winch.
Glosso-comon.
Grain-elevator.
Gripe.
Hay.
Hay-loader.
Hod-elevator.
Hog-elevator.
Hoist.
Hoisting-apparatus.
Hoisting-boats.
Hoisting-machine.
Horns.
Horse-run.
Hydraulic crane.
Hydraulic elevator.
Hydraulic hoist.
Hydraulic lift.
Hydrostatic press.
Ice-elevator.
Inclined plane.
Jack.
Jeers.
Jib.
Jib-crane.
Jigger.
Lever-hoist.
Lewis.
Lift.
Lift-canal.
Lift-hammer.
Lifting-apparatus.
Lifting-jack.
Lifting-screw.
Loader.
Lock. Canal
Man-engine.
Masting-shears.
Mouline.
Movable ladder.
Needle.
Overhead-crane.
Parbuckle.
Plate-hoist.
Pneumatic hoist.
Portable derrick.
Pulley.
Purchase.
Rigger.
Rotary crane.
Sack-hoist.
Sack-lifter.
Safety-cage.
Sheer.
Sheer-hulk.
Sheers.
Side-winch.
Skid.
Sliding-pulley.
Slings.
Stacking-derrick.
Steam-crane.
Steam-hoist.
Steam-winch.
Stump-extractor.
Sweep.
Tackle.
Traveler.
Traveling-crane.
Traveling-derrick.
Traversing-elevator.
Triangle.
Water-crane.
Well-bucket elevator.
Whimsey.
Whim.
Whip.
Whip-crane.
Whip-windlass.
Winch.
Winding-engine.
Winding-tackle.
Windlass.

Among the modern facilities for taking care of farm produce, the horse hay-fork suspended by tackle from an elevated beam in the barn deserves a special mention. For the varieties of the fork, see FORK. This device is usually suspended by tackle from the beam by means of a clutch or tongs. (See CLUTCH.) The clutch, however, is not the only means of suspending the tackle and fork; in stacking hay a derrick is used, and in some barns a still more complicated device. When the load has reached its elevation, a pawl is raised which allows the carriage to traverse on the track and transport the load horizontally and return when the load is discharged. The brake moderates the rate of the hoisting-rope in running over the pulleys.

Fig. 2531.



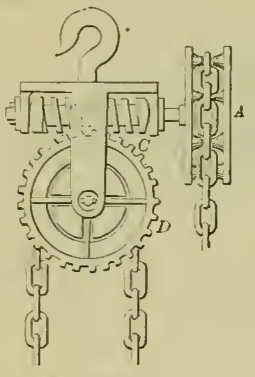
Hay-Hoisting Apparatus.

In another form of hoisting-machine, a platform, provided with rollers at its bottom, rests upon a large worm-wheel which meshes equally into two vertical worm-racks or segmental screws. Motion is imparted to the worm-wheel by a small gear-wheel meshing with a toothed rack on the lower surface of the worm-wheel.

Under this head may also be mentioned a device for lifting bricks, mortar, etc., to the top of buildings in course of erection. In this, buckets for the elevation of building material are fixed upon an endless chain. The chain is worked by a windlass at its upper end.

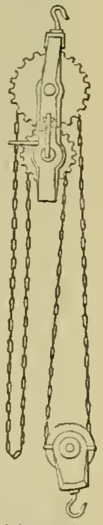
Hoist'ing-tack'le. A rope or chain and pulley used for hoisting. The simplest form of tackle is the *whip*, then follow the *whip-on-whip* and other forms of tackle cited in the list above. The form shown in Fig. 2533 is a differential tackle, and consists of two shafts, on each of which is a sprocket and a gear-wheel, the two latter meshing with each other. The proportion between the diameters of the gear and sprocket wheel on one shaft differs from the proportion between the diameters of the gear and sprocket wheels on the other shaft, in order that by overhauling the endless chain which is connected with the teeth of the two sprocket-pulleys, the block bearing the weight to be raised and connected by the chain with the sprockets may be raised or lowered as desired. The lower sprocket-wheel is applied so that it may be thrown out of connection with the upper one and locked so as to prevent retroaction.

Fig. 2532.



Worm-Wheel Tackle.

Fig. 2533.



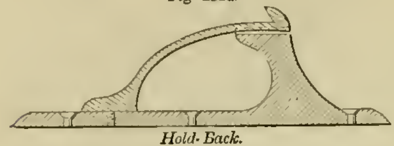
Differential Hoisting-Tackle.

Fig. 2532 has a large wheel *A* on which is a worm *C* gearing into the chain-wheel *D*. Such a tackle will hold its load at any point at which the power ceases to be applied, and will not allow it to come down "on the run." The threads of a screw act as a stop or check to the windlass wheel.

Hold. (*Shipwrighting.*) The interior part of a ship, in which the cargo of a merchant vessel or the provisions and stores of a man-of-war are stored. The portions are distinguished as the *fore*, *main*, and *after* holds.

Hold-back Hook. (*Vehicle.*) A projection on a carriage-shaft to which the breeching-strap of a horse is connected, to enable the animal to hold back the vehicle.

Fig. 2534.



Hold-Back.

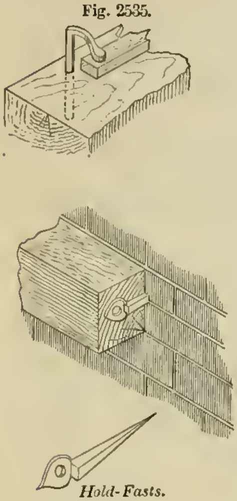
Hold-beam. (*Shipbuilding.*) One of those which support the lower deck in a merchantman; the *orlop* deck in a man-of-war.

Hold-fast. A means by which something is clamped to another.

The bench *hold-fast* is an arched bar, whose shank passes through a mortise in the bench, the *dog* pressing upon the work to be held. See Bench-clamp.

A wall *hold-fast* is a spike, which is driven into the wall, and has a flat head through which a nail is driven into the object to be attached.

Fig. 2535.



Hold-Fasts.

Hold′ing-down Bolt. (*Steam-engine.*) One of twelve or more strong bolts, which are passed from the outside of a steam-vessel through the floor-timbers, sleepers, foundation-plate of the engine, and the bosses on the cylinders, condensers, and side-frames, and are secured by strong nuts. The bolts are of copper or tinned iron, to resist the action of sea-water.

Hold′ing-up Ham′mer. A hammer held by the assistant against the head of the rivet while it is being riveted. See Riveting.

Hole. A depression made to hold a blast.

Sinking, *boring*, *pumping*, *drilling*, are terms made use of.

Loading or *charging* the hole is the putting in of the powder.

Tamping is the packing of material upon the powder.

Hole-board. (*Weaving.*) See Compass-board.

Hol′ing. 1. (*Mining.*) The under-cutting of coal by means of a pick wielded by a man lying upon his side. The making of vertical cuts at the sides is called *shearing*, and when these are made the stratum of coal is broken down by wedges driven in above.

2. (*Roofing.*) Piercing slates for holding nails.

Hol′ing-axe. A narrow axe for cutting mortises in fence-posts, for a *post-and-rail* fence.

Hol′land. (*Fabric.*) Linen or linen and cotton goods, white or self-colored, and with a glazed surface. Used for linings. As originally imported from Holland (whence its name), it was closely woven linen cloth.

Hol′low. A depression or unoccupied space, as —

a. The empty portion of a bastion.

b. The part of a cantle under the crupper-loop.

c. The gullet of a saddle under the pommel.

d. The depression in an anvil-face or fullering-tool used in forging round work.

e. A cavetto or recess bead in molding.

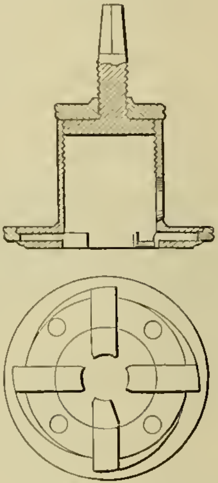
f. The seat of the shot in a counterbored gun. A *dent*.

Hol′low-adze. (*Coopering.*) A howel; a tool having a curved blade to chamfer the chine on the inside of a cask end.

Hol′low-au′ger. One for making round tenons in chair-work, on spokes, etc.

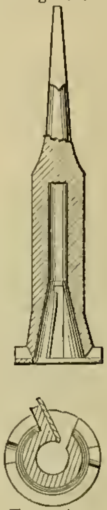
The end of the spoke or other piece of wood on which a round tenon is to be cut, is inserted into the tubular portion, whose throat has several radial rests and a radial cutter. The tool is revolved, and the blank is fed forward on the rests. The length of the tenon is gaged by the adjustable stop at the rear end of the tube.

Fig. 2536.



Hollow-Auger.

Fig. 2537.



Tenon-Auger.

Fig. 2537 is a form in which the auger cuts a tapering tenon and a shoulder upon the spoke simultaneously.

Hol′low-au′ger Bit. A wood-boring tool adapted to be used in a brace. It is of a hollow cylindrical form, and has cutters presented inwardly which make a cylindrical tenon on the end of the stuff. See Hollow-auger.

Hol′low-drift. 1. A tubular tool for driving a hole. See Drift.

2. A tool used in filling signal-rockets.

Hol′low-edge File. A file with a concave edge for dressing teeth of small gear wheels and pinions.

Hol′low-ing and Back′ing-ma-chine′. (*Coopering.*) A machine for rounding staves, giving the outer convexity and inner concavity.

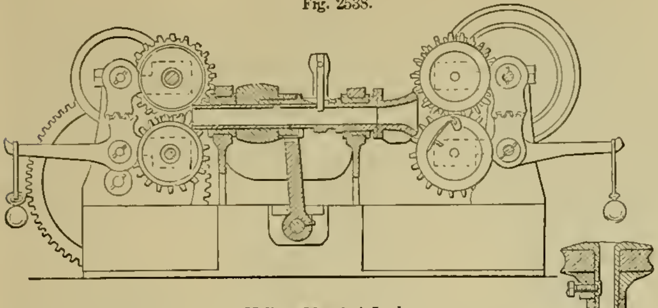
Hol′low-ing-knife. (*Coopering.*) A drawing-knife for working on concave surfaces.

Hol′low-ing-plane. (*Carpentry.*) A plane with a round convex sole.

Hol′low-joint Wire. Small tubes employed in making joints, as in the casing of watches.

Hol′low-man′drel Lathe. One for small round stuff, such as broom-handles, scythe-snaths, stuff for clothes-pins, chair-rounds, round pickets, rails, etc. The stuff is fed by grooved rollers into the trumpet mouth of the revolving hollow mandrel. The tool projecting from the internal periphery of the mandrel turns the blank into shape. The spring forms a stop for the strip, and its position indicates the time for its insertion berween the feed-rollers. The rollers which draw out the turned stick have circumferential depressions, which contain grooved annuli of rubber, which press with an adjustable force on the handle.

Fig. 2538.



Hollow-Mandrel Lathe.

Hol′low-new′el. The well-hole or opening in the center of winding stairs. *Open-newel*, in contradistinction to *solid-newel* or *corkscrew* staircase.

Hol′low-plane. A molding-plane with a convex sole. A *round-sole* plane.

Hol′low-punch. (*Saddlery and Shoemaking.*) The hollow punch is employed to make holes for rivets in leather; holes for eyelets in paper, leather, or fabric; holes for laces in shoes and stays, and on other occasions where a smooth, round hole is to be cut out of a yielding material. It is also known as an *eyeleting*-punch from its use as a means for punching holes for eyelets.

In a modified form, as the punch-pliers, it is used for punching cardboard tickets, tags, and papers for filing. A *ticket-punch.*

A *wad-cutter* is also a hollow punch.

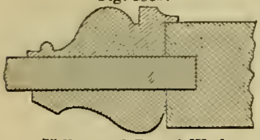
Hol′low-quoin. (*Hydraulic Engineering.*) One having a vertical recess for the hanging-post of a lock-gate to abut against.

Hol′low-rail. A tubular railroad rail, steam heated to prevent the accretion of snow and ice. Grime's English patent, 1831.

In Woodhouse's English patent, 1803, the rail forms a water-pipe.

Hol′lows and Rounds. (*Joinery.*) Concave and convex planes, respectively for working moldings. The illustration shows the use of *hollows and rounds*, in the molding of a panel door. They are made in pairs, and as many as eighteen pairs to a set.

Fig. 2539.



Hollow and Round Work.

Hol′low-ware. Cast-iron culinary vessels, such as pots, kettles, skillets, etc.

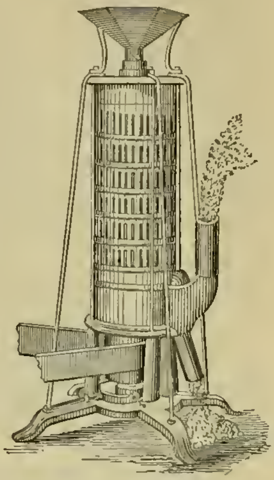
Ho-lom′e-ter. An instrument for taking measurements. See Meter.

Hol′o-pho′tal Light. (*Optics.*) A name applied to such forms of lighting-apparatus for lighthouses as utilize the whole of the available light, by subjecting it all to the corrective action of the instrument; as, for instance, Thomas Stevenson's Catadioptric Light (which see).

Hol-o-ster′ic Ba-rom′e-ter. One made of solid materials, so as to show variations of atmospheric pressure without the intervention of liquids.

The *aneroid* of Vidi, and the bent tube of Bourdon, are examples of *holosteric* barometers, but the word is sometimes used specifically to denote the former. The barometer constructed on the principle of the balance is described in Leupold. See Barometer.

Fig. 2540.



Vertical Hominy-Mill.

Hol′ster. 1. A leather case by the saddle-bow to hold a pistol.

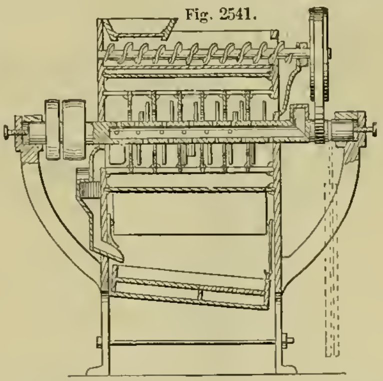
2. A pistol-case carried on the person.

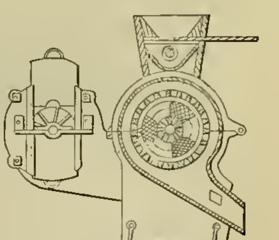
Ho′ly-stone. A large stone used with sand for scouring a ship's decks.

Hom′i-ny-mill. A machine in which shelled corn is subjected to a grating or beating action which removes the cuticle and the germ, and, by persistent and sufficiently energetic action may break the grain as small as may be wanted. The sizes are graded by sifting.

In Fig. 2540 the corn is fed in above, and is subjected to the action of a series of beaters on the rotating vertical shaft. A fan in the case below blows out the dust, bran, and powdered germ.

Fig. 2541.





Horizontal Hominy-Mill.

In Fig. 2541 the mill consists of a double case, the inner shell of which is provided with semi-annular plates or partitions. Within the case is a revolving hollow scouring and blowing shaft, having an air-gathering cup or scoop upon one of its ends, and at the opposite end is a discharge-spout and a blast-passage. Roughened scouring and smooth conveying blades are set spirally around the hollow blowing-shaft.

Hone. A flat slab, usually of some description of slaty stone, used for giving a keen edge to a cutting-tool after sharpening on the grindstone. Various kinds, differing greatly in texture and hardness, are employed. Norway ragstone, water-of-Ayr, bluestone, German-hone, and many other varieties, have a more or less extended reputation for their adaptation to special requirements, being used either dry or moistened with water or with oil. The *Turkey oil-stone*, which comes from Asia Minor, is generally known, and is employed for imparting an edge to chisels, plane-bits, and all the finer varieties of cutting-tools. It is usually cemented in a slab of wood and provided with a wooden cover.

The finest variety of stone suitable for hones is found in Arkansas, and is also known as Washita.

The metallic hone is a small round bar of steel, with fine longitudinal striations. For use it is moistened with oil and sprinkled with rottenstone or other fine abradant.

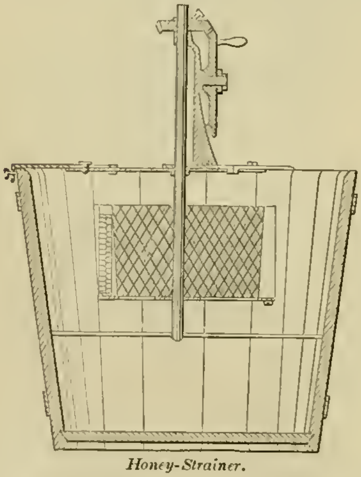
Fayrer's swing hone is a strip of brass pivoted at each end, so as to adjust itself to the edge of the razor. An abrading powder mixed with oil is applied upon one side, on which the razor is roughly sharpened, when the brass slip is turned and a keen edge imparted by the other side, moistened with a finer composition and oil.

Artificial stones and emery-charged leather are also used as hones. See Grinding and Polishing.

Hon′ey-comb. A flaw in a casting.

Hon′ey-strain′er. A device for separating the honey from the comb. In a common form the comb is cut up and placed in a tub or tray to allow the honey to drain from the broken cells. In other cases it is pressed. The example is an application of the centrifugal filter to this purpose. After the *cap* has been cut off the comb, it is placed in a wire-gauze basket which is rapidly rotated. The honey is thrown out by centrifugal force. The drained combs are returned to the hives to be again filled with honey.

Fig. 2542



Honey-Strainer.

Hon′i-ton-lace. (*Fabric.*) A variety of lace made by placing a perforated pattern upon a pillow, and then so twisting and interweaving the thread by means of bobbins, pins, and spindles, as to produce the required pattern.

Hood. 1. (*Mechanical.*) A dome-shaped projection or canopy over a discharging or receiving orifice in a structure, as of a fireplace, chimney, or ventilator.

A *cowl* over a chimney, ashore or aboard.

2. (*Wear.*) A soft covering which shrouds the head. Some are attached to a cloak. "With any that wears a *hood.*" "A *cowled* monk."

3. (*Vehicles.*) A carriage-top which may be elevated or depressed.

4. (*Hydraulic Engineering.*) The capping of the piles of a starling.

5. The top of a pump.

6. The *companion* of a hatchway.

7. (*Nautical.*) *a.* A covering for a companion-hatch, scuttle, chain-pump, or skylight. A *cowl* for the galley chimney.

b. One of the foremost or aftermost planks of a strake. The *hood-ends* fit into the rabbets of the stem and stern posts.

8. (*Saddlery.*) The leathern shield in front of a wooden stirrup, which serves to protect the foot of the rider.

9. (*Sporting.*) The blinding cap on the head of a hawk to make him sit quietly on his perch. Said to have been invented by the Arabians.

Falconry was an ancient custom in Tartary; Ctesias, contemporary of Alexander the Great, mentions that hares and foxes were hunted in India by falcons. Aristotle speaks of the practice in Thrace. It was common in Italy in the time of Martial.

It attained its climax in Europe in the twelfth century.

Hood′ing-end. (*Shipbuilding.*) The end of a *hood* or endmost plank of a complete strake. The *hooding-ends* fit into rabbets of the stem and stern posts.

Hood-mold′ing. (*Architecture.*) A crown-molding. A *head*-molding.

Hood-quar′ter. (*Vehicles.*) One of the side pieces of the back portion of a hood.

Hoof-pad. (*Menage.*) A device attached to the hoof of a horse to keep the foot, or the shoe of the foot to which it is attached, from cutting the fellow foot or the fetlock. A device to prevent *interfering.*

Hoof-par′ing Knife. (*Farriery.*) A knife with a recurved blade, used for paring hoofs, to fit horseshoes thereon; the sharply curved portion enables the knife to act as a *scorper* in the fissures between the *frog* and *sole.* See *g*, Fig. 2545.

Hoof-spread′er. (*Farriery.*) A device for expanding mechanically the hoof of a horse suffering from contraction of the foot.

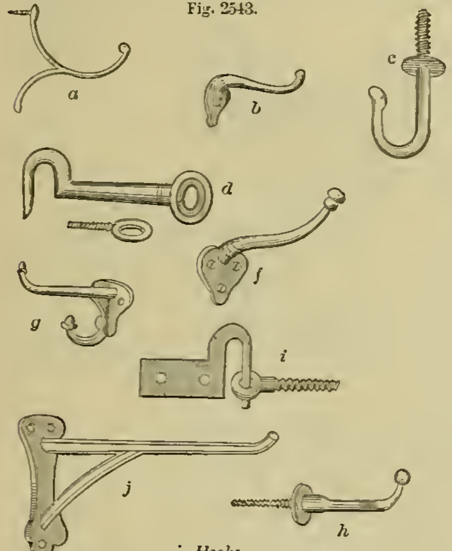
Hook. 1. A curved piece of metal (usually) by which an object is caught or suspended. A tool having a shape similar to the foregoing. See under the following list: —

Axle-hook.
Bench-hook.
Bid-hook.
Bill-hook.
Bloom-hook.
Boat-hook.
Boot-hook.
Breast-hook.
Button-hook.
Cambrel.
Can-hook.
Cant-hook.
Cat-hook.
Chain-hook.
Check-hook.
Chimney-hook.
Clasp-hook.
Clothes-line hook.
Clives.
Clove-hook.
Coat-hook.
Cotton-hook.
Cottrel-hook.
Creeper.

Crochet-hook.
Davit-fall hook.
Draft-hook.
Drag.
Dung-hook.
Eccentric-hook.
Fall-block hook.
Fire-hook.
Fish-hook.
Flesh-hook.
Fore-hook.
Gab-hook.
Gate-hook.
Grapple.
Grappling-hook.
Gullet-hook.
Harness-snap.
Hat-hook.
Heddle-hook.
Hog-hook.
Hold-back hook.
Hook and butt.
Hook and eye.
Hook-block.
Hook-bolt.
Hook-butt.
Hooked tool.
Hooking-frame.
Hook-motion.
Hook-rope.
Hook-scarf.
Hook. Sewing-machine
Hook-tool.
Hook-wrench.
Hose-hook.
Ice-hook.
Laying-hook.
Match-hook.
Meat-hook.
Mousing-hook.
Pad-hook.
Placenta-hook.
Plank-hook.
Pot-hook.
Pruning-hook.
Pulley suspension-hook.
Rack-hook.
Reaping-hook.
Safety-hook.
Sewing-machine hook.
Shave-hook.
Sheep-hook.
Shell-hook.
Shutter-hook.
Sister-hook.
Snap-hook.
Spring-hook.
Suspension-hook.
Tackle-hook.
Tenaculum-hook.
Tenter-hook.
Tow-hook.
Trace-hook.
Wad-hook.
Watch-chain hook.

Besides these are many which come under the name of hardware, and whose names indicate their purpose :—

Fig. 2543.



Hooks.

Awning-hook.
Bird-cage hook.
Cabin-door hook.
Clothes-hook (*f a b c*).
Cotton-hook.
Dressing-glass hook.
Harness-hook (*j*).
Head-board hook (*i*).
Hook and eye (*d*).
Horse-hitching hook.
Lamp-hook.
School-house hook.
Screw-hook (*h*).
Wardrobe-hook (*a b c*).

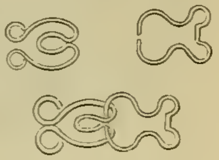
2. (*Shipbuilding.*) A knee or strengthening frame conforming to the inner shape of the vessel and supporting the bow or forward ends of the decks. See STEM.

3. (*Knitting-machine.*) The barbed extremity of the needle, which retains the yarn. The *beard.*

Hook and Butt. A mode of scarfing timber so that the parts resist tensile strain to part them. A *hook-scarf.* See SCARF.

Hook and Eye. An ordinary fastening of ladies' dresses. Made of flattened wire and bent to form, as in the example.

Fig. 2544.



Hook and Eye.

Hook-block. A pulley-block strapped with a hook, in contradistinction to one with an *eye* or a *tail.* See cut of BURTON.

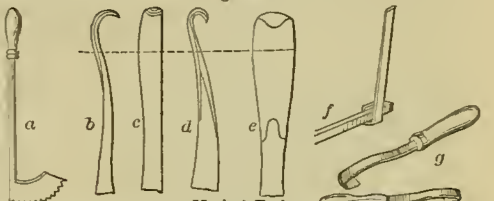
Hook-bolt. A bolt with a hook-head. Used on board ship to fasten lower-deck ports.

Hook-butt. (*Carpentry.*) A mode of scarfing timber. See SCARF.

Hooked-bolt. One with a lip used to fasten boards on to a ship's frame or a wharf.

Hooked-tool. 1. A marble-worker's chisel (*a*), the end bent to a right angle, and used in positions where the square chisel cannot be readily employed.

Fig. 2545.



Hooked Tools.

2. Wood-turning tools of the nature of scorpers (*b c d e*).

3. A bent iron rod (*f*) forming three sides of a square, one end being prolonged for a handle. Used in *taking the twist out* of a bar while forging.

4. A hoof-paring knife (*g*).

Hook'er. (*Nautical.*) A one-masted merchant vessel of the English and Dutch waters. A *howker.*

Hooke's Gear'ing. A kind of gearing in which the teeth are somewhat obliquely across the face of the wheel, so that the contact of each tooth commences at its foremost end and terminates at the aftermost end ; the *pitch* of the spiral is such that the contact of one pair of teeth does not terminate until that of the next pair has commenced.

Hooke's stepped gearing is of a somewhat similar design.

Hooke's Joint. A universal joint. A GIMBAL-JOINT (which see).

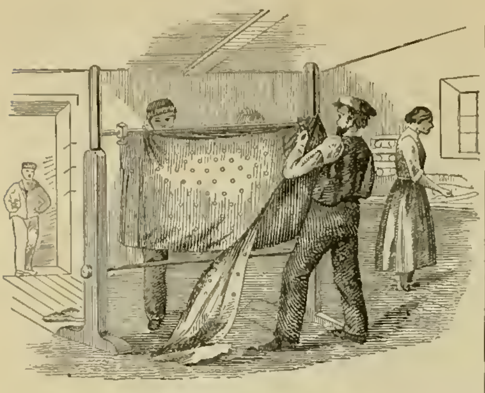
Hook'ing-frame. A frame with hooks upon which cloth is measured and suspended, being folded back and forth until the required quantity is reached, when it is cut off and removed to be packed.

Hook-mo'tion. (*Steam-engine.*) A valve-gear having hooks for actuating and reversing.

Hook-rope. (*Nautical.*) One six or eight fathoms long, with a hook and thimble spliced at one end and whipped at the other. It is used to drag chain and for similar purposes.

Hook-scarf. (*Carpentry.*) A mode of fastening timbers together endways, so that they lock to each other. See SCARF.

Fig. 2546.



Hooking-Frame.

Hook-tool. (*Lathe.*) *a.* A form of hand-tool used in metal turning, which is of a hook shape, and is supported on a rest below and beyond which it extends. A HANGING-TOOL (which see).

b. A wood-turning tool having a bent portion used for bottoming boxes, or lids, or other hollow work. See Fig. 2545.

Hook-wrench. A form of spanner which has a bent end adapted to grasp a nut or coupling piece and turn it. See Fig. 2545.

Hoop. 1. (*Coopering.*) A strip of metal or wood united at the ends and driven around a cask to hold the staves together.

Hoops for casks are known as : —

Bulge-hoop ; the hoop nearest the swell of a cask.

Chine or *chime* hoop ; or *head*-hoop ; the hoop nearer to the end or *chine*.

Flat-hoop ; a thin hoop ; flat on both sides.

Half-round hoop ; a hoop whose outside is the undressed exterior of the pole.

Quarter-hoop ; an intermediate hoop between the bulge and chine.

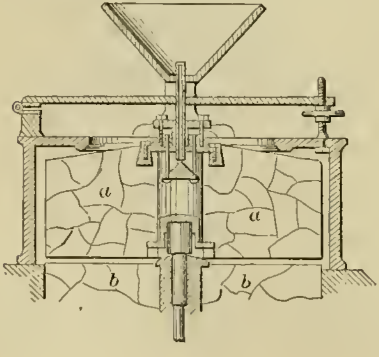
Truss-hoop ; a stout hoop of wood, used before or preliminary to the final hooping.

2. (*Nautical.*) *a.* One of the rings to which the *weather-leach* of a *fore-and-aft* sail is bent, and by which it slides on the *mast* or *stay* as the sail is hoisted or lowered. A *hank*.

b. A band on a wooden anchor stock.

3. (*Milling.*) *a.* The enclosing case of a run of stones. It stands on the husk. *a* is the runner, *b* the bed-stone.

Fig. 2547



Grinding-Mill.

b. A metallic band around a mill-stone.

4. A strap around an eccentric.

5. (*Apparel.*) *a.* A thin strip (usually of steel and covered with braid), used in expanding the skirts of ladies' dresses.

b. A frame made of pliable, steel, braid-covered hoops, united by vertical tapes and adapted to expand the skirt of a lady's dress. Frames of similar shape but differently constructed were in use in the time of Pope and of Queen Bess.

Hoop-bend'ing Ma-chine'. (*Coopering.*) A machine for curving hoops ; generally consisting of a set of three rollers between which the hoop is passed, the upper roller acting against and between the two lower ones, and having its lower surface depressed below the upper line of the two lower ones.

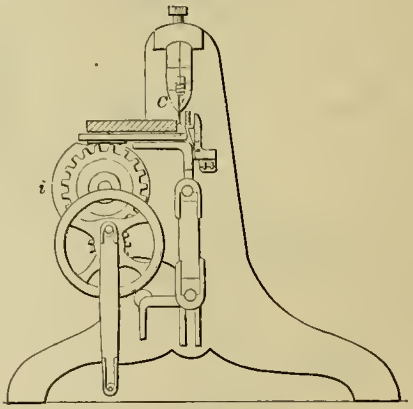
Hoop-coil'ing Ma-chine'. (*Coopering.*) A machine by which split, sawn, or cut hoop-stuff for barrels is wound upon a drum so as to be secured in a coiled condition for shipment and use.

Hoop-cramp. (*Coopering.*) A ring-clutch for holding the ends of a hoop which are lapped over each other.

Hoop-crimp'ing Ma-chine'. (*Coopering.*) One for giving the bend to hoop-stuff to render the hoops tractable in fitting to barrels and casks.

Hoop-cut'ting Ma-chine'. (*Coopering.*) One for cutting from the log or from the edge of a board a slat for a hoop. When made from the log, the latter is rotated between each cut, and the knife makes an incision a depth equal to the width of the hoop, which is removed by another cutter. In cutting from a board, a reciprocating knife *C* cuts hoops from the edge of a plank resting on a table which is alternately raised and lowered by a cam *i* to impart an edgewise taper or bevel to the hoops.

Fig. 2548.



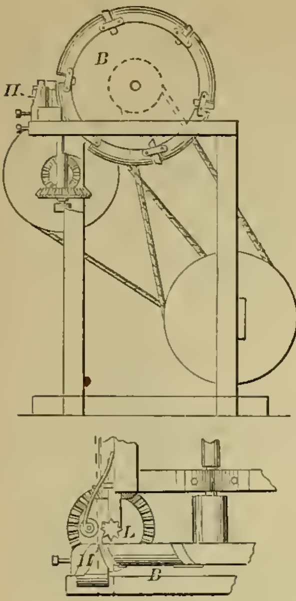
Hoop-Cutting Machine.

Hoop-dress'ing Ma-chine'. (*Coopering.*) A machine for dressing rived hoops to an even thickness. In the example, the hoops are dressed by means of a revolving cutter-wheel, in connection with a guide-block and pressure and feed roller. The lower part of the figure shows the operation more in detail, the hoop passing between the rotary cutter *B* and the head-block *H*. *L* is the feed-roller.

Hoop-driv'er. (*Coopering.*) *a.* A hand-tool which is rested on the edge of the hoop and beaten by a hammer or mallet to force the hoop on to the cask.

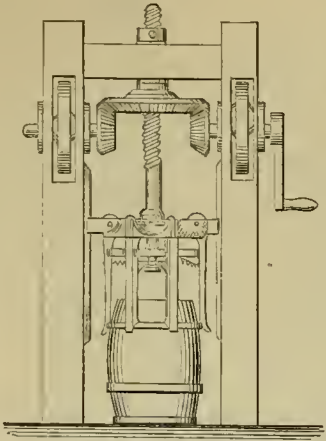
b. A machine by which the hoops are forced on simultaneously.

Fig. 2549.



Hoop-Dresser.

Fig. 2550.



Hoop-Driving Machine.

Attached to a screw-shaft revolved by gearing is a head to which are pivoted pendant drivers, which are adjusted to the side of the cask by a cam-disk with projections on the periphery that force the drivers outward as it is turned, and by revolving the screw-shaft, the head is depressed and drives the hoops upon the cask.

Hoop′ing. (*Founding.*) The iron-work around a molding-box.

Hoop-iron. Flat, thin bar-iron.

Hoop-lock. 1. (*Coopering.*) *a.* A mode of connecting the ends of the split pole or slat which forms a hoop.

b. One of the interlocking notches near the ends of a barrel-hoop.

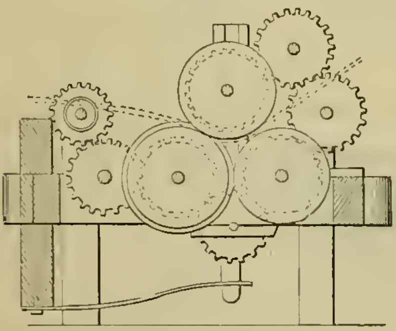
Machines are made for cutting hoop-locks, having descending cutters shaped to the curved form of the notch required.

2. A fastening for the ends of hoops; used in baling hay or cotton. See BALE-TIE.

Hoop-plan′ing Ma-chine′. (*Coopering.*) A machine for thinning down and dressing the surface or surfaces of hoop-pole stuff, or of stuff sawed or cut for hoops. See HOOP-DRESSING MACHINE.

Hoop-punch′ing Ma-chine′. (*Coopering.*) A machine for punching rivet-holes in iron hoops for casks.

Fig. 2551



Hoop-Riving Machine.

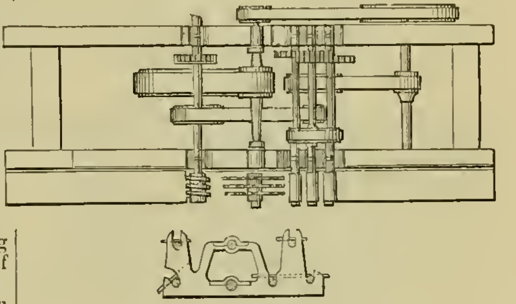
Hoop-rack′ing Ma-chine′. (*Coopering.*) One for forcibly bending rived hoops to make them tractable in placing them around casks.

Hoop-riv′ing Ma-chine′. (*Coopering.*) A machine in which the bar of wood to be rived is sawed out of a proper width for the hoop required, and the end checked by a gang of circular saws. The end is then placed between the guiding friction wheels and advanced to the groove of the wheel, where it is seized by the bite of the upper pressure disk, and passing along is deflected upwards by another wheel emerging from between the latter wheel and the upper disk in a riven condition.

Hoop-saw′ing Ma-chine′. (*Coopering.*) *a.* A machine in which gaged stuff is fed to a gang of circular saws and reduced to dimensions for making hoops. In the example, the saw-shaft has journal bearing either above or below the guide-rollers. The guide-rollers are kept in their journals by pins traversing the upwardly projecting sides of the said journals.

b. A machine which removes, by successive actions, a thin strip for the edge of a board.

Fig. 2552.

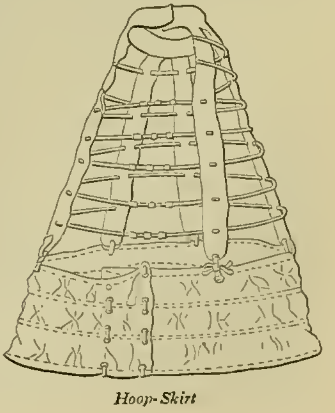


Hoop-Sawing Machine.

c. A machine which saws hoops from a log, which is rotated between each cut, the thickness of a hoop plus the kerf; the saw cutting down into the log the width of a hoop, and a second saw or a cutter removing the hoop so cut.

Hoop-shav′ing Ma-chine′. (*Coopering.*) One for reducing the thickness of hoop stuff, and dressing the edge which lies against the cask. See HOOP-DRESSING MACHINE.

Fig. 2553.



Hoop-Skirt

Hoop-skirt. The fardingale of the time of Queen Elizabeth. See also the "Tatler," January 5, 1710.

The modern hoop-skirt is formed of braid-covered flat steel-wire hoops, united by tapes and shaped upon a former. Various ingenious devices are adopted for making, tempering, covering, marking, and sizing the wire, for clasping the *spangles* which unite the tapes and wires at their intersections.

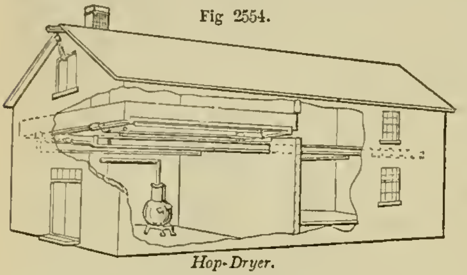
Hoop Splay'ing and Bend'ing Ma-chine'. (*Coopering.*) A machine for spreading hoop-iron on one side so as to enable it to set snugly on the bilge, and at the same time bending the hoop to the curve of the cask.

Hoop-split'ting Ma-chine'. (*Coopering.*) A machine to rive hoops from stuff properly prepared. See Hoop-riving Machine.

Hop-back. (*Brewing.*) The vessel beneath the copper which receives the infusion of malt and hops, and has a perforated bottom which strains off the hops from the unfermented beer.

Hop-dry'er. A chamber in which hops are artificially dried. In the example, a tilting drying-frame runs on a track extending through the drying and store rooms, so that the hops, after drying above the furnace in the former room, may be deposited in the latter.

Fig 2554.



Hop-Dryer.

Also called an *oast*, or *hop-kiln*.

Hop-frame. (*Agriculture.*) A trellis on which hops are supported while growing. Hops are usually grown on poles, which are pulled out of the ground and laid across trestles for the convenience of the hop-pickers. Hop-frames are some of them made to recline to bring them within reach of the pickers.

Hop'per. 1. (*Machinery.*) A chute for feeding any material to a machine. It is generally of an inverted frustal shape, as in brick-machines for feeding clay to the pug-mill; in winnowing-machines, for feeding the grain and chaff to the upper riddle; in grinding-mills, for feeding grain to the stones. Its name is derived from the latter, as it used to be shaken by a *damsel* (projection) on the spindle, in order to keep the grain fed down into the throat. It now feeds the grain into a shaking *shoe*, which is agitated by the *damsel*. See Grinding-mill.

The term is also applied to the reservoir which contains the grain in seeding-machines, planters, drills, etc.

The term is also applied to a feeder, such as the fuel reservoir of a stove.

The holder of blanks in a machine, as the screw-blanks in a screw-cutting machine. The planchets in a coining-machine, eyelets or spangles in machines using those articles, and many others too numerous to mention.

2. The basin of a water-closet.

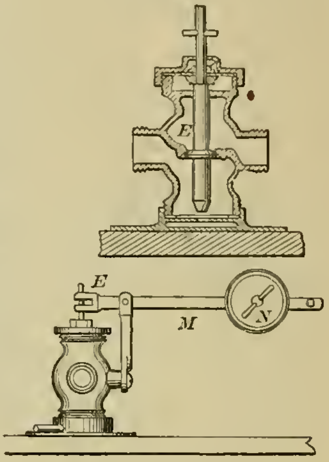
3. (*Glass.*) A conical vessel suspended from the ceiling, containing sand and water for the use of the glass-cutter.

4. (*Music.*) A jointed, upright piece attached to the back of a key in a piano-forte movement, to lift the hammer, instead of the stiff wire or lifter used formerly. It is an arrangement for allowing the key to impel the hammer and then escape from it, so that the hammer is free to fall away from the string immediately. It is a feature of the *double-action* piano-forte movement. See Piano-forte.

Hop'per-boy. A device in a grinding-mill, consisting of a revolving rake drawing the meal over a discharge opening in the floor. Invented by Oliver Evans.

Hop'per-cock. A valve for water-closets, etc. In the example, pressure on the seat depresses the stem *E* with its valve, allowing the water to pass through and out of the opposite eduction opening. When the pressure is relieved the weight *N* on the lever *M* attached to the rod *E* lifts the valve again into its seat.

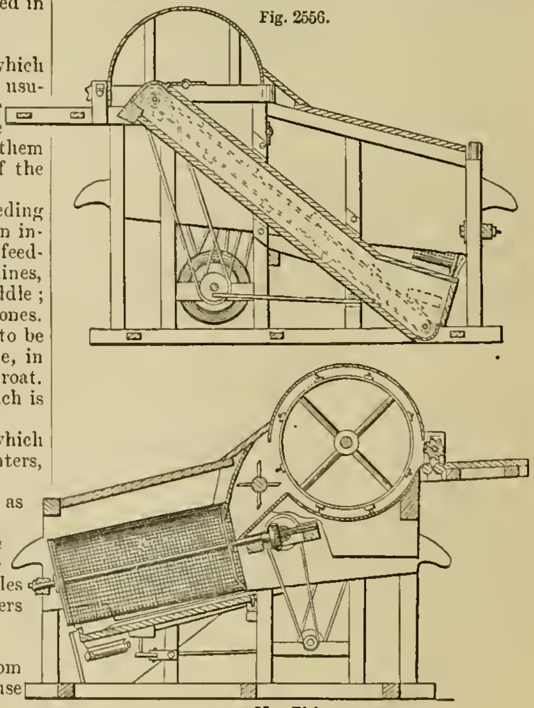
Fig. 2555.



Hopper-Cock.

Hop-pick'-er. (*Husbandry.*) A machine for picking hops. The branches are stripped from the vines and passed into the machine between

Fig. 2556.



Hop-Picker.

the feed-rollers, when they encounter the teeth of the picker, which detach the hops from the vines and pass both through the trough into the screen, wherefrom the hops drop into the shaker, whence they are conveyed by the elevator to sacks.

The figures are respectively a side elevation and longitudinal vertical section.

Hop'ple. (*Menage.*) A device for confining the legs of horses so as to hamper their motion and thus restrain their wandering. A *hobble.*

The devices are principally modes for shortening their step and thus reducing their speed, as well as lessening their inducement to stray, owing to the inconvenience of motion and unaccustomed restraint.

a is one intended for training. The pads are strapped around the pastern and above the knee respectively, and are connected to each other by a rubber band rove through a staple on the upper pad, and regulated as to length by the buckles on the lower pad.

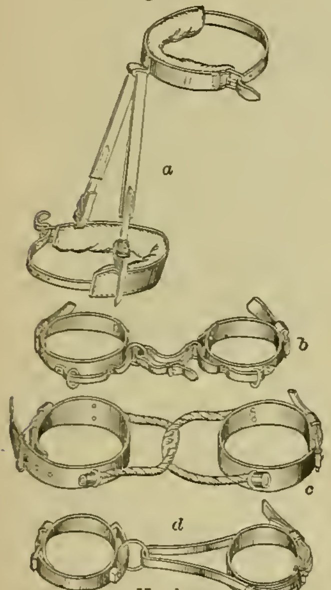
b is Captain Eagle's hopple, in which the coupling-strap ring moves in staples in the fetlock straps, and does not tend to rotate the latter and thus gall the limb.

c has coupling-loops which divide the abrasive motion between them.

d has a strap which slips through the ring instead of turning the leg-band.

Hop-pole. (*Husbandry.*) A training-pole for hops. It consists of little but a simple sapling or trunk of one of the lighter trees, the wood depending upon the means and kinds at hand.

Fig. 2557.

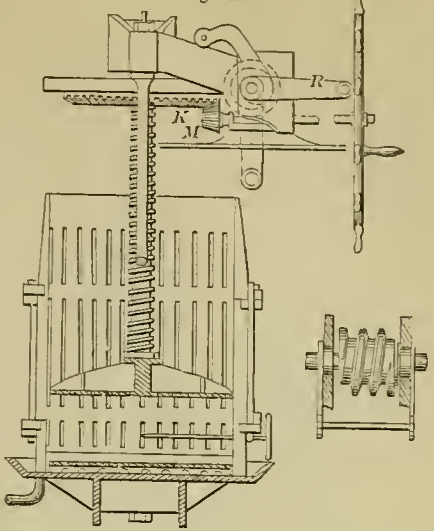


Hopples.

Hop-press. (*Brewing.*) A machine for expressing the liquid from hops after boiling.

In the press shown, a rapid rotation of the screw in the early part of the operation is obtained through the bevel gear *K M* by turning the hand-wheel. When the resistance becomes great, the hand-wheel is thrown out of gear and a worm-wheel connected, which by turning cranks *R* gives a slow but powerful impulse to the screw.

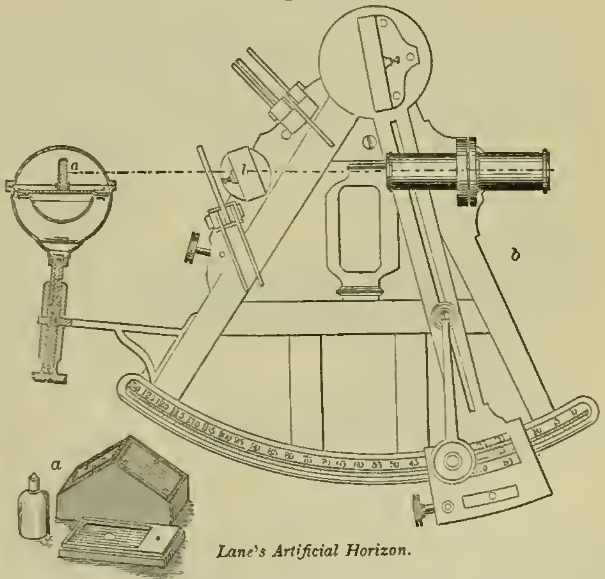
Fig. 2558.



Hop-Press.

Ho-ri'zon, Ar-ti-fi'cial. (*Optics.*) A rectangular platform (*a*, lower figure), with raised sides, and legs arranged for leveling. A glass roof protects the mercury, which is poured upon the platform and forms the horizon.

Fig. 2559.



Lane's Artificial Horizon.

Lane has a method of determining the artificial horizon for sextants, etc. To a sextant *b* of the usual construction, with an index-glass, horizon-glass, and eye-piece, is added a vertical mirror or reflecting surface *a*, the plane of which is perpendicular to a continuation of the visual ray passing from the eye-piece and intersecting a hair-line *b*, or its equivalent, which is placed in the frame of the horizon-glass, or at any point between the mirror *a* and the eye, where it can be seen by the latter, with or without the aid of a lens.

The plane of the horizon is a tangent to the curvature of the earth at any place, and is assumed very nearly by the surface of a quiescent liquid, which thus becomes an artificial horizon from which the altitude — of a heavenly body, for instance — may be measured. From the law of the reflection of light, it follows that the angle subtended at the eye of an observer by a star and its image as seen reflected from such a liquid surface is twice that of the altitude of the star above the horizon. On account of its high reflecting power, mercury is the liquid generally used for an artificial horizon.

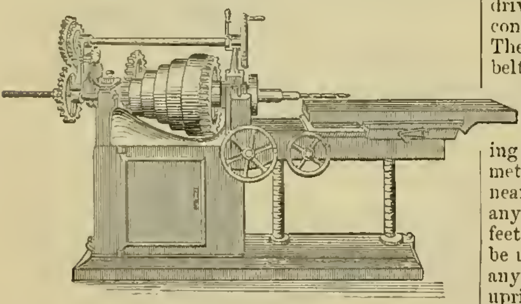
A horizontal spinning speculum was adopted by Lerson, of England, and this was improved by Smeaton, who used a polished metallic speculum about three and a half inches in diameter enclosed in a circular rim of brass, so fitted that the center of gravity of the whole shall fall near the spot on which it spins. This is the end of a steel axis running through the center of the speculum, above which it finishes in a square for the convenience of fitting a roller on it, bearing a piece of tape wound round it. It spins in an agate cup.

Ho-ri'zon-glass'es. (*Optics.*) The two speculums on one of the radii of a quadrant or sextant. The one half of the fore horizon-glass is silvered, while the other half is transparent, in order that an object may be seen directly through it. The back horizon-glass is silvered above and below, but has a transparent stripe across the middle, through which the horizon can be seen.

Hor-i-zon'tal Di'al. One with a plane parallel to the horizon, having its gnomon elevated according to the latitude of the place.

Hor-i-zon'tal Drill. (*Machinery.*) A boring-machine whose drill-arbor works horizontally and parallel with the bed to which the work is dogged. It has variable feed and quick hand traverse to boring-spindle, arranged so as to be changed instantly from one to the other; compound tables arranged to move vertically, with horizontal movement at right angles and parallel to drilling-spindle; the arbor which carries the drilling-spindle is arranged with face-plates, so that the machine can be used as a face-lathe.

Fig. 2560.

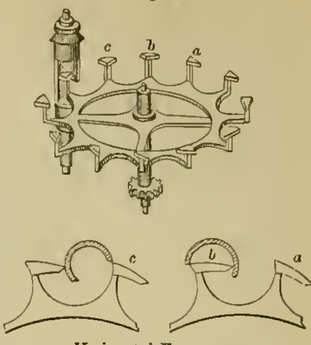


Sellers's Horizontal Drill.

Hor-i-zon'tal Es-cape'ment. One in which the impulse is given by the teeth of a horizontal wheel acting on a hollow cylinder on the axis of the balance. It was invented by Graham, about 1700.

The diagram shows the action, the cylinder being represented in two positions at different portions of its oscillation. The pallets *a b c* on the wheel rest alternately on the inside and the outside of the cylinder, their beveled edges sliding against the edges of the cylinder, to communicate an impulse thereto. It is a *dead-beat* escapement. There is considerable friction. The parts are delicate and hard to repair. The cylinder has been made of a ruby, but at great expense.

Fig. 2561.

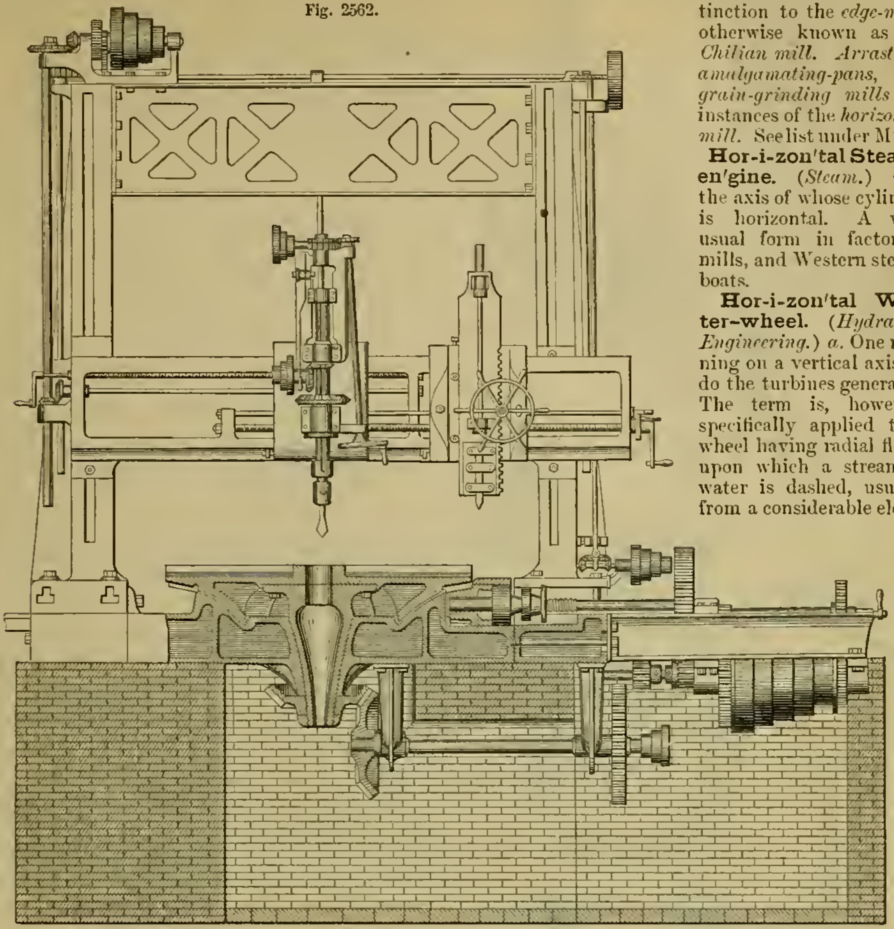


Horizontal Escapement.

Hor-i-zon'tal Lathe. A *vertical turning and boring machine.* The one illustrated is set up in the Boston Navy-Yard, and is, perhaps, the largest in use, being of such a size that a monitor turret can be turned in it entire. The work-table, instead of traveling in slides, is circular, and revolves like a face-plate on a vertical axis. The tools are held in heads on a cross-slide, which is fitted to two uprights resting on cheek-pieces bolted to the main casting or foundation-piece.

On the under side of the revolving table is a bevel-gear driven by a pinion, which may be backed out of gear by means of a hand-wheel on a thread on the horizontal shaft. The hub of this pinion, being slightly larger in diameter than the pinion itself, is used as a journal, by means of which the pinion is caused to revolve with great steadiness, and when out of gear the pinion is within the pillow-block. This is required when a quick motion is given to the table by means of a pair of miter-gears, one of which is attached to the lower end of the table-bearing. One of the heads on the cross-slide is fitted for drilling, the spindle being 4½ inches diameter, with a travel of 18 inches, independent of the cross-slide. This drill-spindle is driven by means of miter-gears and shafting from a cone placed on the top of the upper cross-brace. The revolving table is driven by means of a 6-inch belt running on a 5-speeded cone, the smallest pulley of which is 17 inches diameter, the largest 34 inches, strongly back-geared in such manner as to allow 20 different speeds. The conical bearing of the revolving table is lined with Babbitt metal. By placing the uprights with cross-slide near the revolving table, the drill may be placed at any point within the surface of a diameter of 12 feet; while in the same position the other head may be used for the purpose of boring, facing, or turning anything of the same size. By moving back the uprights near the ends of the cheek-pieces the machine is capable of boring, facing, or turning anything up to 24 feet diameter. The main casting, in which the table revolves, is 10 feet 4 inches square by 24 inches deep, except at the center, where a projection receives the lower end of the bearing; at this point it is 9½ inches deeper. This casting weighs 26,000 pounds; weight of circular table, 13,000; weight of the cheek-pieces on which the uprights move, 14,000 pounds each. These pieces are 21 feet long, 24 inches high, 3 inches wide; the cross-slide 15 feet long, 33 inches high, deepest part of arched back 22 inches. This is cast hollow. The two uprights are connected at their upper ends by means of a cross-brace 11 feet 4 inches long by 36 inches deep. The tool-holder slide weighs 1,000 pounds, and is fitted with rack and pinion for quick movements, and screw for self-feed. The cross-slide is raised or lowered by means of screws and worm-wheel driven by power. The uprights, with the cross-slide, may also be moved to and fro on the cheek-pieces by means of power applied to screws working in nuts at their lower ends.

Fig. 2562.



Horizontal Lathe.

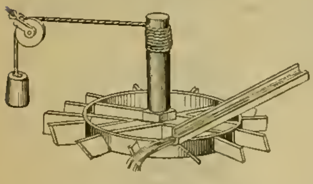
Hor-i-zon'tal Mill. A mill in which the acting surfaces are in a horizontal plane at right angles to the vertical axis of the rotating stone or stones. The term is in contradistinction to the *edge-mill*, otherwise known as the *Chilian mill*. *Arrastras*, *amalgamating-pans*, and *grain-grinding mills* are instances of the *horizontal mill*. See list under Mill.

Hor-i-zon'tal Steam-en'gine. (*Steam.*) One the axis of whose cylinder is horizontal. A very usual form in factories, mills, and Western steamboats.

Hor-i-zon'tal Wa'ter-wheel. (*Hydraulic Engineering.*) *a.* One running on a vertical axis, as do the turbines generally. The term is, however, specifically applied to a wheel having radial floats upon which a stream of water is dashed, usually from a considerable elevation. The floats may be set spirally, so as the better to receive the impact of the water.

This form of wheel has but little prominence in this country, but is used in Central America and some other places where a small body of water with a considerable head is available, and the mechanical appliances at hand will not furnish a better arrangement.

Fig. 2563.



Horizontal Water-Wheel.

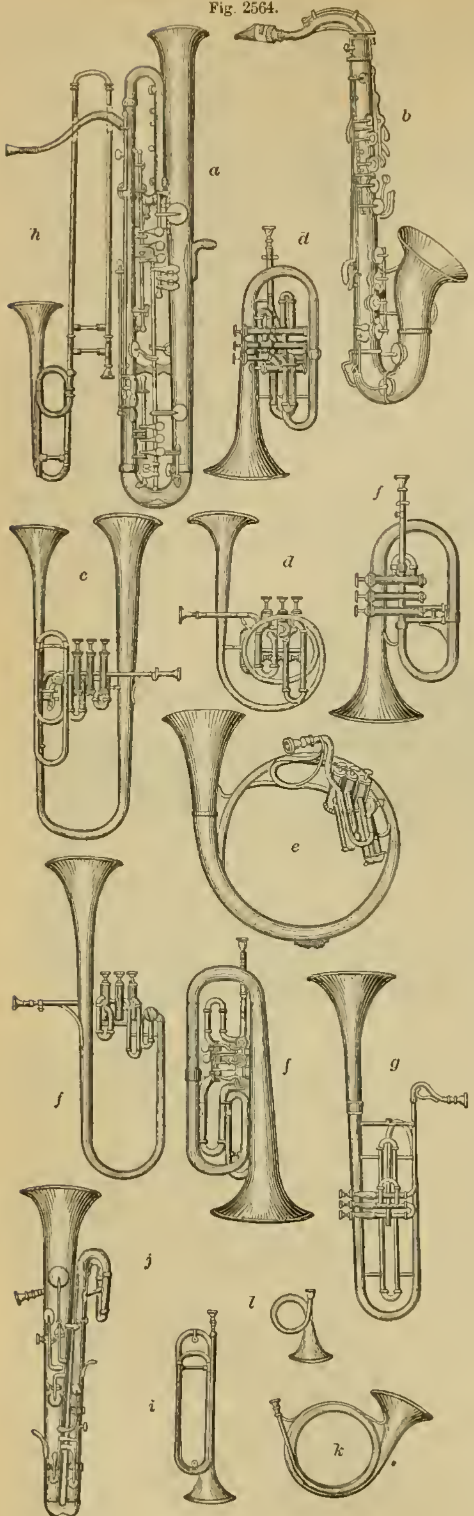
b. A *turbine*, as it is usually arranged.

Horn. 1. A hard projection from the heads of certain animals, cattle, sheep, and goats. Mechanically and chemically speaking, the *horns* of these animals must not be confounded with the antlers of the various species of deer, which are more nearly allied to bone and ivory. The finer varieties of horn have but 2 or 3 per cent of earthy matter, while bones have over 50 per cent. If we seek for other articles nearly allied to true *horn*, we shall find them in tortoise-shell, hoofs, claws, nails, quills, whalebone.

The bony core of the horn being removed, the next process is to cut off with a saw the tip of the horn, that is, the whole of its solid part, which is used by the cutlers for knife-handles, is turned into buttons, and is applied to sundry other purposes. The remainder of the horn is left entire or is sawn across into lengths, according to the use to which it is destined.

Next, it is immersed in boiling water for half an hour, by which it is softened; and while hot is held in the flame of a coal or wood fire, taking care to bring the inside as well as the outside of the horn, if from an old animal, in contact with the blaze. It is kept here till it acquires the temperature of melting lead or thereabouts, and in consequence becomes very soft. In this state it is slit lengthwise by a strong pointed knife like a pruning-knife, and by means of two pairs of pincers, applied

Fig. 2564.



Horns.

one to each edge of the slit, the cylinder is opened nearly flat.

The degree of compression is regulated by the use to which the horn is afterwards to be applied; when it is intended for leaves of lanterns, the pressure is to be sufficiently strong (in the language of the workmen) to break the grain; by which is meant separating in a slight degree the laminæ of which it is composed, so as to allow a round-pointed knife to be introduced between them in order to effect a complete separation. The plates are laid one by one on a board covered with hide, and being fastened down are scraped with a draw-knife; when reduced to a proper thickness and smoothed, they are polished by a woolen rag dipped in charcoal dust, adding a little water from time to time; they are then rubbed with rottenstone, and polished with horn shavings.

For combs, the plates of horn should be pressed as little as possible, so that the teeth may not split at the points. They are shaped chiefly by means of rasps and scrapers of various forms, after having been roughed out by a hatchet or saw; the teeth are cut by a double saw fixed in a back, the two blades being set to different depths, so that the first cuts the tooth only half-way down, and is followed by the other which cuts to the full depth; the teeth are then finished and pointed by triangular rasps. Articles too large to be made from a single plate of horn are made by joining two or more plates together by heating them sufficiently to melt, but not to decompose, the horn, and subjecting them to pressure; when well done the juncture cannot be perceived.

If a work in horn, as a large comb, is required to be of a curved or wavy figure, it is finished flat, and is then put into boiling water until it becomes soft, when it is transferred to a die of hard wood, in which it is pressed, and there remains until cold.

Horn is colored by boiling it in infusions of colors. Imitations of tortoise-shell are made by applying hot a solution of pearlash, quicklime, litharge, and dragon's blood. This is laid on in streaks and blotches to imitate the shell, and a second application gives the darker spots. Horn drinking-cups are made by cutting the horn into lengths, softening, expanding the horn on a wooden mold, turning, polishing, bottoming, and mounting. The bottom is cut out by a *crown* saw, and is pushed into a groove near the bottom of the cup, the softened horn allowing it to pass, and contracting to hold it safely.

Horn for knife-handles is sawn into blanks, heated, pared, and partially shaped; then heated in water and pressed between dies. It is afterwards scraped, buffed, and polished.

Deer-horns are worked like bone or ivory.

2. (*Music.*) A wind instrument of metal, of which many elegant and excellent instruments may be considered as varieties. The name (*horn*) suggests the article first used for the purpose: —

Bugle.
Clavicor.
Cornet.
Cornopean.
Duplex-pelitti.
French-horn.
Helicon.
Hunting-horn.
Kent-bugle.
Key-bugle.
Ophicleide.
Post-horn.
Sarrusophone.
Saxhorn.
Saxophone.
Trombone.
Trumpet.
Tuba.

The *French horn* is a brass musical instrument, of a complex, spiral form, increasing in diameter to its end or mouth. The tone is governed by pistons, or by crooks which change the pitch, and the character of the tone by the hand inserted into the mouth or *pavilion*.

The horn of the wild bull, tipped with silver and slung by a silver chain, was the *bugle horn* of the hunter in former times.

The "*echo*" attachment of the horn or bugle is a switch on one of the convolutions of the instrument, by which the sound is conducted through a small pipe, and a diminuendo effect produced, resembling an echo.

The *tuba* is a bass horn, — name from its shape.

Some of these instruments, as those marked *a*, *b*, *c*, *d*, *e*, *f*, *h*, *j*, in the accompanying cut, are made *en suite*, of sizes and compass to take different parts in concerted pieces of music, and are known as, —

Soprano.
Contralto.
Tenor.
Baritone.
Bass.
Double-bass, or
Contra-bass, etc.

Or by the pitch of the key of the instrument, as : —

E-flat.
B-flat, etc.

The accompanying cut shows several varieties : —

a Sarrusophone.
b Saxophone.
c Duplex pelitti.
d d cornets *à pistons*.
e Helicon *à pistons*.
f f f Saxhorns.
g Clavicor.
h Trombone.
i Trumpet.
j Ophicleide.
k Hunting-horn.
l Post-horn.

3. (*Mechanics.*) A projecting portion of an object.

4. (*Saddlery.*) *a.* The high pommel of a Spanish or half-Spanish saddle. Sometimes made of horn.

b. The projections on the forward part of a woman's saddle, between which the right leg is placed. The inside one is the *small-horn*, the outer the *large-horn*.

5. (*Forging.*) The *beak* of an anvil around which objects are bent.

6. (*Nautical.*) *a.* The arm of a cleat or kevel.

b. One member of the jaw of a boom.

7. (*Mining.*) A spoon or scoop of horn, in which washings are tested in prospecting.

8. (*Milling.*) One of the points of a driver, on the summit of a millstone spindle, and which project into the *coffins* of the runner to convey the motion of the spindle thereto.

9. One of the prongs or crutches of an elevating screw or jack.

10. A curved projection on the forepart of a plane.

11. A powder-flask, of horn.

Horn, Ar-ti-fi'cial. *a.* An artificial horn for lanterns was made some 70 years since in France, consisting of brass gauze dipped repeatedly in dissolved isinglass and varnished.

b. Gelatine from bones, tanned by the ordinary process. It is used for the same purposes as horn or tortoise-shell. It is softened by boiling in a solution of potash, when it may be pressed into shape and dried between molds. It may be inlaid while in the soft state, and stained or striped to resemble fancy woods.

c. Caoutchouc, sulphur, gutta-percha, vulcanized by heat ; gypsum, resin, or lead may be added, or matter for coloring.

d. Take linseed-oil 10 pounds, protochloride of sulphur 1 pound, bisulphide of carbon 3 pounds. Of the product take 10 pounds ; asphaltum, 4 pounds ; flowers of sulphur, 2 pounds ; crude gutta-percha, 4 pounds. Put in heater and raise temperature to 300° to 350° F.

e. Horn as a substitute for whalebone : —

Boil ox-horns in water, then in oil, press while hot, and cut into shape by circular saws.

f. Towers's patent. Rawhide is dipped in melted sulphur, and molded while in a heated condition. See also PYROXYLINE ; IVORY, ARTIFICIAL.

Horn-book. A primer of the fifteenth century. The alphabet, vowels, and Lord's Prayer were printed on a slip of paper, which was covered with a thin layer of horn to keep it from being torn.

Horn-card. A graduated drafting scale or protractor, made of horn.

Horn-drum. (*Hydraulic Engineering.*) A water-raising wheel divided into sections by curved partitions. It resembles one form of TYMPANUM (which see).

Horn-lead. (*Mining.*) Native chloride of lead. So called from its consistence.

Horn-mer'cu-ry. See HORN-QUICKSILVER.

Horn'pipe. (*Music.*) A Welsh wind-instrument, having a wooden pipe with holes at intervals, and a horn at each end.

Horn-plate. (*Railroad Engineering.*) The *axle-guard* or vertical frame in which an axle-box slides up and down as the springs dilate and contract. A *pedestal*.

Horn-quick'sil-ver. (*Mining.*) Native bichloride of mercury or calomel.

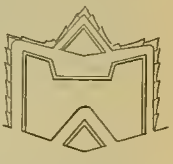
Horns. (*Mining.*) The guides for the ropes on the drum.

Horn-sil'ver. (*Mining.*) Native chloride of silver. So called from its conduct under the cutting-tool. Fused chloride of silver.

Horn-tip. (*Husbandry.*) A button or knob placed on the end of the horn of an animal of the cow kind. It is usually put on to render the horn less dangerous, sometimes for ornament.

Horn-work. (*Fortification.*) A work consisting of two *half-bastions* and a *curtain*, with two long sides called *wings*, which connect it with the main work, by which it is commanded.

Fig. 2565.



Horn-Work.

It is an extended defensible position to occupy advantageous ground or to command ground otherwise unseen.

Hor'o-loge. A timepiece ; a clock or watch. See next article.

Hor'o-log'ic-al In'stru-ments. Time-measurers. See —

Alarm-clock.
Alarm-watch.
Astronomical clock.
Balance.
Barrel.
Calendar-clock.
Cannon-clock.
Case-winding watch.
Center-seconds watch.
Chime-barrel.
Chronograph.
Chronometer.
Clepsydra.
Clock.
Clock-movement.
Clock-pillar.
Compensation-balance.
Compensation-pendulum.
Count-wheel.
Cuckoo-clock.
Curb-pins.
Dial.
Dial-work.
Ding-dong.
Electric clock.
Electric pendulum.
Electric time-ball.
Electro-magnetic clock.
Equation-watch.
Escapement.
Fusee.
Flying-pinion.
Globe-clock.
Gnomon.
Going-barrel.
Going-wheel.
Gridiron-pendulum.
Hair-spring.
Half-minute glass.
Hammer.
Hammer-tail spring.
Hand.
Hawk's bill.
Heliotrope.
Hour-glass.
Hunter-watch.
Hydraulic clock.
Hydroscope.

Illuminating-clock.
Independent seconds' watch.
Jewel. Watch
Lepine-watch.
Lid-winding watch.
Lifting-piece.
Log-glass.
Mainspring.
Micronometer.
Minute-glass.
Minute-hand.
Minute-jack.
Motion.
Movement.
Musical clock.
Panto-chronometer.
Pendant.
Pendant-winding watch.
Pendulum.
Polar-clock.
Polar-dial.
Potence.
Prill-piece.
Rack.
Rack-hook.
Rack-tail.
Regulator.
Repeating-watch.
Rolling-pendulum.
Sand-glass.
Sidereal clock.
Snail.
Solar-chronometer.
Star-wheel.
Stem-winding watch.
Stop-watch.
Stop-work.
Strike or silent.
Sun-dial.
Telegraph-clock.
Time-ball.
Time-piece.
Train.
Turret-clock.
Verge.
Warning-piece.
Watch.
Watch-alarm.
Watch-case.
Watch-clock.
Watchmaker's files.
Watch-regulator.
Watch-screw.
Watch-spring.
Water-clock.

Ho-rom′e-ter. An instrument for measuring time, as a *clepsydra, clock, dial, watch.* See previous article.

Hor′o-scope. A species of planisphere invented by Jean Paduanus. See PLANISPHERE.

Horse. 1. (*Nautical.*) *a.* A foot-rope attached by *stirrups* beneath a yard for the seamen to stand on in reefing. A *foot-rope.*

b. A breast-rope in the chains to secure the leadsman.

c. An iron bar across a boat for a stay-sail sheet or boom-sheet to travel on.

d. A rope reaching from the *knight-head* to the upper part of the *bowsprit-cap*, for the safety of the men walking out upon the bowsprit in rough weather.

2. A wooden bar or frame with legs, used for supporting something. As a *clothes-horse* for clothes; a *saw-horse* for a board or timber while being sawed; a frame to hold a saddle; a *trestle* for joiner-work to rest upon while being keyed up.

A *shaving-horse* is a beam supported by legs, and having a *jaw* which is closed by the pressure of the feet against the treadle below, and is thereby caused to hold a shingle, axe-handle, spoke, or other article while being shaved by a *drawing-knife.*

3. (*Leather.*) The trestle or sloping board of the currier on which he spreads his skins while currying.

4. (*Printing.*) A slanting board at the end of the *bank* or table, to hold a supply of paper for a press.

5. (*Mining.*) A mass of earthy matter intervening between the branches of a vein of ore or coal. The vein straddling on each side of the non-metalliferous rock is said to *take horse.*

6. (*Hydraulic Engineering.*) That on which the mooring of a flying-bridge rides and traverses, and which consists of two masts with horizontal beams at their heads.

7. A hook-shaped tool used for hammered or raised work.

8. A vaulting-block in a gymnasium.

Horse-ar-til′ler-y. Flying artillery. Gunners mounted on horseback and on the limber.

Horse-boat. A ferry-boat moved by horses. The horse-power may be applied to paddles or to a rope stretching across the stream.

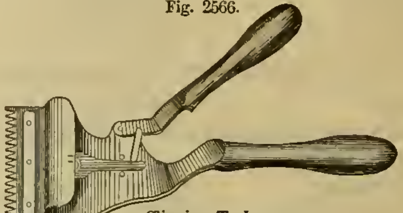
Horse-box. (*Railway.*) The English term for a horse-car used in shipping gentlemen's horses between town and country as the seasons come and go; sending hunters on to the *meet* that they may be fresh for a start; forwarding animals to exhibitions, to market, etc.

Horse-brush. (*Menage.*) One for grooming horses. Such are usually elliptical in shape, but have been made long and flexible with a handle at each end to lap around the legs.

Horse-cap′stan. A *whim.* A capstan worked by horses for raising ore, water, etc.

Horse-clip′ping Tool. A form of shears in which a pair of serrated knives reciprocate over each other, cutting off the hairs, which are cut as they come between the teeth.

Fig. 2566.



Clipping-Tool.

Horse-col′lar. A roll of leather stuffed with straw, husk, or sponge, and placed around the neck of a horse and against the shoulder, to pull by. It has two creases to hold the hame. See COLLAR, 4.

Horse Ferry-boat. One in which paddles or a rope reaching across the river are worked by a horse on board the boat.

Horse-gear. The English term for the horse-power, applied to thrashing-machines, pumps, etc. See HORSE-POWER.

Horse-hair. The hair of the manes and tails of horses, used in making haircloth, etc. See HAIR-CLOTH.

Horse Hay-fork. See FORK; HAY-FORK.

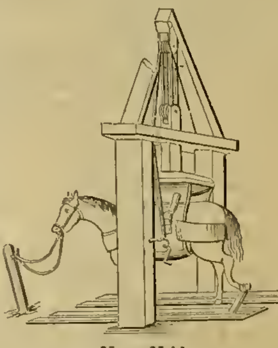
Horse-hoe. The English name for the cultivator for crops in rows. See HOEING-MACHINE.

Horse-hitch′ing Hook. (*Menage.*) A snap-hook on a short chain or strap attacked to a post or wall. The hook is snapped into the bit-ring, and the arrangement saves the trouble of carrying a hitch-strap.

Horse-hold′er. (*Menage.*) A stocks or slinging frame for unruly horses while shoeing, or for sick or disabled horses.

In the example, the horse is raised by a wide belly-band that is connected to and operated by pulleys above. The foot to be shod is secured to a sliding post that runs in a groove on the floor.

Fig. 2567.



Horse-Holder.

Horse-i′ron. (*Shipwrighting.*) A calking-iron of large size. A *making-iron.*

Horse-lit′ter. (*Vehicle.*) A palanquin or stretcher resting on poles and borne by two horses.

Horse-mill. A mill turned by a horse. See Grinding-mill; Mill.

Horse-nail. A nail with a thick, strong head; used in securing shoes to the feet of horses. See Horse-shoe Nails.

Horse-path. (*Hydraulic Engineering.*) The *towing-path* of a canal.

Horse-pow'er. 1. The measure of a steam-engine's power, as originally settled by James Watt. A lifting power equal to 33,000 pounds raised one foot high per minute. This was taken by Mr. Watt as the average power exerted by a mill-horse traveling at the rate of 2½ miles an hour (or 220 feet a minute), and raising a weight of 150 pounds by a rope passing over a pulley.

When a steam-engine is declared to be of such or such a horse-power, the expression must be understood in a qualified sense. Thus it is assumed that the furnace is worked in a certain average manner, and that a proportional evaporation takes place in the boiler. An engine whose nominal power is that of 100 horses may, by urging the furnace in an extraordinary manner, be made to produce an effect much greater than that of its nominal power; or, on the other hand, by keeping the furnace low, it may be, and frequently is, worked considerably under its nominal power.

For every horse-power which the engine is expected to exert, a power of evaporating one cubic foot of water per hour is provided in the boiler.

For the consumption of the fuel necessary to produce this effect, one square foot of *grate surface* per horse-power is provided.

The boiler requires 15 to 18 square feet of heating surface per horse-power. These are average estimates, the Cornish boiler and the locomotive-boiler being the extremes at each end of the scale.

Many circumstances of arrangement, the perfection with which the fuel is burned, the draft, mode of feeding, character of coal, etc., modify these results.

The power of water-wheels, etc., is expressed in horse-power.

Mr. Tredgold compiled a table showing the maximum quantity of labor that a horse of average strength is capable of performing at different velocities, in drawing *boats* on *canals*, and carriages on railways and turnpike-roads respectively: —

Velocity in Miles per Hour.	Duration in Hours of the Day's Work at preceding Velocity.	Force of Traction in Pounds.	Useful Effect of One Horse working One Day in Tons drawn One Mile.		
			On a Canal.	On a level Railway.	On a level Turnpike.
2½	11½	83⅓	520	115	14
3	8	83⅓	243	92	12
3½	$5\frac{9}{10}$	83⅓	153	82	10
4	4½	83⅓	102	72	9
5	$2\frac{9}{10}$	83⅓	52	57	7.2
6	2	83⅓	30	48	6
7	1½	83⅓	19	41	5.1
8	1⅛	83⅓	12.8	36	4.5
9	$\frac{9}{10}$	83⅓	9	32	4
10	¾	83⅓	6.6	28.8	3.6

The average force exerted by a horse at a plow, at a rate of 2½ miles per hour, and with an exertion which he is capable of sustaining for the usual hours per day and every working day, as deduced from dynamometrical experiments at eight plowing-matches, at each of which from 5 to 7 teams were employed, was 163 pounds.

The number of horses subjected to the test was 144, and the observations were made by Mr. Bevan at Woburn and Ashridge, under the observation of some distinguished agriculturists.

In connection with the subject of *horse-power*, it may be well to notice that the terms *power* and *duty* are not synonymous, but opposite, terms.

Power means the quantity of work that can be performed in a given time.

Duty signifies the amount of work that can be performed with a given expenditure of fuel.

To obtain the full amount of *power*, the steam is worked at full pressure the whole of the piston-stroke.

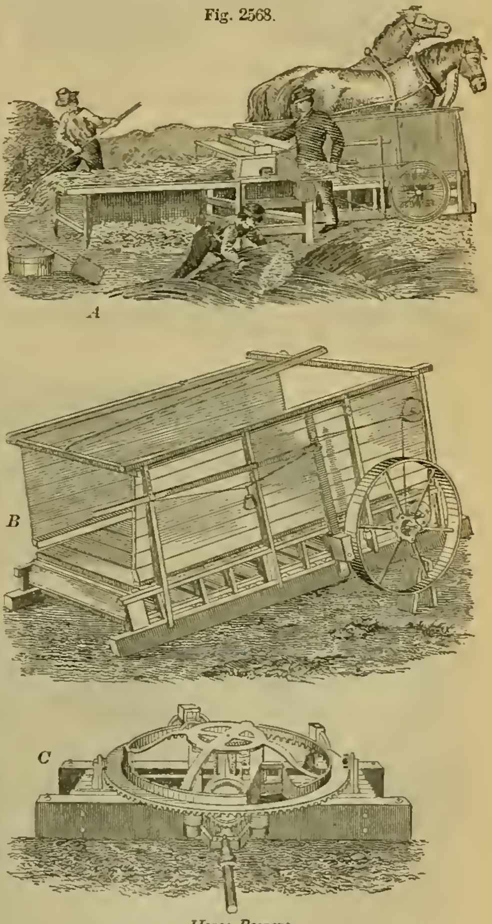
To obtain the highest *duty*, it is used expansively.

A cheap engine, unprovided with the expansion arrangement, will exhibit a greater power than a more expensive engine worked expansively, other things being equal; but the latter will be the more economical in running.

To repeat: power has no reference to the quality of an engine, but to the capacity of its cylinder in connection with a stated pressure of steam. Economy or waste of steam in working does not enter into the question.

Duty disregards time, and the size or power of the engine. It merely inquires how much work is done by a given expenditure of fuel. See Cut-off; Duty.

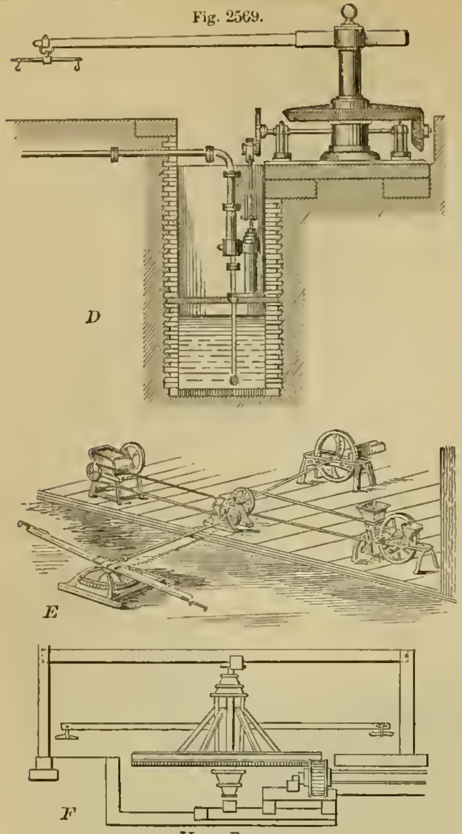
Fig. 2568.



Horse-Powers.

2. A machine in which the power of horses is exerted to drive other machinery.

Fig. 2569.



Horse-Powers.

A (Fig. 2568) is one which the horses walk upon a traveling platform, which slips beneath their feet as the animals pull upon a bar at the rear of the machine. It is shown in connection with a small thrashing-machine.

B is a similar machine without its tenants, and exhibiting the parts more clearly.

C is an ordinary horse-power, such as is used for thrashing-machines, drag-saws, clover-hullers, and corn-shellers. It is dismounted from the wagon, secured by stakes and chains, and levers placed in the sockets, which in this case are four in number, intended for two horses to each lever.

The diameter of the path should be 25 to 30 feet. The horse works to best advantage at 2½ miles per hour of 220 feet in a minute. The force is estimated at 22,000 pounds raised one foot high per minute, which is 66 per cent of the power exerted in drawing in a direct line.

D (Fig. 2569) is an arrangement of horse-power for working a pump.

E is an arrangement for driving a cutting-box, grinding-mill, and corn-sheller, for either of which a hominy-mill or apple-grinder may be substituted when desired.

F is an English arrangement, in which the crown-wheel drives a lantern pinion.

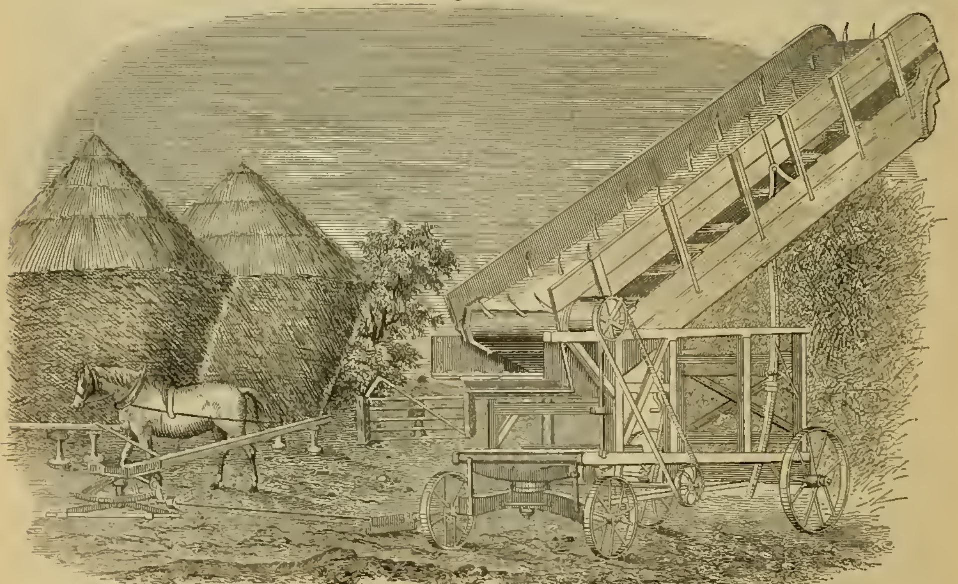
Fig. 2570 shows the English horse-power as applied to a straw-stacker, placed at the delivery end of the straw-carrier of a thrashing-machine. It has a master-wheel and pinions, and the power is conveyed by belting and shafting to an endless apron with tines.

Fig. 2571 shows an American mounted horse-power, that is, one which is used without dismounting from the wheels, by which it is moved from place to place. Power can be applied from both sides and both ends at the same time, or from either point alone, as desired. *U* are the levers to which the horses are attached; *C* is the master-wheel, driving the pinions on shaft *F*, which carries the wheels *D G*; the latter convey motion to the pinions on the inner ends of the tumbling shafts.

Horse-rail'road. A railroad for city or suburban use, whose cars are drawn by horses.

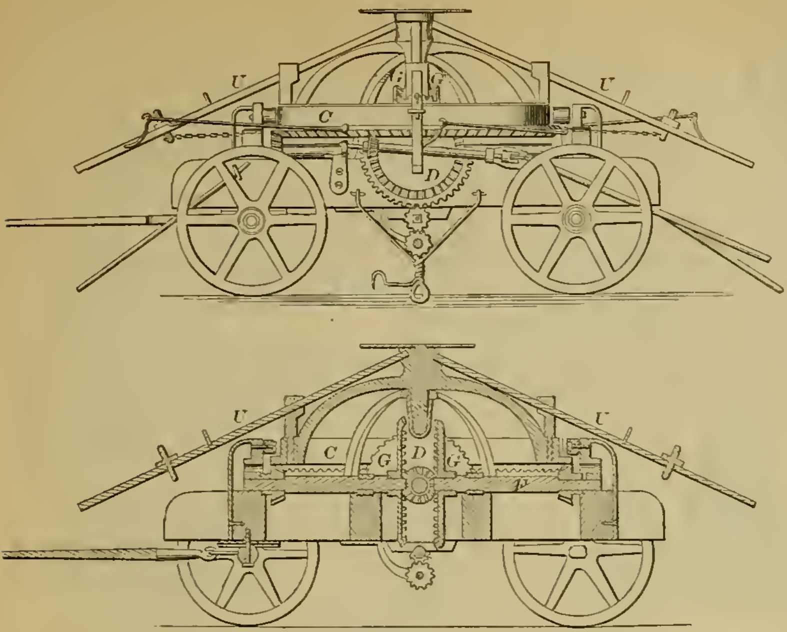
The first railroads were in mines, and for carrying

Fig. 2570.



English Horse-Power.

Fig. 2571.



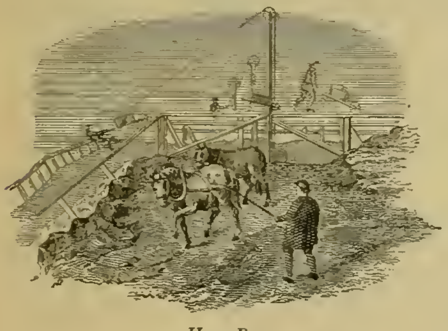
Mounted Horse-Power.

coal to the seaboard. These are yet, many of them, worked by horse-power. See Railway; Street-Railway; Locomotive.

Horse-rake. A hay or stubble rake drawn by horse-power. See Rake; Hay-rake.

Horse-run. A device for drawing loaded wheelbarrows up an inclined plane in making excavations.

Fig. 2572.



Horse-Run.

It consists of a rope passing over two pulleys. The horse is hitched to the fall and the wheelbarrow hooked to the other end of the rope.

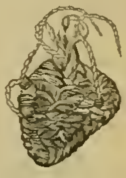
Horse′shoe. 1. (*Menage.*) Horses were not shod in Egypt, Assyria, or Palestine. The latter country was supplied with horses by the Egyptians. Solomon paid 150 shekels of silver, equal in value to $75, for each horse. This was a high price, the difference in relative value of the shekel and a given weight of wheat, meat, or other necessary, being considered.

Isaiah speaks of horses whose "hoofs shall be counted like flint," — a valuable quality where they were shoeless.

The Syrians and Hittites were supplied with Egyptian horses by Solomon, who turned an honest penny by this means.

Aristotle and Pliny mention the covering of horse's feet in stony places to protect the hoof from breakage and wear, but it is probable that such covering was a bandage or boot, and was used principally on long journeys. Suetonius refers to the dismounting of Vespasian's muleteer to shoe his mules. Wrappings of plaited fiber, such as hemp or spartium (broom), were used, as was also leather.

Fig 2573.



Japanese Horseshoe.

In Japan the horses have clogs of twisted straw, of which a large supply is carried on a journey. When worn, another is immediately applied. Our plan would no doubt appear a barbarous custom in their minds. The Siberians and Kamtschatkians use traveling-socks for their dogs. Captain Cook refers to them.

Camels in old times were similarly provided, as we learn from Aristotle and Pliny. These boots were drawn on over the feet, and it does not appear that iron or other metallic plates were nailed to the hoofs. Such boots were shod with metal for the rich. The mules of Nero were shod with silver; those of his wife Poppæa with gold. Xenophon, Arrian, Artemidorus, refer to these boots. For less stately purposes mules were shod with iron.

> "Ferream ut soleam tenaci in vargine mula."
> Catullus.

Homer mentions brazen-footed steeds (Iliad, VIII. 41, and XIII. 24), probably a merely metaphorical expression implying strength. Mithridates and Alexander experienced great difficulty with their cavalry, owing to the soreness of the unprotected feet of the horses in long marches. Pollux, in his dictionary, does not mention horseshoes of metal. The first certain mention of shoes nailed to the hoofs is in the works of the Emperor Leo, ninth century. The practice of shoeing horses is said to have been introduced into England by William I.

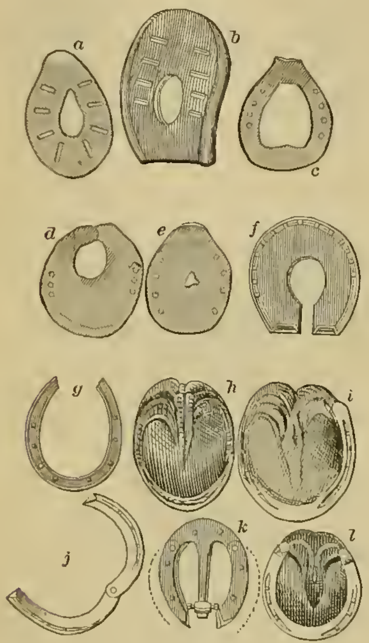
The principal parts of a horseshoe are: the two *faces*, upper and lower; the two *edges*, inner and outer; the toe, or front part; the *quarters*, between the toe and the heels; the *calks*, projections from the lower part of each heel; steel calks are also frequently added to the toe; the *fullering*, or crease in the lower face, in which the nail-holes, generally eight, are made: the *clip*, a kind of claw, usually at the upper edge of the toe, for protecting the hoof and assisting to keep the shoe in place.

The upper face is beveled, or made slightly concave, to prevent the iron from resting on the arch of the sole of the foot.

Horseshoes made by machinery are now generally employed. They are made of five sizes, and are numbered from 1 to 5, the first being the smallest and the latter the largest. Nos. 3 and 4 are those most commonly required.

"In two respects," says Loudon, "the shoeing of Holland differs from ours. 1. To prevent splitting, the fore hoofs are pared away at the toe, and the shoe so fitted that the toes do not touch the ground when the foot stands flat; the weight resting on the middle and the heel of the shoe. 2. The shoe is nailed on perfectly flat and close to the foot, which is flattened to receive it; the iron is thereby deprived of all spring, and the hold of the nails is undisturbed." The frog comes in contact with the ground. This mode of shoeing may not commend itself to our farmers and teamsters, but the Dutch have good horses, use them well, work them hard, and their practice is worth considering.

Fig. 2574.



Horseshoes.

A *bar-shoe* is one in which the shoe is continued round below the heel. It is used on hoofs liable to contraction at the heel, its purpose being to keep them spread.

A *stifle-shoe* is one with a round bar, convex side downward, giving it an unsteady foundation on the ground. It is placed on the foot of the *well* hind leg, so as to compel or induce the animal to throw the weight of the hind quarters on the other foot to reduce the luxation or weakness at the stifle-joint of the leg.

In 1810, Rotch obtained an English patent for an elastic horseshoe, consisting of a sheet-iron sole attached to an india-rubber upper, which was slipped upon the foot, clasping the crown and encircling the pastern. A regular shoe was riveted to the sheet-iron sole of the boot when required. The *upper* or caoutchouc band was prolonged upward as far as deemed necessary, and, in case of *interfering* horses, was made to cover the fetlock. He also applied the caoutchouc bands to the knees, as *knee-caps*.

Charlier substitutes for the ordinary shoe an iron band, let into a rectangular groove scooped from the outer circle of the horse's foot. This band is fastened with seven rectangular nails, driven into oval holes. The soles of the foot and the frog are thus allowed to touch the ground.

Dudley's *cast-iron* horseshoe, English patent, 1823, was cast in a mold modeled from the foot of the horse, and subsequently rendered malleable in a furnace.

Besides the construction of the shoe proper, there are certain attachments thereto, such as, —

Snow-pads, which fit within the shoe and prevent the accretion of snow or ice therein.

Movable calks, which may be attached at any time, if the ground freeze or become sleety during a journey.

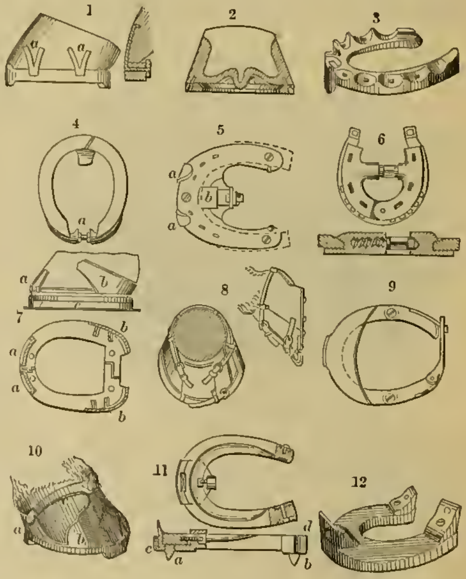
a represents an early Arabian shoe.
b, an Arabian shoe of modern date.
c, a Moorish shoe.
d, a Persian shoe.
e, a Portuguese shoe.
f, an old English shoe.
g, a racing-plate.
h, a tip-shoe.
i, a three-quarter shoe.
j, a jointed shoe.
k, a screw-shoe.
l, a calked shoe.

Fig. 2575 illustrates various horseshoes.

1. The bifurcated springs *a a* clip the hoof, and are attached to the shoe by bolt and nut.

2. Countersunk-headed screws parallel to the wall of the hoof are employed for fastening the shoe.

Fig. 2575.



Horseshoes.

3. Ridges and indentations are formed upon the sole of the shoe. Goodenough's horseshoe has an indented ridge on its under side, perforated for the insertion of nails.

4. For contracted hoofs. By means of the screw

a and nuts between the heel-clips the branches of the shoe may be spread and maintained the proper distance apart.

5. A supplemental roughing shoe is attached to the upper shoe by clips *a a* and a sliding screw-block *b*. Pins at the rear prevent lateral displacement.

6. The shoe is hinged at the toe, and is designed to be permanent. It is beveled on its upper inner edge, to receive the flange of a removable false shoe, that is expanded outwardly by a screw, so as to fit snugly to the permanent shoe, and sustain all the wear.

7. A double-shoe. The upper one is hinged at the toe, and has a jointed cross-bar at the heel; curved clips *a a b b* fit the walls of the hoof and secure the shoe in place. To this the lower plate *c* is secured by screws.

8. The shoe is attached to the hoof by pieces of leather at the front and quarters secured by connecting straps.

9. The shoe has a toe-cap, is jointed at the sides, and has clips and pivoted catch or connecting bar at the rear, dispensing with nails.

10. Rear clips *a*, toe-cap *b*, and strap *c*, held by a button on the toe-cap, hold the shoe to the hoof.

11. The removable toe and heel calks *a b* are dovetailed into plates *c d*, which are fastened to the shoe by screws.

12. The toe and heel calks are adjustably fastened to the shoe by screws.

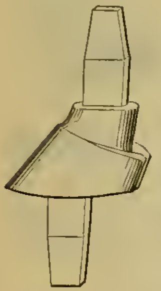
See Fleming's "Practical Horseshoer"; "Rational Horseshoeing," N. Y., 1873.

Refractory animals are confined in a *brake* while shoeing. The brake for cattle is represented under OX-SHOES (which see). The brake for horses consists essentially of an arrangement of straps to bear the weight of the animal, and to prevent his lunging forward, backward, or rearing; also of posts or bars to which his hind or fore feet are lashed while shoeing.

2. (*Lathe.*) A movable support for varying the gearing and the velocity of the screw which moves the slide.

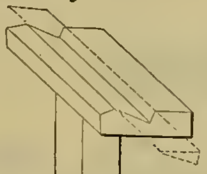
Horse'shoe-an'vil. One which corresponds in shape and size to the hoof of a horse, and has shanks which permit its adjustment in the socket-hole of the anvil, in either a natural or a reversed position. It affords a means of making and fitting the bands and clasps by which the removable horseshoes are attached, in place of nails.

Fig. 2576.



Wilkinson's Anvil.

Fig. 2577.



Calk-Swaging Anvil.

The calk-swaging anvil has a groove across its face, in which a bar of metal is swaged to the level of the plane surface of the anvil, thereby acquiring a triangular shape in cross-section, and forming a rod from which sharpened calks may be cut.

See ANVIL, pp. 121, 122.

Horse'shoe-clamp. (*Shipbuilding.*) An iron strap by which the *gripe* and *fore-foot* are attached. See STEM.

Horse'shoe-ma-chine'. A machine in which bar-iron is converted into horseshoe blanks or horseshoes.

Burden of Troy, New York, patented a machine for this purpose in November, 1835, which had segmental reciprocating dies to shape a straight blank by giving it the requisite thicknesses at the respective parts, and the creases for the nail-heads. The piece rested on a rocking anvil-bed. His patent of September 10, 1843, described a reciprocating rectilinear movement, cutting off from a heated rod a straight blank and impressing by dies, which made the fullering and nail-holes. His patent of June 20, 1857, was reissued June 3, 1865, and extended in 1871. In it the motions are rotary and continuous. The red-hot bar is introduced at the side of the machine, and a sufficient piece cut off by a descending cutter. It passes between guides to a stop, and is held in place till a bending-piece on a roller comes against it and carries it along. This piece corresponds to the inner shape of the shoe, and with this as a former the blank is carried past a series of dies which press it to shape, thinning the inner edge, thickening the heels, pinching in the heels, making the creases by dies and the nail-holes by punches, in succession. After flattening, the shoe is dropped from the machine.

Other forms of machines have circular beds, carrying formers which pass the blank between dies which act successively upon the edges and face to give the required proportions and contour, as well as the creases and nail-holes.

Another form pinches the heated blank between a center former and two posts, while top rollers shape it vertically and side rollers lap the heels around the receding portion of the former, which acts as a die.

In another, the bar is fed in between the shears until it butts against the adjustable gage-plate. Being severed by the shears, the bender advances and drives it between a pair of rollers, giving it a proximate horseshoe shape. The heels of the shoe fall into a depression, and as the bender retires the shoe is drawn from it. The creasing and nail punch are on an oscillating lever, and the latter acts upon and in conjunction with a lower lever, which perfects the perforation.

In one rotary form of machine, the *former* which carries the blank is rotated first between two friction rollers placed on and under a stationary bridge, then under a reducing-roll, a guide-roll, finishing bending device, and hammering-rolls, the shoe being discharged by a pin thrown up by a cam.

Horse'shoe-mag'net. An artificial iron magnet of a horseshoe form.

Horse'shoe-nail. A nail made of superior soft iron and used to fasten on horseshoes. It has a flat pointed tang, and a relatively heavy countersunk head. See NAIL.

Lengths of horseshoe nails :—

No. 5 .	. 1½	inches.	No. 8 .	. 2	inches.
No. 6	. 1¾	"	No. 9	. 2¼	"
No. 7 .	. 1⅞	"	No. 10 .	. 2½	"

Horse'shoe Nail-ma-chine'. One in which rods of iron are shaped into nails for the purpose stated.

In one form of this machine, the nail-rod is fed downward through a heating furnace in front of a stationary anvil by means of a cam geared to make one movement. As each finished nail is cut off at right angles to the face of this anvil, two sliding hammers, having faces of the contour the reverse of the sides of the finished nail, are forced against the sides of the blank simultaneously by means of springs; a third hammer works perpendicularly to the face of the anvil, alternately with the other two, by which the nail is forged. When the nail has been sufficiently hammered, it is cut off by a knife moved against it at the top of the anvil by a cam.

In another, the nails are made directly from the rod by a continuous operation, the blank from which the nail is to be made being first cut from the rod and then passed successively through a series of revolving dies operating in pairs, by which it is gradually drawn down and finished.

Horse′shoe-rack. (*Nautical.*) A sweep curving from the bitt-heads abaft the mainmast carrying a set of nine-pin swivel-blocks, as the *fair-leaders* of the light running-gear, halliards, etc.

Horse-tail. 1. Dutch rush, used for scouring.

2. A Turkish standard, the number indicating the rank of a commander.

Hors′ing-block. A frame to raise the ends of wheeling-planks in excavating.

Hors′ing-i′ron. (*Nautical.*) A calker's chisel attached to a withy handle, and used with a beetle in driving oakum into a vessel's seams.

Hors′ing-up. (*Shipwrighting.*) The final driving of oakum into the seams between the planking of ships. See MAKING-IRON.

Hose. 1. Flexible tubing, usually for the conveyance of water, especially for fire-engine service. Smaller hose is used for street-watering, for gas service with drop-lights, for acoustic instruments, stems of hubble-bubbles, hookahs, etc.

Various are the materials: —

Fabric covered with leather.

Wire, cement, and intestine.

Paper saturated with paraffine.

Fabric saturated with carbolic acid and copper salts.

Woven tubes of fibrous material saturated with caoutchouc; or treated with corrosive sublimate, chloride of lime, pyrolignite of iron, resinous materials.

Fabric coated or lined with caoutchouc or gutta-percha in solution.

Leathern hose, treated with beeswax, linseed-oil, and pitch.

Rings or spiral twist of hard-rubber, in or outside of hose, and vulcanized all together.

Internal and external rubber tubes; intervening concentric, seamless tube, woven or braided; all vulcanized together.

India-rubber or gutta-percha tube, around which is woven or braided a netting of cord,, yarn, or wire.

Hose is made by longitudinal extension through dies, or of a seamless fabric by knitting or braiding, by winding in spiral slips, or by lapping around a mandrel as long as the sections, which are afterwards coated. Different materials require various treatment.

Another mode of making hose is by feeding a tube of fabric, leather, or other material, through systems of revolving bobbins, which braid upon the tube a cord or twine covering. See Fig. 2584.

Fig. 2578 shows a number of kinds of hose, the differences being in the modes of winding, joining, material, character, and succession of the folds, etc.

a is a flexible hose of woven and lapped tubes and water-proof linings.

b is a similar hose with the waterproof material as a coating.

c is a flexible pipe made of woven fabric with a water-proof lining, and riveted.

d, a tube of rubber or gutta-percha, or of fabric coated with the gums, closely wound with twine.

e, a hose made of two or more concentric seamless tubes of fiber, the inner one lined with caoutchouc.

f has a cemented strip over the seam.

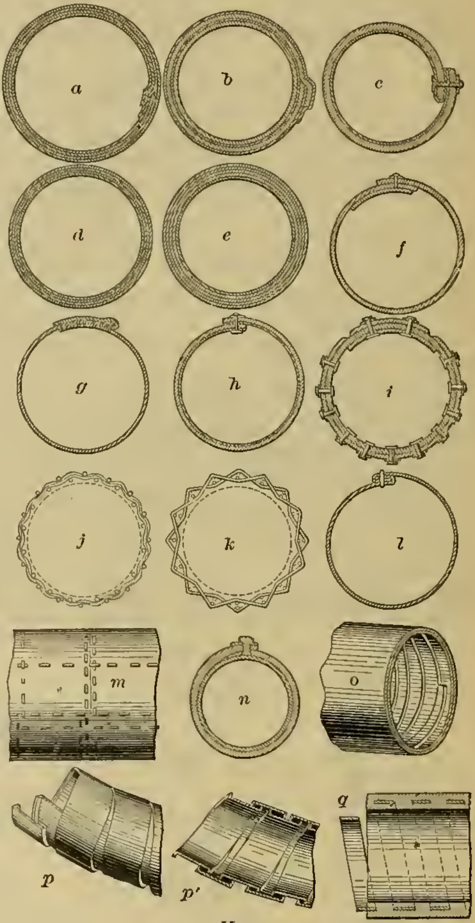
g is stitched through and through with several rows, and the sections joined with diagonal rows of stitches. A welt covers the outside of the join.

h has a fibrous covering, rubber lining, and riveted junction.

i has a double row of rivets along the seam, and a spiral doubly riveted welt lapping the oblique junction of sections.

j is made of strands of fibrous material soaked in gutta-percha or rubber cement, and then woven or braided.

Fig. 2578.



Hose.

k, an outer tube of wire or twine, is woven or braided upon an inner tube or lining.

l, hydraulic hose whose meeting edges are interlocked so as to present a fourfold thickness to the rivets.

m has a lapped seam sewed with leathern thongs.

n is leathern hose with a spiral metallic lining.

o is a suction-hose having a spirally laid flat wire lining and a seamless textile fabric covering treated with waterproof material.

p p′ are two views of a suction-hose showing a stiffener made of two spiral bands which engage each other by means of inward and outward flanges.

q is a vulcanized rubber suction-hose composed of an exterior body, an interior lining, and an intermediate spirally coiled metallic strengthening rib.

Flax or hempen hose woven without a seam, and payed with waterproof material, was used generally on the continent of Europe previous to the introduction of india-rubber hose.

Leather was used in England and in the United States, and still maintains its ground for some purposes. Leathern hose was first sewn with waxed twine, then copper wire was substituted, and finally riveting.

Leathern hose, made in detachable sections, for application to fire-engines, was invented by Heide, a Dutchman, in 1672, and was common in the Netherlands soon after.

The spiral coil of wire inserted throughout the length of suction-hose, to keep it from collapsing, was used with the Newsham fire-engine, London, about 1780.

Rubber hose is made by wrapping RUBBER-CLOTH (which see) around a tube of the required size, the number of plies depending upon the required strength. The tube is then placed in a heater and subjected, for a sufficient time, to a steam pressure of 80 pounds to the square inch = 280° F., which melts the sulphur and vulcanizes the gum.

The tube is then withdrawn from the hose.

Or a sheet of rubber wrapped on a tube and covered by several webs of cloth, saturated with prepared rubber, and eventually by a sheet of rubber. The hose, when formed, is taken to a steam-boiler of great length, where, while still remaining upon the iron pipes, it is heated and cured by a process similar to that before described; after which the rubber is drawn off from the pipe, and it is ready for the market.

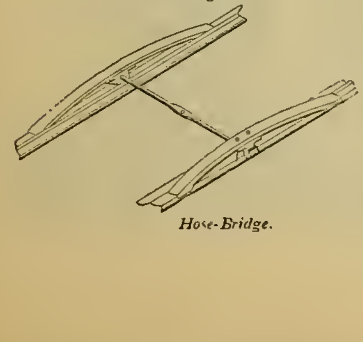
Among the earliest mention of hose is the following passage in Herodotus (450 B. C.). It refers to the mode of watering the hosts of Cambyses the Persian, during his passage of the desert to attack Psammenitus, the son of Amasis, the Pharaoh of Egypt: —

"There is a great river in Arabia, called the Corys, which empties itself into the Erythræan [Red] Sea. The Arabian king, they say, made a pipe of the skins of oxen and other beasts, reaching from this river all the way to the desert, and so brought the water to certain cisterns which he had had dug in the desert to receive it. It is a 12 days' journey from the river to this desert tract. And the water, they say, was brought through 3 separate pipes, to as many different places." — Book III. c. 9.

He adds that it is an improbable story, but that he will not pass it by altogether. The *idea* certainly, so far as we are concerned, is as old as the recorder, who wrote about 2300 years ago.

2. (*Printing-press.*) A case connected by hooks with the platen, for guiding and raising it.

Fig. 2579.



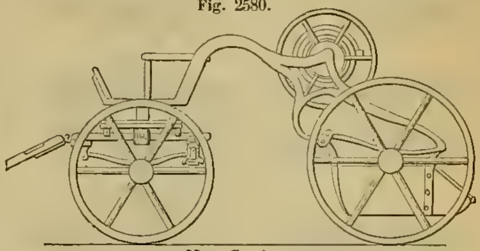
Hose-Bridge.

Hose-bridge. A bridge for carriages or street-cars to allow them to cross fire-engine hose laid in the street.

One form of it was patented by Demarest in 1853. The example shown is to bridge hose which lies across a street-railway.

Hose-car′riage. A reel on wheels to carry hose for fire-engine service. In the example, a fuel-box for the boiler-supply is supported on the same frame. The front wheels turn beneath the elevated perch.

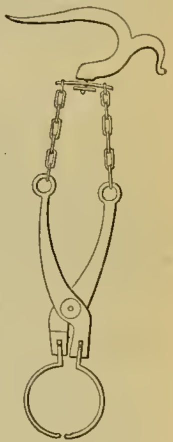
Fig. 2580.



Hose-Carriage.

Hose-car′ri-er. A tongs for gripping hose in *lighting up* full hose when in service.

Fig. 2581.



Hose-Carrier.

Hose-coup′ling. A joint-piece or pair of interlocking connecting pieces, by which ends of hose-sections are joined together in line. There are many forms.

a has a swivel which fits against a collar on the nipple, and its flanges are engaged by the sleeve, which also screws upon the back screw on the other nipple, pressing the ends of the sections against the intervening annular packing.

In *b*, the segmental rib and projected screw-block of the outer coupling-piece enter a circumferential groove of the other piece.

In another ordinary form, the sections of hose are bound with wire, or thimbles upon collar-pieces, one of which has a threaded exterior and the other a threaded sleeve, which screws upon the former. A *spanner* or wrench is used to tighten the connection.

In *c*, a portion of the threads on the screw and socket are cut away to enable the parts to be slipped past each other, and lock by a partial revolution, when the undivided threads catch and complete the joint.

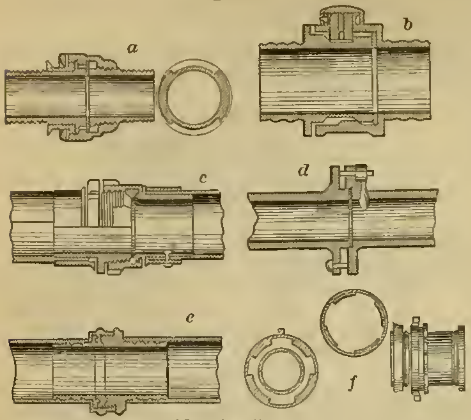
d. The two parts are slid together and the pins enter their respective grooves at the opposite sides; the handle is then turned, and the cam-head locks the parts together.

e. The packing-ring is formed to enter two rectangular annular grooves in one part of the coupling and a V-shaped annular groove in the other part.

f. The projections on the outer cylinder interlock with a groove in a collar on the inner cylinder. Expansible packing is enclosed between collars and is forced against the outer cylinder by compression. The hose is brought over the convex, circumferentially grooved ends of the coupling and confined by a screw-threaded ring.

In the Westinghouse coupling for air-brake pipes of railway-cars, the parts are connected by a spring-hook fastening. Each half-coupling contains a puppet-valve which seats outwardly. Guiding wings are made on the valve-stems, and the stems project outwardly such distance that when the hose are coupled up, the stems, coming end to end, will each unseat the other valve. Hence, when the couplings are united, the valves will always be open, and *vice versa*. See BRAKE.

Fig. 2582.



Hose-Couplings.

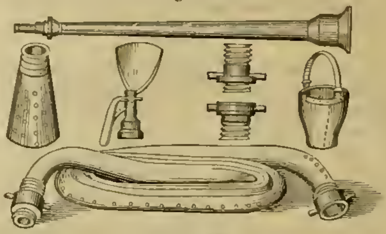
Hose-fit'tings. The various parts by which hose are attached section to section, or a section of the hose to the engine or the nozzle.

The nozzles are of various kinds. The cut shows,—

A *branch-pipe*, with *jet* or *nozzle*.

A *strainer* for the end of the supply or *suction hose*, which is let down into a cistern.

Fig. 2583.



Hose-Fittings.

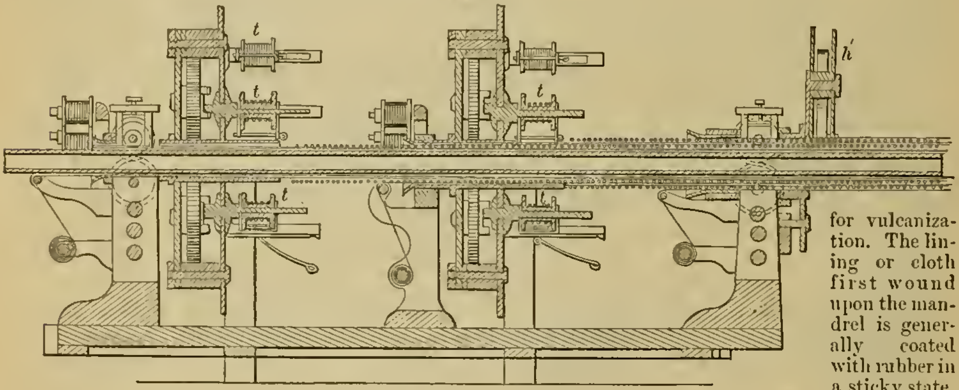
A *spreader* jet.

Couplings or *hose-unions.*

A leathern fire-bucket. These are also made of canvas or galvanized iron.

A section of leathern hose, copper riveted, and having coupling sections at each end.

Fig. 2584.



Hose-Making Machine.

Hose-hooks. 1. The hooks by which the platen of a printing-press is suspended.

2. A tongs for carrying hose. See HOSE-CARRIER.

Hose-jump'er. For street railroads. A *hose-bridge*.

Hose-mak'ing Ma-chine'. A machine for winding or weaving a flexible tube of textile and rubber fabrics.

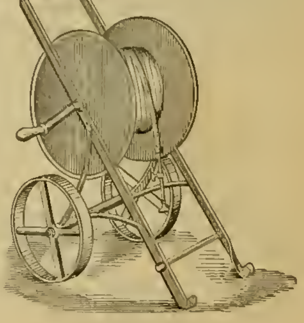
Fig. 2584 shows a machine adapted to this purpose. A layer of rubber, or cloth saturated with rubber, is wound around a mandrel which extends the full length of the machine. As the fabric moves along from left to right it is wound with thread or wire from the first set of bobbins *t t*. Before it reaches the second set of bobbins for another coating or *ply*, it may receive a set of longitudinal cords, threads, or wires from the intermediate reels. It is then again wound by the second set of bobbins *t t*, and finally receives a coating of cloth, tin-foil, or other material from the spool *h'*, and is then ready for vulcanization. The lining or cloth first wound upon the mandrel is generally coated with rubber in a sticky state, and the longitudinal or transverse binders may be so coated, or saturated with rubber. See INDIA-RUBBER.

Hose-pro-tect'or. A hose-bridge to enable vehicles to cross hose without compressing or cutting it. See HOSE-BRIDGE.

Hose-reel. 1. A carriage to carry hose for the service of a fire-engine. See HOSE-CARRIAGE.

2. A reel to carry hose for garden, stable, or other domestic uses.

Fig 2585.



Reel for Garden-Hose.

Hose-shield. A hose-protector. See HOSE-BRIDGE.

Hose-trough. (*Blasting.*) A wooden tunnel for the powder-hose to fire the charges of mines.

Hos′pi-tal-wag′on. A carriage on four wheels, having four or six springs, used for carrying the wounded of an army. An *ambulance.*

A wagon carrying surgeons' supplies and instruments, or bedding, food, and other supplies for a field hospital. The Prussian hospital-wagons are fitted up with combination cases, in which are packed everything supposed to be necessary in a hospital for wounded, including bandages, splints, drugs and anæsthetics, blankets, and an amputating-table, besides an assortment of tags, on one of which the surgeon writes his orders as to what is to be done in each case, attaches it to the patient, and leaves him to the care of others. Five ambulances, three supply-wagons (carrying food, bedding, and tents), and two surgeons' wagons constitute a hospital train for a division, and will accommodate 200 patients, requiring 13 surgeons and 74 men for their care.

Hot-air En′gine. One driven by the heating of a body of air admitted to the cylinder. They are of two kinds: —

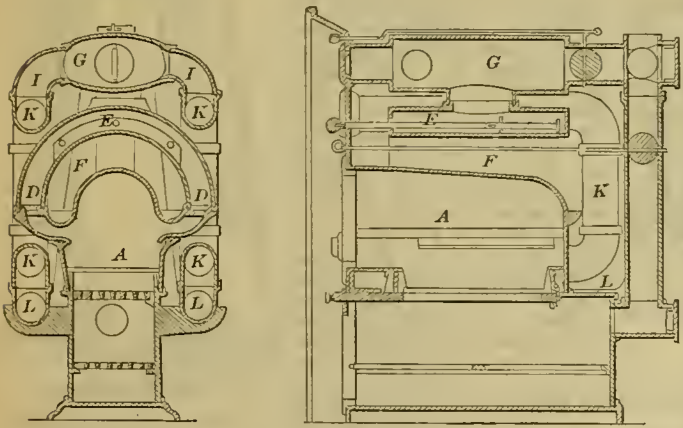
First, those which draw their supplies directly from the atmosphere, and discharge them into the atmosphere again after they have produced their effect. Such are the Ericsson, Stillman, Roper, Baldwin, Messer, Wilcox engines, described on pp. 40 – 43. See also Dr. Barnard's report on the French Exposition, pp. 34 – 40, and plate 1.

Second, those which employ continually the same air, which is alternately heated and cooled, but which is not allowed to escape. Such are the Glazebrook (1797), Parkinson and Crosley (1827), Laubereau (1849), Schwartz, described on pp. 43, 44.

These and other distinguishing features are described under AIR-ENGINE (which see).

Hot-air Fur′nace. One in which air is heated for warming houses, or for purposes of drying, usually the former. The arrangements are various, but a common kind is a form of stove in a brick chamber, the air coursing around the stove and among certain pipes and chambers in which circulate the volatile products of combustion. In the example (Fig. 2586) the furnace, with the exception of its face-plate, is inclosed in an air-chamber. The caloric current passes from the furnace *A* around through *D E*, into the auxiliary radiator *G*, down by the V-shaped driving flues *I K L*, and so to the exit. The air circulates around each of the flues in chamber *F*, and against the plates of the furnace.

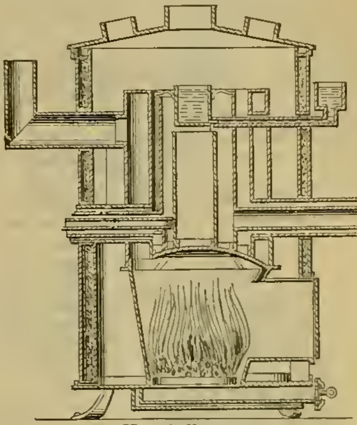
Fig. 2586.



Hot-Air Furnace.

In Fig. 2587, a series of concentric annular air-flues are placed above the combustion-chamber and communicate with the external atmosphere through pipes extending into each flue near its bottom. The external jacket of the furnace is filled with coal-ashes. A water-pan above the fire-pot is fed from an external communicating vessel.

Fig. 2587.



Hot-Air Furnace.

Hot-bed Frame. The structure of sides and ends on which the sash of a hot-bed rest.

Hot-blast. A blast of air heated previous to its introduction into the smelting-furnace.

The process was invented by Nielson, of Glasgow, Scotland, and patented in 1828.

In 1845, Budd patented in England the utilization of the heated gases from the blast-furnace for heating the blast. By means of the hot-blast, anthracite coals were used successfully in smelting iron in Wales, in 1837, and at Mauch Chunk, Pennsylvania, in 1838, 1839.

Hot-blast Fur′nace. The temperature of the air, previous to its being thrown upon the charge in the furnace, is raised to about 600° in an outer chamber or in a series of pipes. These are variously arranged.

In that illustrated (*A*, Fig. 2588), the air is first condensed in an exterior chamber, whence it is forced into the pipe *a* within the reverberatory furnace *b*. Branches from this pipe terminate in the tuyeres on each side of the furnace, which has a separate fireplace.

In Staffordshire, the hot-air apparatus is at the mouth of the furnace, and consists of an exterior and interior tube, the former closed and the latter open at each end. The annular space between them is connected by cross-pipes; through these the air is impelled and passes thence to the tuyeres.

In 1834 M. Dufrenoy reported to the French government the results reached at the Clyde iron-works, which were as follows: —

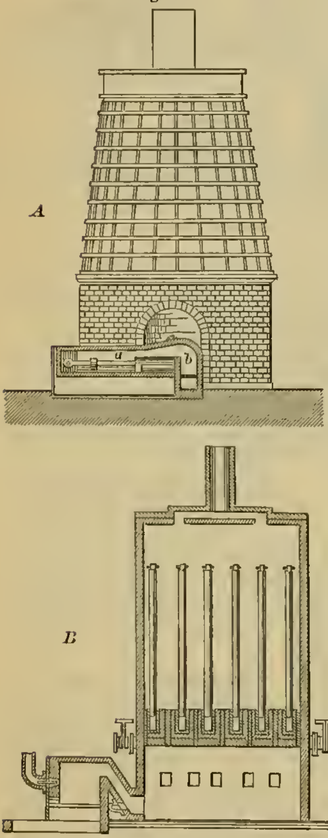
For the year . . .	1829	1831	1833
Temperature of blast .	Cold	450° F.	612° F.
Coal used per ton of iron.	As coke.	As coke.	In raw state.
For fusion, cwt. . .	133	86	40
For heating air, raw coal	nil	5	8
For blowing engines, coal	20	7	11
	153	98	59
Cwt. limestone per ton of iron	10½	9	7

Besides this advantage, the make was increased by more than one third, and a blowing engine, which only supplied three furnaces with cold blast, was equal to four when the air was heated.

Player's stove (*B*, Fig. 2588) for heating furnace-blasts (English) is so constructed as to use the waste gases from blast-furnaces, drawing them by means of a steam-jet into a stove, where they are consumed to heat the air-blast.

The stove consumes the gas in a separate chamber from that containing the pipes to be heated; air to support combustion is allowed to enter, and the heated fumes escape through a series of narrow slots into an air-tight chamber having a damper on the top and containing a series of vertical reverting pipes through which passes the blast to be heated. As the highly heated fumes will not again ignite without a fresh supply of oxygen, the cast-iron blast-pipes remain uninjured under a heat of 1100° or 1200°.

Fig. 2588.



Hot-Blast Stove.

An auxiliary fireplace for burning coal is shown attached to the hot-blast stove. From this fireplace a flue conducts the flame, smoke, and gases from the blast-furnace into the chamber where the combustion is completed. Attached to the end of this fireplace, and connected with flues at the furnace-top, is a branch gas-pipe with a small steam-jet placed near its orifice to create a partial vacuum. This draws the gases down from the furnace-top and forces them into the stoves, where they are burned. The gas-pipe and jet may be placed at the bottom end of the combustion-chamber of the hot-blast stove.

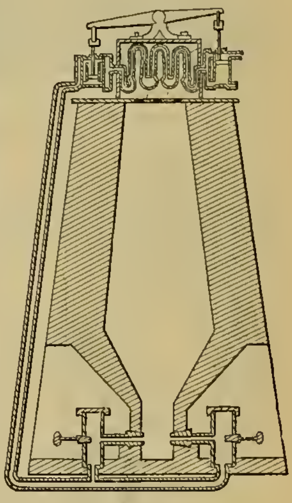
The arrangement of pipes is in six treble rows, each stove contains 18 pipes, 8 inches in diameter by 14 feet high, giving about 1,000 square feet of heating surface. The pipes are disposed three in a row; the blast thus passing up and down three times, discharging into connecting chambers in the roof of the combustion chamber below.

Since 1840, the blast has been gradually made hotter and hotter, and the means of economically and regularly giving the air a temperature of 1,000 or more degrees have attracted much attention.

Cowper's patent is founded on the Siemens regenerative principle, a cellular mass of brick-work being first raised to a high heat, and this heat then imparted to the blast, which is made to pass through it, while a similar mass of brick-work is being heated, ready for use as soon as the first shall have become partially cooled. Whitwell makes his brick-work into large compartments instead of cellular. It is claimed that the blast can be heated to 1800° by this stove, and a regular working heat of 1400° be steadily maintained. To estimate properly the great importance of improved devices for heating the blast, it should be remembered that for every ton of materials charged in at the tunnel-head at least three tons' weight of air is blown in at the bottom through the tuyeres; it can therefore be readily understood how desirable it is that this air should be put into the furnace already heated, instead of throwing the work of heating it upon the fuel in the furnace, which should find abundant employment in smelting the ore only.

In McDowell's apparatus (Fig. 2589), the air-engine and air-pump pistons are connected to opposite ends of a walking-beam; both have double action, and are connected to a serpentine pipe in a chamber at the top of the cupola and communicating therewith. The pump and engine have suitable valves, and communicate respectively with the outer air and the blast-pipe. See also Blowing-apparatus.

Fig. 2589.



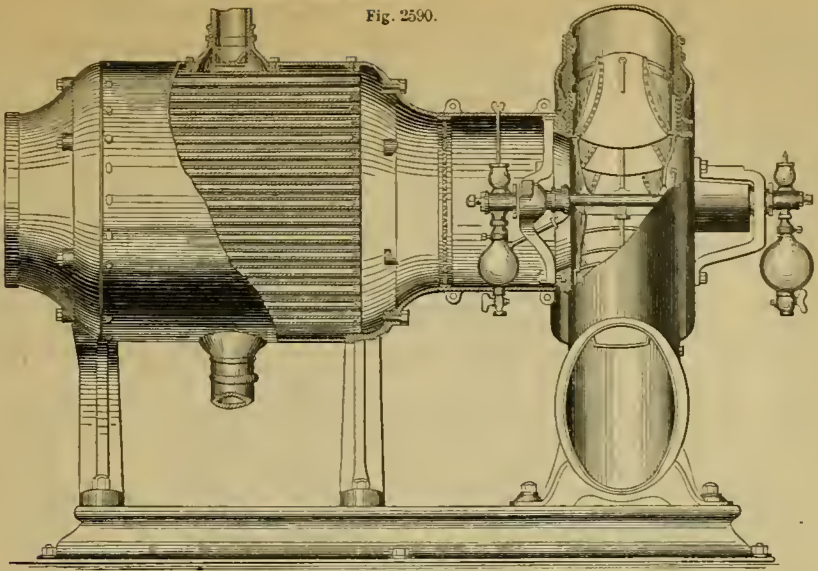
Hot-Blast Smelting-Furnace.

Fig. 2590 represents Sturtevant's hot-blast apparatus for drying timber and other materials. In this, air is drawn in by a suction fan, and passed through a series of longitudinal tubes inserted in a cylinder heated by exhaust steam from the engine, whence, at a temperature of 150° to 200°, it is conducted to the drying-room. See Lumber-dryer.

Hotch'ing-tub. (*Metallurgy.*) A tub and sieve in which lead ore is agitated in water to separate the metallic and refuse parts. It is preliminary to the *buddle*. See Hutch.

The *cuttings* are detained by the sieve; the *smeddum* passes through into the bottom of the box.

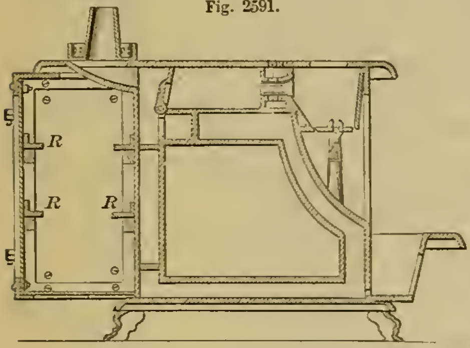
Fig. 2590.



Sturtevant's Hot-Blast Apparatus.

Hot-clos'et. 1. One attached to a stove to keep victuals or plates warm. That shown has ledges *R R* for shelves in the closet.

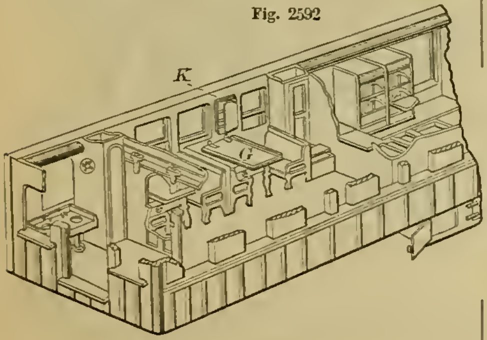
Fig. 2591.



Cooking-Stove with Hot-Closet.

2. (*Candle-making.*) A chamber in which candle-molds are kept at a heat of 150° Fah., previous to pouring, to prevent the chilling of the stearic acid. The steam heat is applied dry.

Fig. 2592



Hotel Car.

Ho-tel'-car. One arranged for affording meals to passengers on board while on a journey. Closets *K* are arranged between each pair of windows. A water-tank *B* is placed at the upper part of one side, to which also tables *G* are attached, and part of the car is partitioned off as a kitchen, with a cooking-range. A provision chamber *E* is attached beneath the floor of the car.

Hot-flue. A chamber, heated by hot-air pipes, in which printed calicoes are dried.

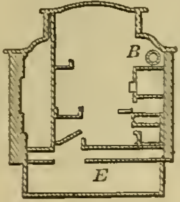
A drying-chamber for cloths or paper, starch, etc.

Hot-gild'ing. A name applied to amalgam gilding, in which the mercury is driven off by heat.

Hot-house. 1. (*Pottery.*) A room where strong heat completes the drying of green ware, previously to placing in seggars and firing in a kiln.

2. (*Horticulture.*) A plant-house where a relatively high artificial temperature is maintained in order to facilitate vegetable growth.

The botanic gardens of Pisa, Padua, and Bologna, established from 1544 to 1568, did not contain hot-houses. In the thirteenth century, however, Albertus Magnus, who was equally active and influential in promoting natural knowledge and the study of the Aristotelian philosophy, possessed a hot-house in the convent of the Dominicans at Cologne. This celebrated man, who had already fallen under the suspicion of sorcery on account of his speaking-machine, entertained the king of the Romans, Wilhelm of Holland, on the 6th of January, 1249, in a large space in the convent garden, where he kept up an agreeable warmth, and preserved fruit-trees and plants in warmth throughout the winter. This entertainment was exaggerated into a tale of wonder in the chronicle Joannis de Beka, written in the fourteenth century.



There is no evidence that forcing-houses were used in ancient horticulture. The conduction of heat by caliducts for baths and apartments was well known, but it does not appear that these facilities were used for floricultural purposes.

Regular hot-houses are of late introduction in our botanic gardens. Ripe pineapples were first obtained in Europe at the end of the seventeenth century. Linnæus states that the first banana which flowered in Europe was in Vienna, in the garden of Prince Eugene, in 1731.

The accordant accounts of Hernando Cortes, in his reports to the Emperor Charles V., of Bernal Diaz, Gomara, Oviedo, and Hernandez, leave no doubt that at the time of the conquest of Montezuma's empire, there were in no part of Europe menageries and botanic gardens which could be compared to those of Huaxtepec, Chapultepec, and Tezcuco.

Hot-press. (*Paper.*) A means of calendering and smoothing paper by subjecting it to heavy pressure between glazed boards; a hot iron plate is placed at every 20 sheets or so, to heat the pile.

Hot-saw. A buzz-saw for cutting up hot bar-iron, just from the rolls, into bars or into pieces for being piled, reheated, and rerolled.

Hot-short. (*Metal-working.*) Iron which is disposed to crack or break when worked at a red heat, and is difficult to weld, is said to be hot-short. It is frequently the presence of sulphur to the extent of, say, 0.033 per cent, which makes it brittle.

Hot-shot. Cannon-balls made red hot in a furnace in order to fire wooden structures into which they are thrown.

Hot-wall. A wall with included flues to assist in ripening the fruit of trees trained against it.

In some cases the wall is traversed by a number of flues leading from a furnace or furnaces; in others the entire wall is double, the included space being crossed occasionally by ties which keep the two walls together.

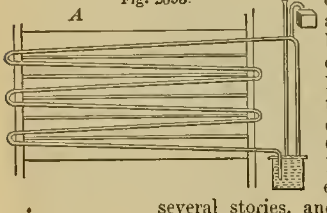
Its use is principally in northern countries in ripening fruits which do not mature in the natural temperature of the latitude, such as the peach, nectarine, and apricot in England.

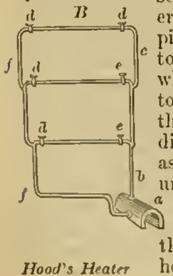
Hot-wa'ter Fau'cet. The faucet of a bath, tank, beck, vat, or wash-basin, which admits the hot water, for scalding, infusing, washing, leaching, or other purpose.

Hot-wa'ter Heat'ing-ap'pa-ra'tus. A means of heating by the passage of hot water through pipes in rooms.

Bonnemain appears to have been the first to introduce the circulation of hot water in a system of pipes, as a means of warming apartments and buildings. He devised it in 1777, in connection with his incubator. See Calorifère; Incubator. The egg-chamber had several stories, and each was traversed by one or more bends of the pipes, which were so arranged as to have a constant inclination, by which the cooler water descended to the boiler. The velocity of the current depends upon the difference in temperature of the ascending and descending columns.

Fig. 2593.





Hood's Heater

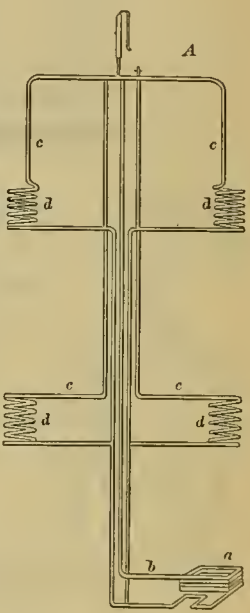
This is shown at *A* (Fig. 2593).

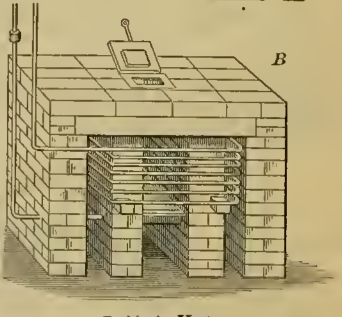
Hot-water heating-apparatus on the *low-pressure* system employs a heat at or below the boiling point. By the *high-pressure* system the heat is increased to 350°, and the water has a tendency to form steam of 70 pounds pressure to the square inch.

Bonnemain's system was of the low-pressure kind, and this class of heaters has been much improved by Hood; see his "Practical Treatise on the Warming of Buildings by Hot Water" (London, third edition, 1855).

Hood's apparatus for heating (*B*, Fig. 2593) had several variations, but the main features are similar to those of Bonnemain. It consisted of a boiler *a* and ascending pipe *b c*, with branches to each story, regulated by faucets *d e*. The descending pipes *f* carry back the cooler water. By another system, each story has its own ascending and descending pipes, with separate connection to the boiler. An air-faucet at top is necessary to allow escape of air from the pipes when starting up.

Fig. 2594.





Perkins's Heater.

The boiler must be sufficiently strong to bear the hydrostatic pressure of the column of water. A boiler, 3 by 2 and 2 feet deep, with a pipe 28 feet high proceeding from it, will sustain a pressure of 66,816 pounds.

The size of the boiler will depend upon the extent and size of pipe, but one square foot of boiler fire-surface is allowed to every 50 feet of 4-inch pipe, the temperature of which is to be kept 140° above that of the surrounding air.

The quantity of pipe is thus stated in his work above referred to: —

"Allowing 3½ cubic feet of air for each person in the room or hall, as the quantity per minute which is to be warmed, and one cubic foot per minute as the quantity cooled by each square foot of window-glass; then ascertain the whole quantity of air that is to be heated, and apply the following rule:

"Multiply 125 (the excess of temperature of the pipe above the surrounding air) by the difference between the temperature at which the room is to be kept when at its maximum, and the temperature of the external air; and divide this product by the difference between the temperature of the pipes and the proposed temperature of the room; then the quotient thus obtained, when multiplied by the number of cubic feet of air to be warmed per minute, and this product divided by 222 (the number of cubic feet of air raised 1° per minute by 1 foot of 4-

inch pipe), will give the number of feet in length, of pipe 4 inches in diameter, which will produce the desired effect." For 3-inch pipes multiply the said number by 1.33; for 2-inch pipes multiply by 2. The given diameters of the pipes are outside measurement. Small pipes have a relatively larger area of heating surface.

Perkins's high-pressure hot water heating-apparatus (*A B*, Fig. 2594) consisted of a continuous wrought-iron pipe, which formed a coil *a* in the furnace, and passed from story to story of the building, being amplified into coils at special points, as in the apartments to be warmed. The pipe was ½ inch in internal diameter and ¼ inch thick, and about ⅛ of the length of the pipe formed the furnace coil. The heated water in the coil *a* becomes charged with minute globules of steam and ascends in pipe *b*, from whence it is distributed right and left to the apartments by branch pipes *c* and coils *d*. The descending pipes carry the hot water to the story below, where it heats the apartments by means of other coils *d*, which discharge into the descending pipes, by which the water again reaches the furnace coil.

A common arrangement is shown at *B* in the figure; the pipe is coiled around the inner casing of the furnace, coming in contact with the fire only in front; this casing and the top of the furnace are composed of fire-brick, the fire-grate being in the center and elevated a foot or so from the floor; fuel is supplied through a hole in the top. The smoke passes through the chamber containing the pipes, and escapes through a hole in the back.

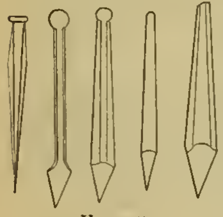
Hot-wa'ter Pipe. (*Steam.*) The pipe which receives the hot water from the hot-well and discharges it.

Hot-wa'ter Pump. (*Steam-engine.*) A pump which raises water from the hot-well of a condensing steam-engine and discharges it into the feed-water cistern, whence it passes in graduated quantities to the boiler. See also FEED-WATER APPARATUS; INJECTOR.

Hot-well. A compartment in the cistern in which the condenser and air-pump of a condensing-engine are submerged, and from which the warm water is drawn for the supply of the boiler.

The submerged *injection-chamber* and the *air-pump* connect by a passage, whose valve opens during the ascent of the piston and closes during its descent. The uncondensed steam, the air, and the water of condensation pass by this passage to the air-pump, through the bucket of the latter as it descends, and are ejected into the *hot-well*. The heated water is drawn thence to supply the boiler. See AIR-PUMP; CORNISH STEAM-ENGINE.

Fig. 2595.



Houguette.

Hou-guette'. The etching-needle of the marble-worker. Fig. 2595 shows several different forms.

Hound'ing. (*Nautical.*) That portion of a mast between the deck and the top of the hounds.

Hounds. 1. (*Vehicle.*) Side bars which strengthen certain portions of the running-gears of a vehicle.

a, tongue-hounds.	*d, coupling pole* or *reach.*
b, hounds.	*e, tongue.*
c, hind-hounds.	

In wagons, the *hounds* of the fore-axle pass forward and on each side of the tongue, to which they are secured by the tongue-bolt.

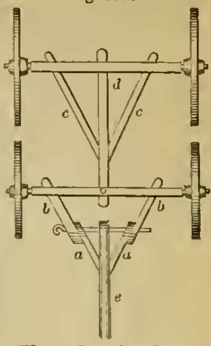
The hounds of the hind-axle unite and are fastened to the coupling-pole by the coupling-pin.

2. (*Nautical.*) Projections on the mast-head to support the trestle-trees and top. Cheeks fayed to the sides of the mast-head.

Hour-cir'cle. (*Globes.*) A small brass circle fixed to the north pole, divided into twenty-four hours, and furnished with an index for pointing them out.

Hour-glass. A glass having two bulbs and a connecting opening through which the sand in one bulb runs into the other. The amount of sand and size of the opening are such that a given amount of time is consumed in the passage.

Fig. 2596.



Wagon Running-Gears.

On an ancient bas-relief at Rome an hour-glass is placed in the hands of Morpheus, and Athenæus says that the ancients carried portable hour-glasses with them as measurers of time.

Glasses of this description are yet used for marking small periods of time; such as, —

1. The three-minute glass, or *egg-glass*, in which the sand passes in the time mentioned.

2. The half-minute glass used in ascertaining the rate of a ship by the *log*.

The line is knotted at such intervals that the spaces bear the same relation to a nautical mile that the half-minute does to an hour. That is, they are $\frac{1}{120}$ of a nautical mile apart, — about $50\frac{75}{120}$ feet.

The line being on a reel, the *chip* is thrown overboard, and, catching in the water, causes the line to run off the reel. When the *stray-line* has run out, the half-minute glass is turned, and the number of knots on the string which pass through the seaman's hand indicates the number of nautical miles per hour that the vessel is sailing.

The use of the hour-glass in calculating a ship's course is much older than that of the log, the rate being estimated by the eye. The hour-glasses, *ampolettas*, used in the expedition of Columbus, ran out in half an hour, so that the interval of a day and a night was reckoned at 48 ampolettas, and so the journal — log-book — recorded. The log is not mentioned. It was used in the Pacific by Magellan. See LOG.

The horoscopus in the Egyptian processions carried with him the measurer of time, an hour-glass.

The "Sûrya Siddhânta," a Sanscrit treatise on astronomy, treats of the "stringed sand receptacles" for measuring time; these were doubtless of the general character of our hour-glasses.

Hour-glasses were unknown in China formerly, and of late are mentioned by them as of importation from the West.

A tradition of the Middle Ages relates that the sand-glass (sablier) was invented by Liutprand, a monk of Chartres, who reinvented the art of making glass after the secret had been lost for ages.

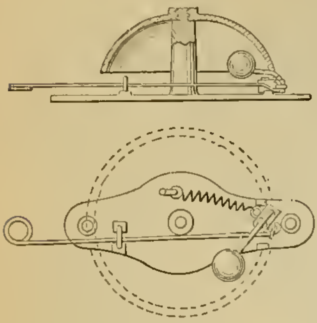
Shortly after receiving the famous clepsydra from Haroun al Raschid, Charlemagne caused a monster sablier to be made, which required turning but once in 12 hours. It had the horary divisions marked upon the outside.

The hour-glass or half-hour glass was a regular part of pulpit furniture in the sixteenth century, to denote to the preacher when it was time to close. It was used in Massachusetts two centuries since for the same purpose.

Hour-hand. (*Horology.*) That one which shows the hour on a watch-dial, performing its revolution in 12 hours.

House-bell. A form of bell for doors of houses; formerly a bell suspended by a coiled strip which gave it the repetitive action when the wire was once pulled; now more usually a form of gong which gives a single sound. In the example, the bell is screwed to a central post and the clapper is fastened to an oscillating block which is moved by a rod and retracted by a spring.

Fig. 2597.



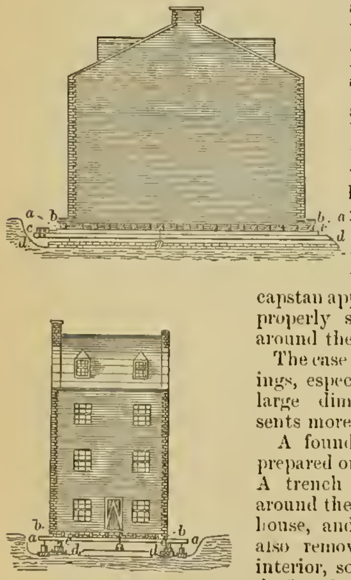
House-Bell.

House-boat. A boat used as a dwelling. Common in China, and once common on our Western rivers.

House-line. (*Nautical.*) Or *housing.* A fine line having three strands, smaller than rope-yarn and used for seizings, fastening thimbles of sails to their ropes, etc.

House-mov'ing. The operation of removing small or moderate-sized frame structures from one locality to another is a task of comparatively easy accomplishment. The house is supported on beams laid in the direction to be taken, beneath which rollers are placed and the power of tackle or of a capstan applied to a rope properly secured to or around the house.

Fig 2598.



House-Moving.

The case of brick buildings, especially those of large dimensions, presents more difficulty.

A foundation is first prepared on the new site. A trench is next cut around the outside of the house, and the earth is also removed from the interior, so as to expose the foundation. Through this, openings are made, into which are inserted, at intervals of about three feet, at right angles to the direction that the house is to be moved, stout beams *a* which project about three feet beyond the walls at each end. Under each of these projecting ends a screw-jack is placed, resting on a firm foundation, and, by the operation of these, the beams *a* are brought up into close contact with the superstructure, the intermediate masonry being removed. Above and resting upon the beams *a* are placed beams *b*, through openings made in the walls for the purpose, and below, transversely to them and in the direction the house is to be moved, two beams *c d* are placed under each end wall; the lower of these has a tongue, and serves as a guide for the upper, which is grooved, and slides upon it. The two surfaces of contact are greased, and a powerful screw-jack, butting against the beams *c*, is fixed horizontally to each of the beams *d*, and operated until the structure is moved the distance which the limit of motion of the screw-jacks allows. They are then unfastened and the operation repeated. By successive additions to the length of the lower beams *d*, this may be continued until the house is moved any required distance.

House-lifting by screw-jacks is now an important business.

This process requires great care and attention, as it is obvious that an inequality in the movement of the numerous screw-jacks tends to crack the walls.

Hous'ing. 1. (*Railway.*) One of the plates or guards on the railway carriage or truck, which form a lateral support for the axle-boxes, and in which they slip up and down as the springs alternately contract and expand. Also called *pedestals, horn-plates, jaws, axle-guards.*

2. The framing holding a journal-box; as, one of the standards holding the journal-boxes of the rolls in a rolling-mill.

3. The uprights supporting the cross-slide of a planer.

4. (*Carpentry.*) The notches in an object for the insertion of another piece; as, —

a. (*Stair-building.*) Notches in the string-boards for the ends of the steps.

b. (*Artillery.*) A prismatic groove in the axletree of a gun-carriage for the cheeks of the transom. Notches in the *brackets* to fit on the axletree bed, and so on.

5. (*Nautical.*) *a.* That portion of a mast which is included between the keelson and the surface of the upper deck.

b. A covering or protection, as of a ship's deck, when laid up in ordinary or under stress of weather, as in the Arctic regions.

c. A cord made of three small yarns and used for seizings.

6. (*Saddlery.*) *a.* A cloth extending rearwardly from the saddle and covering the loins of the horse.

b. The pad of a collar.

c. A hood or covering piece for the collar.

Hous'ing-bear'ers. (*Metal-working.*) The frame in which the rollers of an iron-rolling mill are set. *Housing-frames.*

Hov'el. (*Porcelain.*) A conoidal structure of brick, 40 feet in diameter and 35 feet high, around which the *ovens* or firing-kilns are clustered.

How'el. (*Coopering.*) A plane with a convex sole, used for smoothing the insides of barrels and casks, making the smooth circle at the croze, and also the chamfer on the inside of the chine.

How'it-zer. A cannon, differing from ordinary guns in being shorter and lighter in proportion to its bore, and used for throwing hollow projectiles with comparatively small charges. A 6-pdr. gun weighs 100 pounds more than a 12-pdr. howitzer. Their charge of powder for a 12-pdr. field howitzer is ¾ pound of powder; that for a 12-pdr. mountain howitzer is ½ pound of powder. A smaller chamber at the bottom of the bore receives the powder.

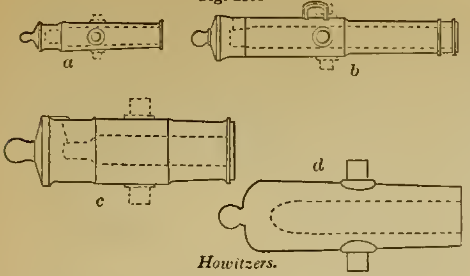
a, mountain-howitzer.

b, field-howitzer.

c, siege-howitzer, model of 1850.

d, the siege-howitzer, 1861, has a chamber the size of the bore. See MOUNTAIN-HOWITZER.

Fig. 2599.



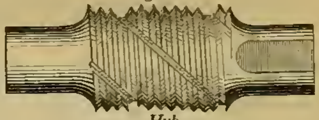
Howitzers.

How'ker. (*Vessel.*) A Dutch vessel with two masts. The *hooker* is an Irish fishing-smack.

Hoy. (*Vessel.*) A one-masted coasting-vessel, used before the era of steamboats for conveying passengers and goods between places, or as a tender upon larger vessels in port.

Hub. 1. A fluted screw of hardened steel, adapted to be placed on a mandrel between the centers of a lathe, notched to present cutting-edges, and to be used in cutting screw-tools, chasing-tools, etc. The chasing-tool, for instance, is laid on the rest and pressed forcibly against the *hub*. (Fig. 2600.)

Fig. 2600.

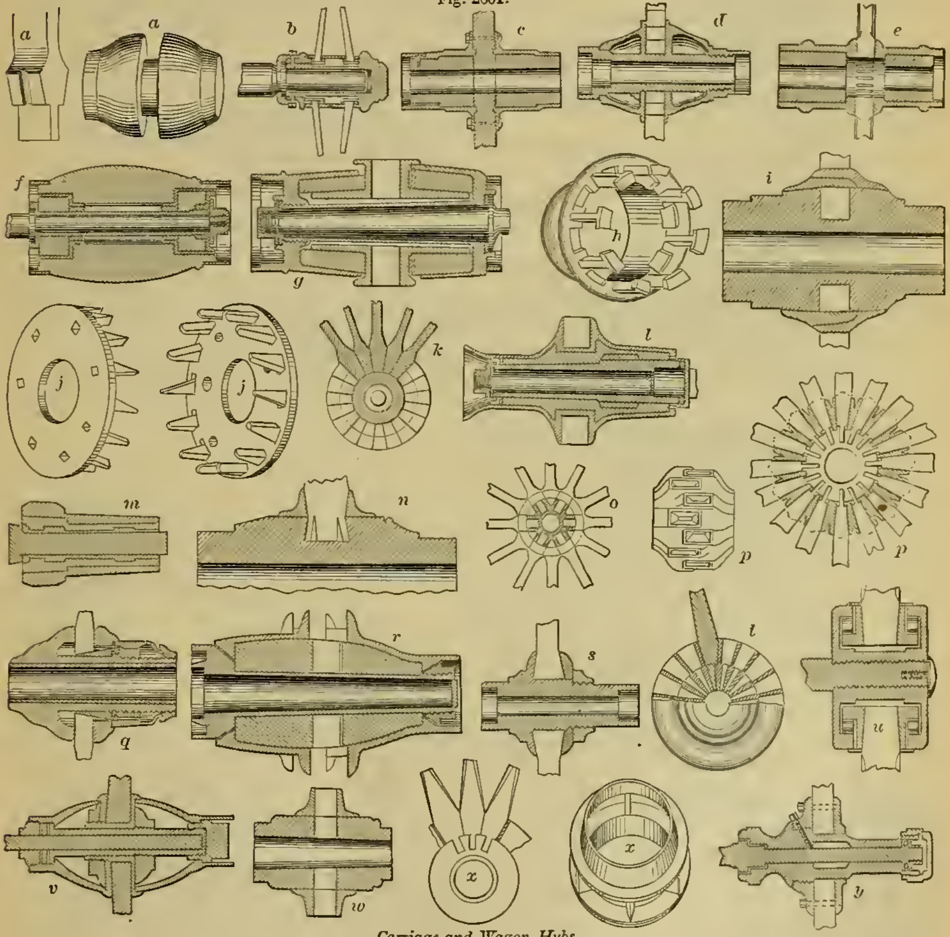


Hub.

2. (*Die-sinking.*) A cylindrical piece of steel on which the design for a coin is engraved in relief. The engraving is done while the steel is soft, and, after hardening, the *hub* is used to make *matrixes*, from which are made *punches* which impress the *dies* used in *coining*. (See Matrix; Punch; Die.) The *hub* or the *punch* is pressed upon the softened steel *blank* in a powerful screw-press; and the *matrix* or *die* is removed, annealed, and replaced several times, as the pressure has the effect of hardening.

3. (*Vehicles.*) The central portion of a wheel which is slipped upon the *arm* of the axle, and in which the spokes are set radially. The *nave*.

Fig. 2601.



Carriage and Wagon Hubs.

A bronze hub, with peripheral sockets for the reception of the spokes, is in an ancient Scythian chariot, found in Egypt, and now in a European museum, probably that of Berlin. It is supposed to have been carried to Egypt as a trophy by a conqueror of that nation. See Chariot.

a is a hub having a circumferential groove, in which the shoulders form a continuous band, while the tenons of the spokes set in mortises in the bottom of the groove.

b is a metallic hub, one portion of which forms the axle-box around which are the nuts on the inner ends of the double set of iron spokes.

c has two circumferential metallic bands, between which the spokes, forming a solid circular series, are clamped and bolted ; the clamps also holding the wooden sleeves around the axle-box.

d. Around the hollow axle-box are clamped two hollow disks, which have projecting lugs to form the spoke mortises.

e has a metallic shell having a depressed center, in which the spoke mortises are formed, and has tubular cases driven in from the ends.

f has rubber disks around the axle-box at each end of the hub.

g has a central disk forming the spoke-sockets, and this is clamped by two outer disks with intervening hollow cones.

h has two hollow shells with T-shaped lugs, which interlock to form spoke-sockets.

i has two overlapping mortised hub-bands.

j has two metallic disks, with projecting lugs to form spoke-mortises ; the disks are drawn together with bolts.

k has a grooved hub with alternate projecting lugs to form dodging mortises.

l has a soft metal or plastic material run in between the axle-box and the shell of the hub.

m resembles the previous in some respects.

n. The hub has a dovetail mortise and wedges to prevent the withdrawal of the spokes, and beveled metallic bands to form seats for the spokes.

o has a mortised hub and metallic bands to clamp the spokes, which form an arch around the hub.

p has a hub-band with staggering metallic sockets, and hub with mortises for the spoke-tenons.

q has wedges against the inner ends of the spokes ; these are driven outward by the inner hub-band, which screws on the sleeve of the outer portion of the hub-band.

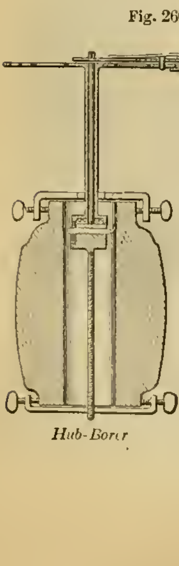
r has a metallic shell with staggering mortises and projecting lips to support the spokes.

s has a metallic hub formed in three parts, — the axle-box and inner hub-band, the outer hub-band, and the clamping-nut. The circular spoke-groove has a dovetail form.

t has a metallic band with beveled mortise.

u. The end flanges are screwed on the axle-arm. The inner ends of the spokes are secured in a mortised flange-ring, between which and the hub-flanges are anti-friction rollers.

Fig. 2602.



Hub-Borer

v has a metallic hub-shell within which is a spoke-socket formed by sleeve, nut, and projecting lips.

w, a mortised metallic band on a wooden hub.

x has a metallic band whose mortises receive the spokes in clusters.

y has a metallic hub which forms the axle-box, and has a lubricating-chamber and spoke-clamps.

4. A block for scotching a carriage or car wheel.

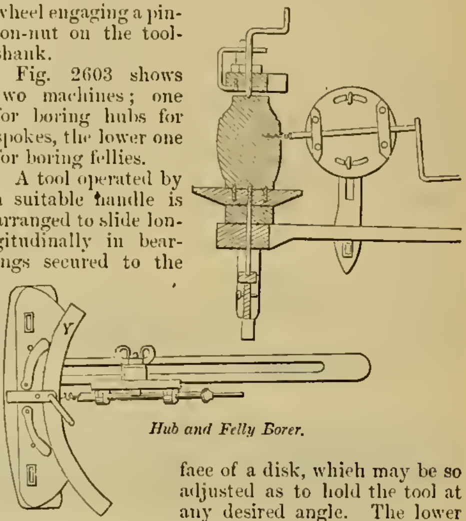
Hub′ble-bub′ble. An onomatopoetic word. A pipe in which the smoke is drawn through water.

Hub-bor′er. (*Wheelwrighting.*) An implement or machine for boring hubs for the boxing or the spokes. That in Fig. 2602 is for the former purpose. Clamps at each end of the hub form guides for the central shaft, which has a box to carry the cutter, whose progression is obtained by the thread on the shaft. The cutter has a threaded shank, and is fed outward to enlarge the diameter of the bore by the rotation of the tube, which has a crown-wheel engaging a pinion-nut on the tool-shank.

Fig. 2603 shows two machines ; one for boring hubs for spokes, the lower one for boring fellies.

A tool operated by a suitable handle is arranged to slide longitudinally in bearings secured to the face of a disk, which may be so adjusted as to hold the tool at any desired angle. The lower figure shows a sliding cross-piece provided with two arms which are adjusted to hold the felly *Y* in position while being bored by a set screw having a handle.

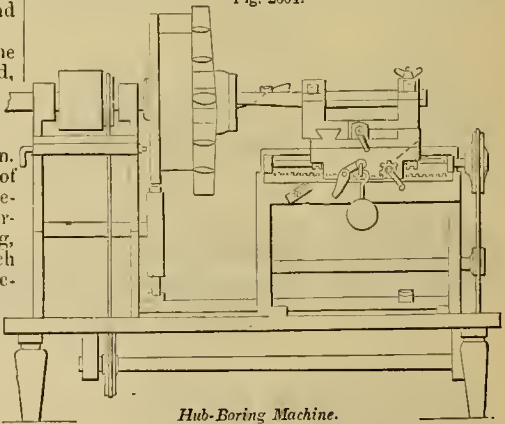
Fig. 2603.



Hub and Felly Borer.

Hub-bor′ing Ma-chine′. The machine (Fig. 2604) bores the hub by the rotation of the latter rather than of the former. The boring-tool is mounted upon a horizontal bed, which is susceptible of an oscillating motion about a center for the purpose of allowing the tool to be set at any desired angle. With this bed is combined a laterally adjustable tool-holder and a longitudinally adjustable carriage. The carriage is provided with a contrivance for throwing it in and out of gear, with a feeding-screw for the purpose of feeding the tool up to its work with a slow motion, and retracting with a quicker motion.

Fig. 2604.

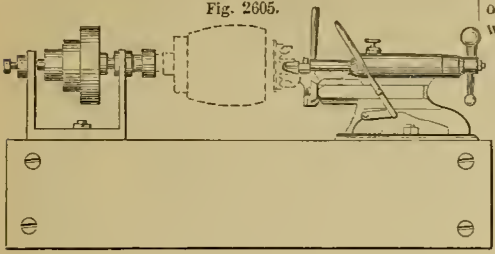


Hub-Boring Machine.

Hub-cen'ter-ing Ma-chine'. (*Wheel-making.*) A machine in which a hub is chucked while the hole for the axle-box is reamed out concentric with the outside shape. A similar mode is adopted for holding the hub while setting the boxes therein.

Hub-lathe. (*Wheelwrighting.*) A form of lathe for turning carriage and wagon hubs. In the example, the cutter is held and fed to its work by a double slide, and its lateral movement is regulated by the adjustable stop attached to the cross-head of the double slide.

Fig. 2605.



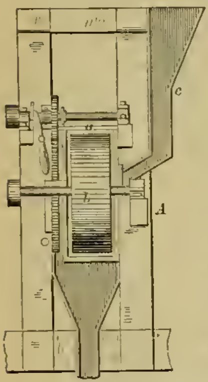
Hub-Lathe

Hub-mor'tis-ing Ma-chine'. (*Wheelwrighting.*) A machine in which a wheel-hub is held upon a mandrel or stake, so disposed that a reciprocating chisel may cut therein the mortises for the spokes. The hub is dogged or clamped so as to prevent rotation while the mortise is being cut, and is then rotated a determinate number of degrees to present the next spot to the cutting-tool.

Hub-turn'ing Ma-chine'. (*Wheelwrighting.*) A form of lathe specially adapted for turning hubs for vehicle wheels.

Huck-a-back. (*Fabric.*) A table linen or toweling having the weft alternately crossed, so as to make it thick at certain points to roughen the surface by producing a raised pattern.

Fig. 2606

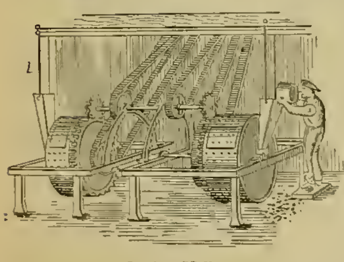


Huf'fling. A process of ornamenting gilded leather.

Hulk. (*Nautical.*) The hull of a vessel not seaworthy, and moored in port for hospital, guard, convict, quarantine, custom-house, storage, victualing, or other purposes.

A *sheer*-hulk is one fitted with *sheers* for masting and dismasting vessels.

Hull. (*Shipbuilding.*) The body of a vessel, exclusive of its masting, rigging, etc. A dismantled *hull* is a *hulk*.



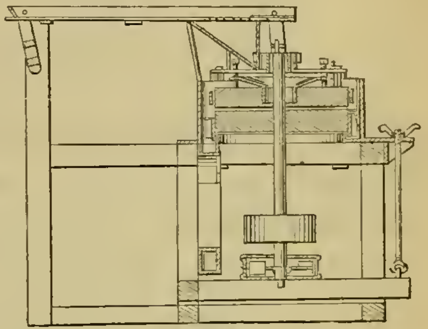
Barley-Huller.

Hull'er. See HULLING-MACHINE.

Hull'ing-ma-chine'. (*Agriculture.*) A device for removing the cuticle from grain, and for breaking it without reducing it to the condition of meal. In the time of Pliny a mortar was employed for this purpose, sand or pieces of brick being placed therein to assist the trituration. Foreign substances, including the husk and bran, were removed by sifting. For this purpose, the Egyptians used sifters made of papyrus and rushes, the ancient Spaniards of flax, and the Gauls invented sieves of horsehair.

The Scotch pearl-barley mill is shown in Fig. 2606, *A* being a section of the cylinder, and *B* a perspective of the machines in operation. It consists of a drum *a*, which is rotated by gearing, and within which a circular grindstone *b* is caused to revolve more rapidly by belting. The grain is fed through a hopper *c* opening axially into the drum, and is removed by a sluice at its side. The drum is lined with sheet-iron, perforated with small holes, which serve to remove the skin and a portion of the outer substance of the grain, bringing it to a spheroidal shape; whence the name of *pearl* barley. *Pot* barley has merely the outer skin removed.

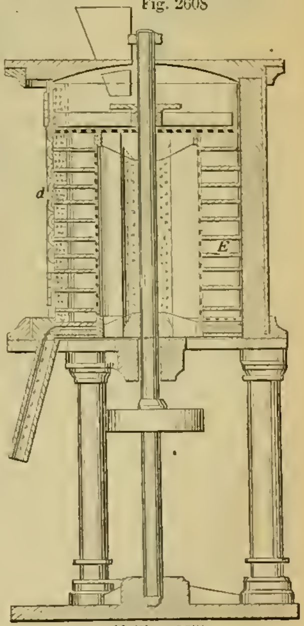
Fig. 2607.



Hulling-Mill.

Fig. 2607 illustrates a machine in which the hulling process is effected between two horizontal stones adjustable relatively to each other, so as to give the requisite trituration without pulverizing the grain.

Fig. 2608



Hulling-Mill.

The machine shown in Fig. 2608 has a revolving wire-gauze cylinder, provided with rough-surfaced shelves *E E*, on to which the grain is successively conducted by conduits *d*, in its downward passage from the hopper. An internal fan eliminates the husk, etc., during the process.

There are some other varieties of machines which depend partly upon percussion, an example of which has a series of ordinary triangular saw-files projecting radially from an axis rotating at high speed within a cylindrical casing. See HOMINY-MACHINE.

Human, and other Animal, Parts and Features represented in Mechanics.

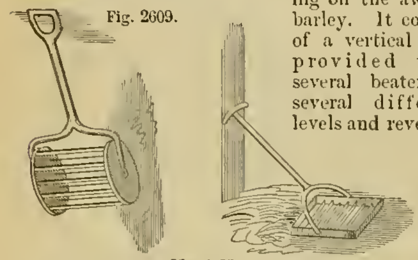
Ankle.
Arm.
Back.
Beard.
Belly.
Body.
Bosom.
Breast.
Breech.
Butt.
Cheek.
Claw.
Crown.
Diaphragm.
Ear.
Elbow.
Eye.
Face.
Finger.
Foot.
Gland.
Groin.
Gullet.
Gum.
Hair.
Hand.
Head.
Heart.
Heel.
Hip.
Jaw.
Joint.
Knee.
Knuckle.
Leg.
Lip.
Lug.
Mouth.
Muzzle.
Nail.
Neck.
Nipple.
Nose.
Palm.
Poll.
Rib.
Seat.
Shank.
Shoulder.
Side.
Skin.
Sole.
Spine.
Step.
Teat.
Throat.
Toe.
Tongue.
Tooth.
Trunk.
Tusk.
Vein.
Waist.
Wrist.

Hum′bug. (*Menage.*) A nippers for grasping the cartilage of the nose. Used with bulls and other refractory bovines.

Hum′hum. (*Fabric.*) A plain, coarse, cotton cloth, made in India.

Hum′mel-ing-ma-chine′. A machine for breaking off the awns of barley. It consists of a vertical shaft provided with several beaters at several different levels and revolving rapidly in a cylindrical case so as to beat the grain as it falls.

Fig. 2609.



Hand-Hummelers.

The operation is also performed in a thrashing-machine by putting the grain through a second time, substituting for the ordinary cover a tin case with teeth made by punching holes through it from the outside. Hand-hummelers or *aveling-machines* (Fig. 2609) are used upon the grain spread on the barn floor, being either rolled or dragged.

The Japanese hummel their rice in a mortar made of a section of a large tree hollowed out.

Hun-ga′ri-an Leath′er. (*Leather.*) A white leather originally made in and imported from Hungary, but now manufactured in other countries.

Mineral salts are substituted for vegetable extracts. The hides are first treated with a mixture of alum and common salt, by which a portion of the sulphate is converted into the chloride of aluminium. An excess of salt keeps the hides supple. The fleshing and scraping processes are proceeded with as in the ordinary modes of tanning, but the hair is removed by shearing instead of liming.

The first alum bath has, alum 7 pounds, salt $4\frac{1}{2}$ pounds, water 8 gallons, for each hide of 85 pounds' weight. The temperature is raised to 120° F., and the sides are extended in the bath, hair side up. They are tramped while in the bath; this is three times repeated in warm liquor, the strength of the liquor being maintained. The skins then lie 8 days in the menstruum.

The skins are taken out, stretched, and shaken, and then treated by a saline bath as before, but only lying 24 hours in the liquor at the conclusion of the repeated tramping processes. The hides are then drained, partially dried, stretched, suspended by their edges, and exsiccated. See TAWING.

The skins are tramped and rolled till rendered supple, and are then ready for the oiling process.

The oiling material is a mixture of tallow and fish-oil, the ordinary *dubbing* of the American currier; this is spread by a mop on the flesh and the hair sides of the skins, which are made into a pile flesh side up.

An open charcoal fire is then lighted in the room, which is closed air tight, and after an interval, and the opening of the door for the escape of carbonic acid, the workmen enter, and grasping a skin by the ends hold it, flesh side down, over the charcoal fire, at the same time stretching it in all directions. As each side is *flamed*, it is laid on a table, the pile of warm and greasy hides being covered with a cloth and left to mellow, absorbing the oil and equalizing the heat throughout the mass.

The hides are then wiped of superfluous grease; laid across poles, flesh side out; dried, weighed, stamped, and marketed. The result is said to be excellent, no acid, alkali, fermentative, or other destructive application or process detracting from the weight or injuring the cohesion of the tissues.

Hun-ga′ri-an Ma-chine′. (*Hydraulic Engineering.*) The Chemnitz pressure engine. See AIR AS A WATER ELEVATOR, Fig. 58.

Hunt′er's Screw. A differential screw; named after its inventor, Dr. John Hunter. See DIFFERENTIAL SCREW.

Hunt′ing-cog. (*Gearing.*) A tooth in a cog-wheel which is *one* more than a number divisible by the number in the pinion with which it engages. If the pinion contains 8 leaves and the wheel 65 teeth, the 65th, or *hunting-cog*, prevents the recurrence of each leaf of the pinion with every 8th cog of the wheel, which would be the effect were the relative numbers 8 and 64. When the numbers are 8 and 65, the wheel will revolve 8 times and the pinion 65 times before the same leaves and teeth will be again engaged.

Hunt′ing-horn. (*Music.*) *a.* A bugle used in the chase.

b. A wind-instrument of metal, usually with a circular tube. See HORN, *k.*

Hunt′ing-watch. (*Horology.*) A watch with a metallic case over the crystal for its protection.

Hur′dle. 1. (*Husbandry.*) A rectangular frame of vertical stakes and interwoven withes of hazel, elm, oak, or other suitable saplings. Hurdles, about 6 feet long and 3 feet high, are used in husbandry in making temporary enclosures and fences, each section being secured by a ring to a driven stake.

Ornamental hurdles for screens, fences, etc., are made of iron, either cast or wrought. Each hurdle forms a panel, and is secured at its ends to stakes. Cast-iron hurdles consist of the marginal frame and an ornamental filling, according to the taste of the designer. Wrought-iron hurdles have a frame of bar-iron, and interlacing work of wire resembling network.

2. In *fortification*, hurdles are smaller, and are used as *revetments* in embrasures to strengthen the parapet. The *gabion* commonly used for this purpose is a *crate*, differing from a hurdle only in being cylindrical. See GABION.

A rectangular, flat structure made of stakes and withes, used in an emergency to stop breaches.

3. (*Hat-making.*) A grid of wood or wire, on which a bunch of felting hair is laid for *bowing*.

Hur'dle-nail. A tough flat-headed nail used in securing the parts of a hurdle together.

Hur'dy-gur'dy. (*Music.*) A stringed instrument having a lute-shaped body and neck. The strings are regulated on the latter by the fingers, and are vibrated by a revolving wheel.

Hurl. (*Hatting.*) The table on which the material for a hat-body or the fur for a nap is *bowed*.

Hur'ri-cane-deck. (*Shipbuilding.*) 1. The upper deck of an American river or lake steamboat above the cabins.

2. A raised platform on an ocean-going steam-vessel, extending from side to side, above deck amidships. A station for the officer in command.

Hur'ries. A *staith* or timber framing, on to which coal-cars are run, and from which they discharge their loads by means of spouts to the holds of the ships.

Hurst. The ring or collar of a trip-hammer helve on which are the trunnions on which it oscillates.

Hur'ter. 1. (*Fortification.*) *a.* A timber placed at the foot of the interior slope as a revetment, to prevent the injury of the parapet by the wheels of the gun.

b. (*Of a gun-carriage.*) Pieces of wood or iron at the front of the chassis to prevent the top carriage from running off when "in battery." The counter-hurter is a similar piece at the rear of the chassis for checking the recoil of the carriage.

2. (*Vehicles.*) A butting-piece on an axle. A strengthening piece placed against a shoulder of an axle.

Hus'band-ry. For list of machines, implements, and tools, see AGRICULTURAL IMPLEMENTS and HUSBANDRY, pp. 23–25.

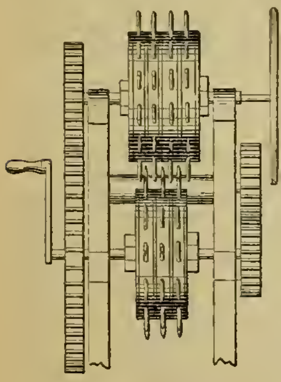
Hush'ing. (*Mining.*) *a.* A term applied to one mode of exposing and collecting ore. In a ravine where surface ore is exposed or but lightly covered, a body of water is dammed and then allowed to *flash* through the ravine, tearing up the earth and stones and exposing new surfaces, from whence the ore is gathered. The word is probably a corruption from *flushing*, which signifies a copious dash of water, as *flushing a sewer*. See FLUSHING.

b. A process of clearing water from the surface of ore, in stream works, by diverting and directing streams of water thereon.

Husk. (*Milling.*) The supporting frame of a run of millstones.

Husk'er. An implement or a machine for removing the shucks from ears of corn. See CORN-HUSKER.

Fig. 2610.



Husk-Hackler.

Husk-hack'ler. A machine for tearing corn-husks into shreds for stuffing for mattresses, pillows, cushions, etc.

Fig. 2610 shows a hackling-machine in which the toothed cylinders are driven at different rates of speed, whereby a splitting and combing action is obtained, as the husks are fed through.

Husk'ing-glove. A glove with claws or prongs, adapted to grasp the ear of corn and tear the husk therefrom. Some of these implements have also cutting jaws to sever the butt of the ear from the stalk.

Husk'ing-peg. A pin or claw worn upon the hand and used to assist in tearing open the shuck when husking ear corn. Ingenuity is apparently exhausted in contriving convenient rings and rests for the fingers, and mode of attaching to the hand.

Hut. The back end or body of the breech-pin of a musket.

Hutch. 1. (*Mining.*) *a.* A low-wheeled car adapted to run on a track in the gallery of a mine, to be lifted on the cage to the surface, and then run off to the dumping chute, by which its contents are carried to wagons.

b. A cistern or box for washing ores.

2. (*Milling.*) The case of a flour bolt. A *bolting-hutch*.

3. A kneading-trough.

Hutch'ing. (*Mining.*) A separation of ore in a sieve, which is suspended from a lever or held in the hands, and agitated in a vat of water. See JIGGER.

Huy-ghen'i-an Eye-piece. (*Optics.*) The *negative eye-piece*, named after its distinguished inventor, Christian Huyghens, a Dutch astronomer (1629–1695). This wonderful man excelled in mathematical and mechanical science and art. He improved the telescope; discovered the ring of Saturn (as such); reapplied the pendulum to beating time, and first accurately adapted it; invented the micrometer; and in his various communications to the Academy of Sciences in Paris and the Royal Society of London illuminated all he undertook.

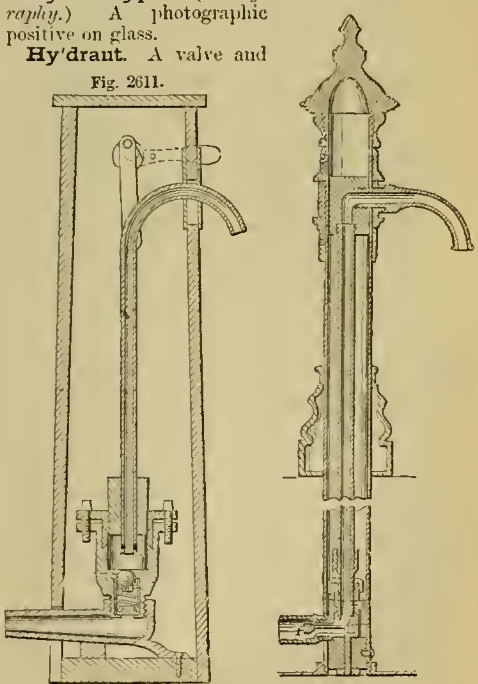
He was one of the emigrants driven from France at the revocation of the Edict of Nantes, and exchanged the friendship of Louis XIV. for that of Newton. See NEGATIVE EYE-PIECE.

Hy-al'o-graph. An instrument for tracing a design on a transparent surface.

Hy-al'o-type. (*Photography.*) A photographic positive on glass.

Hy'drant. A valve and

Fig. 2611. Fig. 2612.



Hydrants.

spout connecting with a water-main, and by which water may be drawn from the latter. In the domestic form, as usual in the yards of our city houses, the spout is elevated sufficiently to allow it to discharge into a tub or bucket, the valve being operated by a handle. Provision is also made for allowing the contents of the discharge-pipe to run back out of the way of frost. In the example, Fig. 2611, the depression of the goose-neck forces a piston into a chamber which empties itself through the discharge-pipe; the end of the pipe depresses a valve and allows the water to flow continuously from the main. The elevation of the goose-neck closes the valve, and the rising of the piston empties the discharge-pipe into the piston-chamber.

In Fig. 2612, the water is let on or off by rotating the tube, which opens or closes the foot-valve *I* by means of a stud on the tube. Near the lower end of the tube is a perforation which may be brought into coincidence with a wasteway when the valve is closed, and thus empty the stand-pipe.

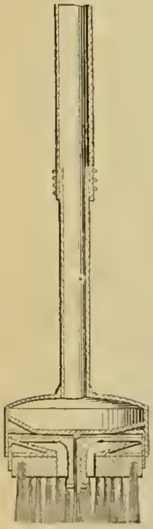
A large kind of hydrant, having a larger service-pipe from the main, and used for connection of hose for street washing or in case of fire, is known as a *fire-plug*.

Hy′dra-pult. A garden syringe. A force-pump on a portable scale.

Hy-drau′lic Belt. An endless woolen band for raising water. The lower bight is immersed in water, and the upper bight passes over a roller. The belt travels about 1,000 feet per minute, and discharges at its upper turn.

Hy-drau′lic Block. (*Shipbuilding.*) An hydraulic lifting-press occupying the place of a *building-block* beneath the keel of a vessel in a repairing-dock. Being adjustable as to hight, it is useful for straightening a ship that has become *hogged* or *sagged*.

Fig. 2613.



Hydraulic Brush.

Hy-drau′lic Brush. One having a hose connection through its handle so as to discharge water upon the surface or object being scrubbed. The one shown, intended for washing windows, has vanes in the stock, and the force of the water causes the brush to revolve and the water to spray upon the window.

Hy-drau′lic Cane. This pump consists of a vertical pipe whose lower end has a valve opening upwardly and plunged in the water of the cistern or well. A rapid vertical reciprocation is given to the tube, and the water is caused to ascend therein; positively as the lower end plunges into the water raising the valve, and relatively as the water slips in the tube as the latter descends quickly. An air-chamber above makes the discharge continuous.

Hy-drau′lic Ce-ment′. A cement which possesses the property of hardening under water and resisting decomposition by that element. Various substances, mixed with sand, have been employed for this purpose, fulfilling more or less perfectly the required conditions.

Septaria are used where readily procurable.

The Romans used pozznolana, volcanic ashes containing a considerable proportion of clay and oxide of iron. A similar product called *trass*, found in large quantities on the Lower Rhine, is used in Germany. For lining their reservoirs, the Romans employed pure lime and finely pounded brick.

The principal supply is, however, derived from various limestones which contain insoluble matters, as silica, alumina, magnesia, and oxide of iron, in varying proportions. These are burned, causing chemical changes and combinations in the constituents of the mass, which is then pulverized for use.

The so-called "Roman" cement, patented in England by Parker in 1796, is prepared from nodular concretions of limestone, usually containing veins of calc spar, found in beds of clay.

Portland cement, which ranks among the highest in point of tenacity and durability, is made from the deposits formed in the beds of some rivers which flow through chalk and clay formations, mixed with a proportion of carbonate of lime. These are incorporated under water, burned, and ground.

Several varieties of hydraulic cement are prepared in the United States, where it is also very generally known as "water lime." See Cement.

Hy-drau′lic Clock. An ancient form of time measurer. It was described by Ctesibus. One was presented by Haroun al Raschid to Charlemagne about A. D. 801. See Clepsydra.

Hy-drau′lic Con-dens′er. (*Gas.*) The chamber into which gas from the retorts is conveyed by the dip-pipes to be cooled. See Hydraulic Main.

Hy-drau′lic Crane. (*Hoisting.*) An application of the hydraulic press to lifting. See Hydraulic Elevator, Hoist, Lift, etc.

Hy-drau′lic Dock. An apparatus (*J*, plate opposite page 1150) by which a vessel is raised clear of the water for examination and repairs. The vessel is brought over a platform which is slung between the frames, being suspended by the requisite number of chains, say 20 on each side, which pass over cast-iron pulleys supported on the top of the wooden framework. The lower ends of the chains are fixed to the platform, and the upper ends to a horizontal beam of wood, which is attached by means of a cross-head to the ram of an hydraulic engine. When the ram, therefore, which is placed in a horizontal position, is moved, by the injection of water into the cast-iron cylinder in which it works, the motion is communicated to the horizontal beam, and thence, by the suspending chains, to the platform bearing the vessel, which is thus slowly raised to the surface.

The longitudinal and the end view of the platform and vessel will explain the operation of the apparatus. In both of these views, *a* represents the platform; *b*, the suspending chains; *c*, the pulleys on which they run; *d*, the horizontal beam to which the chains are attached; *e*, the hydraulic engine; and *f*, the injection-pipe by which the water is forced into the ram.

The fixtures of the cylinder are embedded in a large mass of masonry, so as to render it quite immovable.

There are several racks attached to the apparatus, for supporting the platform, and taking part of the weight off the ram after the vessel is suspended. When she is ready to be lowered, these racks are unshipped, and the water being permitted to escape through a small aperture provided in the cylinder for that purpose, the vessel slowly descends into the water. The perpendicular *lift* of one of these docks in New York Harbor is ten feet.

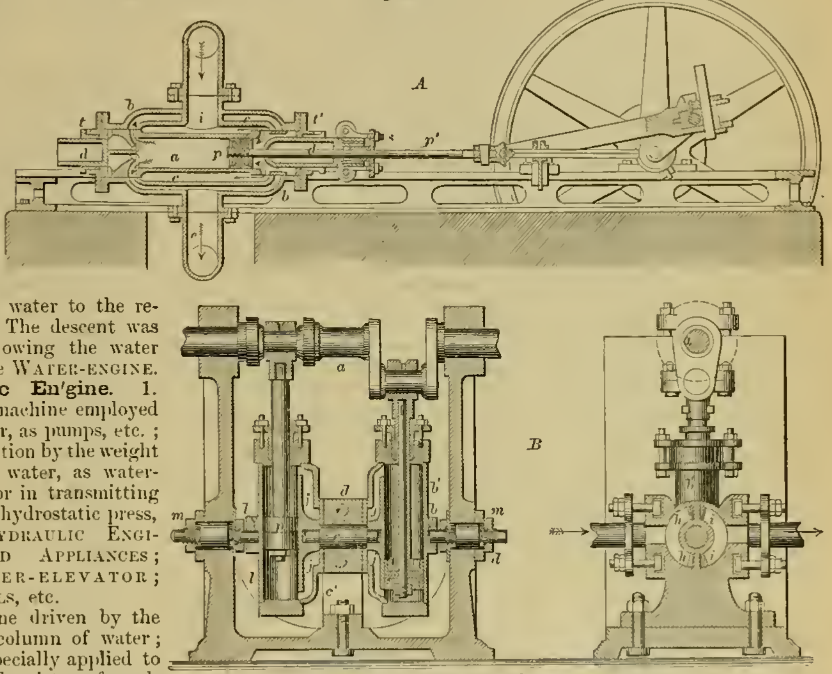
Hy-drau′lic El′e-va′tor. (*Hoisting.*) A platform lift worked by hydraulic power.

A strong rectangular frame having a hydraulic press at each corner. These are operated by a larger and a smaller pump. On the plungers of the pumps rest two additional frames, arranged to have a truly vertical motion. The machine is adapted for transferring railway-carriages from one line of track to another, and for this purpose is placed under the carriage, and the larger pump worked until the frames are brought to bear under the axles; the operation of the smaller pump then lifts the flanges of the wheels clear of the rails. When the carriage is transferred, the water is allowed to flow back from the pumps to the cistern, and the carriage lowered into place on the rails. See also Figs. *J*, plate opposite page 1150, and *L*, page 1157.

In 1812, Bramah patented a plan for laying water-mains in cities, the water to be under heavy pressure from force-pumps, and to be used for extinguishing fires and for operating hydraulic machines in factories, warehouses, etc., for elevating heavy weights, goods, etc.

The Ascenseur Edoux of Paris consists of a cylinder 66 feet long, sunken perpendicularly into the earth, with a plunger descending into it to the same depth, and packed water-tight at the top of the cylinder. Into this, below the packing, water is admitted by means of a valve. The piston rises under the pressure of the water to the required hight. The descent was effected by allowing the water to escape. See WATER-ENGINE.

Fig. 2614.



Water-Engines

Hy-drau'lic En'gine. 1. An engine or machine employed in raising water, as pumps, etc.; or receiving motion by the weight or impulse of water, as water-wheels, etc.; or in transmitting power, as the hydrostatic press, etc. See HYDRAULIC ENGINEERING AND APPLIANCES; PUMP; WATER-ELEVATOR; WATER-WHEELS, etc.

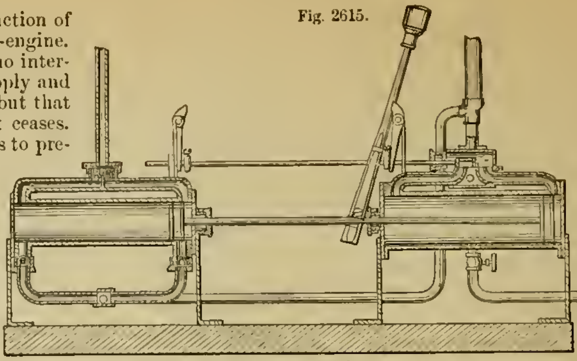
2. A machine driven by the pressure of a column of water; the term is especially applied to one in which the piston of a cylinder is driven by water-power.

The hydraulic engine of Huelgoat, in Brittany, is used to drain a mine; is single-acting, and acts directly to lift the piston of the pump. It makes five and a half strokes per minute, the stroke being a little more than eight feet in length. The piston-rod is 767 feet long, and it weighs 16 tons. The power of the engine is derived from a source at a hight 370 feet above its own level. See Delaunay's "Mechanics."

Perret's hydraulic engine *A* (French) has a cylinder and a double-acting piston. The motion is communicated to a working shaft in the ordinary way. The peculiarities consist in the manner of admitting and discharging the water. This is effected through openings at each end of the cylinder which occupy the greater part of its circumference and form a sort of annulus; there being left only enough solid metal to connect the end of the cylinder with the body. Thus the water is admitted to the interior from all sides. To facilitate this, the cylinder is entirely enveloped by a second cylinder, with a space intervening between the two, which is filled with the water of induction. The extreme portions of the working cylinder are turned very smooth externally in a lathe, and the ends of the enveloping cylinder are here contracted, and turned likewise on the inside, so as to make a joint as nearly as possible water-tight. Both these cylinders are enveloped completely by a third and larger one, between which and the second there is a space for the escape of the water on its discharge. This cylinder and the second are cast in a single piece, and form one body. The extremities of the third, like those of the second, are adapted accurately to the surface of the first, but there is a space between the second and third at this surface, which is as wide as the annular series of openings above described in the first, by which the water is to be admitted into or discharged from the first, which is the working cylinder. The inner cylinder moves backward and forward alternately, so as to present the openings which answer to its valves in front of the spaces which communicate with the supply and exhaust.

The motion of the working cylinder through the small space which is required to effect the admission and discharge of the water is accomplished by means of an eccentric upon the crank shaft, which is set at right angles to the crank, and 90° behind it in the direction of revolution; so that the motion of the cylinder is in a direction contrary to that of the piston in the first half, and in the same direction in the last half, of the stroke. The breadth of the annular opening is exactly equal to that of the metal which separates the supply from the exhaust in the exterior cylinders; and it will be seen that the

Fig. 2615.



Hydraulic Engine.

working cylinder itself performs the function of the slider in the valve-box of the steam-engine. It happens accordingly that there is no interval between the shutting off of the supply and the commencement of the discharge ; but that the efflux begins the moment the influx ceases. The main object of the specific devices is to prevent jar.

a is the inner cylinder.
b the external cylinder.
c the intermediate cylinder.
p is the piston beginning to advance.
i is the induction, *e* the eduction pipe.
d d' are prolongations of the working-cylinder, of smaller diameter, sliding back and forth in stuffing-boxes *t t'*.
p' is the piston-rod working in a stuffing-box *s*.

In Coque's water-engine a small quantity of air is admitted along with the water, to absorb hydraulic concussion.

Ramsbottom's hydraulic engine *B* (English) is oscillating, and employs two cylinders *b' l*, operating one crank-shaft *a*, by means of two cranks at right angles to each other. In one of the accompanying figures the channels of induction are marked *j*, and are cast with the cylinders ; the dotted circle *c* shows the position of the supply and discharge pipes ; in the other figure these pipes are indicated by arrows. The two views are vertical cross-sections at right angles to each other, one being through the axes of the cylinders and the other through the middle post in which the inner trunnions of the cylinders are journaled. The apertures of induction are seen at *h* and those of eduction at *i*, and have the form of truncated circular sectors, whose center is the center of motion. The induction and eduction spaces are divided by a sectoral partition ; the apertures of admission and discharge on the sides of the cylinders are of similar construction. The surfaces of contact between the cylinders *b' l* and the support *d* are plane and polished, and are made water-tight by the adjusting screws *m m* of the pivots. When the piston *p* is at the end of its course in either direction the cylinder and crank are vertical, and the valves all momentarily closed, the openings by which the channels *j j* communicate with the discharge and supply pipes presenting themselves exactly opposite the solid sectors which separate *h* from *i*. In the next moment the flow of water will recommence, the cylinder discharging itself from the full side of the piston, and filling anew from the opposite side. Air-chambers and relief-valves are used as a provision against counter-pressure and hydraulic shocks.

The Ramsbottom engine is largely used in England for operating printing-presses, circular saws, lathes, cranes, etc. In default of a natural head of sufficient power, the head is established in an *accumulator* of power, which is a body of water driven into a reservoir under heavy pressure, by forcing pumps worked by steam. For lighter industries such expedients are unnecessary. In cities in which the water distribution is from elevated reservoirs, and in which the water-supply is sufficiently abundant to justify the application of a portion of it to industrial uses, the water-engine is recommended by the combined advantages of simplicity, neatness, compactness, constant readiness for work, perfect safety, economy while working, and the absolute cessation of expenditure during interruptions and after the work of the day is over.

Fig. 2614 is a form of water-engine in which the water from an elevated reservoir bears upon the pistons of the pump and engine and operates the pump. The slide-valves of the engine and pump are actuated by a lever on the common piston-rod, which is tilted by striking the stuffing-box.

Hy-drau′lic En′gi-neer′ing and De-vi′ces.

Absorbing-well.
Accumulator.
Aft-gate.
Air-lock.
Ajutage.
Alarm-funnel.
Alcaraza.
Anti-guggler.
Apron.
Aquarium.
Aqueduct.
Archimedean screw.
Armor. Submarine
Artesian well.
Ash-leach.
Back.
Back-cutting.
Backwater.
Bag and spoon.
Balance-bar.
Balance-gate.
Ballast-engine.
Ballast-heaver.
Bank-protector.
Barker's mill.
Barrack.
Barrel-filler.
Barrel-filling gage.
Barrel-washer.
Bascule.
Basin.
Batardeau.
Bath.
Bath-heater.
Bath-tub.
Bay.
Bearing-pile.
Beck.
Beer-cooler.
Beer-engine.
Beer-float.
Beer-fountain.
Beer-tap.
Bilge-water alarm.
Bilge-water discharge.
Blast-hole.
Blower. Hydraulic
Boiler-prover.
Bollard.
Bond-rail.
Bonnet.
Boom.
Border-pile.
Bottle-boot.
Bottle-faucet.
Bottle-siphon.
Bottle-stopper.
Bottle-washer.
Bottling-machine.
Bowlder-head.
Branch.
Breakwater.
Breakwater-glacis.
Breasting.
Bridge.
Bubbles.
Bucket.
Bucket-engine.
Bucket-wheel.
Bung.
Burette.
Burrock.
Bye-wash.
Caisson.
Camel.
Camp-sheeting.
Canal.
Canal-lift.
Canal-lock.
Canal-lock gate.
Cane. Hydraulic
Cap.
Catch-basin.
Catch-feeder.
Catch-water drain.
Catch-work.
Cauf.
Centrifugal filter.
Centrifugal pump.
Cesspipe.
Cesspool.
Chain-pump.
Chain-towing.
Chamber-closet.
Chapelet.
Cheek.
Chute.
Cistern.
Clap-sill.
Cleansing-vat.

Clepsydra.
Clough.
Clow.
Coal-breaking jack.
Coal-washer.
Cock.
Coffer.
Coffer-dam.
Coffin.
Colluviarium.
Condenser.
Conduit.
Cooler.
Cooling-floor.
Corbel-piece.
Corking-machine.
Cork-jacket.
Cork-press.
Cork-puller.
Corkscrew.
Counter-drain.
Cradle.
Crane. Hydraulic
Crank-prover.
Crank-puller.
Crawl.
Crevasses. Stopping
Crib.
Croy.
Cruive.
Cumming.
Curb.
Current-fender.
Current-gage.
Current-meter.
Current-regulator.
Current-wheel.
Cut-off.
Cutwater.
Dam.
Danaide.
Dead-well.
Defecator.
Digue.
Dike.
Dip.
Distributing-reservoir.
Diversion-cut.
Diving-apparatus.
Diving-bell.
Dock.
Dolphin.
Draft-box.
Drag.
Drain.
Draining-apparatus.
Draining-auger.
Draining-engine.
Draining-plow.
Draining-pump.
Drain-trap.
Draw-gate.
Dredge.
Dredge-boat.
Dredging-machine.
Drill for well-boring.
Driven well-tube.
Dropping-tube.
Drove.
Drowning-bridle.
Drum-wheel.
Dry-dock.
Dutch-scoop.
Edulcorator.
Ejector.
Emissarium.
Enrockment.
Explorer.
Extinguisher.
Facing.
Fascine.
Faucet.
Feeder.
Feed-head.
Fender.
Fender-pile.
Fermenting-vat.
Filter.
Filter-bed.
Fire-cock.
Fire-engine.
Fire-extinguisher.
Fire-plug.
Fish-garth.
Fish-way.
Flashing.
Flews.
Float.
Float-case.
Floater.
Floating-clough.
Floating-dam.
Floating-dock.
Floating-harbor.
Floating-safe.
Flood-flanking.
Flood-gate.
Flume.
Flushing.
Footing.
Forebay.
Foreland.
Foreshore.
Fountain.
Fountain. Beer
Fountain of Hero.
Fountain-inkstand.
Fountain-lamp.
Fountain-pen.
Fountain. Portable
Frith.
Funnel.
Fyke.
Gabion.
Gage-rod.
Garth.
Gate-chamber.
Goose-neck.
Go-out.
Graving-dock.
Gridiron.
Grillage.
Groin.
Grouting.
Guide-lock.
Guide-pile.
Guard-pile.
Gutter.
Gyle.
Hand-swipe.
Hard.
Hatch.
Head.
Head-bay.
Head-gate.
Heck.
Hedgehog.
Hollow quoin.
Horn-drum.
Horse-path.
Hose.
Hose-bridge.
Hose-coupling.
Hose-shield.
Hydrant.
Hydrant-valve.
Hydraulic belt.
Hydraulic block.
Hydraulic buffer.
Hydraulic cane.
Hydraulic cement.
Hydraulic clock.
Hydraulic crane.
Hydraulic dock.
Hydraulic elevator.
Hydraulic engine.
Hydraulic governor.
Hydraulic hoist.
Hydraulic indicator.
Hydraulic jack.
Hydraulic lift.
Hydraulic lifting-jack.
Hydraulic main.
Hydraulic motor.
Hydraulic nozzle.
Hydraulicon.
Hydraulic pivot.
Hydraulic pressure-pump.
Hydraulic propeller.
Hydraulic punch.
Hydraulic ram.
Hydraulic shears.
Hydraulic slip.
Hydraulic telegraph.
Hydraulic valve.
Hydro-electric machine.
Hydro-extractor.
Hydrometer.
Hydrometric pendulum.
Hydrometrograph.
Hydrophore.
Hydroscope.
Hydrostat.
Hydrostatic balance.
Hydrostatic bellows.
Hydrostatic engine.
Hydrostatic jack.
Hydrostatic lamp.
Hydrostatic press.
Ice-apron.
Ice-breaker.
Impluvium.
Inclined plane.
Invert.
Jette.
Jetty.
Keel-fat.
Keir.
Kemelin.
Kid.
Kiddle.
Ladle-board.
Land-tie.
Land-tank.
Launder.
Leach.
Leaf.
Leak-alarm.
Leam.
Leat.
Levee.
Level.
Life-preserver.
Lift. Canal
Lift. Lock
Lift. Wall
Lighter.
Lighthouse.
Lining.
Liquid-cooler.
Liquid-gage.
Liquid-meter.
Litrameter.
Lock. Canal
Lock-chamber.
Lock-gate.
Lock-paddle.
Lock-sill.
Lock-weir.
Lode.
Main.
Mantle.
Marigraph.
Marine-alarm.
Marine-railway.
Mash-cooler.
Mash-tun.
Measuring-apparatus.
Measuring-faucet.
Measuring-funnel.
Measuring-pump.
Meter.
Mill-dam.
Mineral-water apparatus.
Miser.
Miter-drain.
Miter-post.
Miter-sill.
Mole.
Monte-jus.
Morton's slip.
Mud-boat.
Mud-drag.
Nautical-alarm.
Nautilus.
Needle.
Negative-well.
Noria.
Nozzle.
Oar.
Oenometer.
Oil-feeder.
Ombrometer.
Organ. Hydraulic
Outburst-bank.
Outfall.
Overflow-basin.
Paddle.
Paddle-wheel.
Pannier.
Penchute.
Penstock.
Percolater.
Perpendicular lift.
Peruvian wheel.
Picotah.
Pier.
Pierre-perdue.
Pile.
Pile-driver.
Pile-saw.
Pipe.
Pipette.
Pipe-prover.
Pitched work.
Pitot's tube.

Platform.
Plug. Fire
Pneumatic pile.
Point.
Pond.
Pot-wheel.
Pound.
Pozzuolana.
Pressure-pump.
Propeller.
Psychrometer.
Puddle.
Puddling.
Puffer.
Pugging.
Pull-cock.
Pulp-washer.
Pump.
Pumping-engine.
Punching-bear.
Quay.
Race.
Rail-bender.
Rail-punch.
Rain-gage.
Raising sunken vessels.
Ram. Hydraulic
Reach.
Reservoir.
Rheometer.
Riddle.
Rinsing-machine.
Rip-rap.
Rising-main.
River-wall.
Root.
Round.
Salmon-ladder.
Salmon-stair.
Sand-trap.
Sand-washer.
Sasse.
Saucer.
Scoop.
Scoop-wheel.
Scouring-basin.
Screw. Archimedean
Screw-dock.
Screw-pile.
Scroll.
Sea-gates.
Sea-wall.
Sectional dock.
Separating-weir.
Sett.
Sewer.
Shaft-straightener.
Sheeting-pile.
Shingle-trap.
Ship-jack.
Shoal-alarm.
Shoe.
Shrouding.
Shuttle.
Side-pond.
Sink.
Sink-trap.
Siphon.
Siphon-bottle.
Sirup-stand.
Slack-water navigation.
Slide.
Slip.
Slop-hopper.
Sludging.
Sluice.
Sluice-gate.
Sluice-valve.
Snag-boat.
Soda-fountain.
Sough.
Souterazici.
Spile.
Spout.
Spreader.
Spring-tester.
Spur.
Stade.
Stage.
Staith.
Stanch.
Stand-pipe.
Starling.
Start.
Stay-pile.
Steam fire-engine.
Steam-fountain.
Steam stench-trap.
Sterhydraulic apparatus.
Still.
Stockade.
Stop-cock.
Stop-plank.
Stop-valve.
Storm-pavement.
Street-sprinkling cart.
Street-washer.
Street-watering.
Submarine apparatus.
Submarine armor.
Submarine boat.
Submarine cable.
Submarine excavator.
Submarine lamp.
Submarine telescope.
Submarine valve.
Submarine vessel.
Sump.
Swash-bank.
Sweetening-cock.
Swing-bridge.
Syringe.
Tachometer.
Tail-bay.
Tail-gate.
Tail-race.
Tank. Oil, etc.
Tan-pit.
Tap.
Tapping water-pipe.
Testing-machine.
Thatch wood-work.
Tidal basin.
Tide-alarm.
Tide-gage.
Tide-gate.
Tide-lock.
Tide-mill.
Tide-motor.
Tide-power.
Tide-valve.
Tide-wheel.
Towing.
Trap.
Traversing-jack.
Trough.
Trunk.
Tub.
Tube.
Tube-clamp.
Tube-well.
Tun.
Tunnel.
Turbine.
Tympanum.
Urinal.
Valve.
Vase.
Velinche.
Vent.
Vineficateur.
Wagon-tipper.
Wale.
Warp.
Waste.
Waste-trap.
Waste-weir.
Water-balance.
Water-barrow.
Water-bearing.
Water-bellows.
Water-carrier.
Water-clock.
Water-closet.
Water-cooler.
Water-crane.
Water-engine.
Water-elevator.
Water-frame.
Water-gage.
Water-gas.
Water-gate.
Water-gilding.
Water-glass.
Water-indicator.
Watering-cart.
Water-leg.
Water-level.
Water-line.
Water-lute.
Water-mark.
Water-meter.
Water-mill.
Water-motor.
Water-pillar.
Water-pressure engine.
Water-proofing.
Water-room.
Water-screw.
Water-snail.
Water-supply for locomotives.
Water-twist.
Water-way
Water-wheel.
Water-works.
Wave-power.
Wave-trap.
Way-gate.
Weel.
Weir.
Weir-table.
Well.
Well-boring.
Wet-dock.
Wharf.
Wheel-jack.
Wheel-press.
Wince.
Woltmann's mill.
Worm.
Worm-safe.
Wort-cooler.
Zigzag.

Hy-drau'lic Gov'ern-or. (*Steam.*) Another name for Smeaton's *cataract.* See CATARACT; CORNISH-ENGINE.

Hy-drau'lic Hoist. (*Hoisting.*) One device for this purpose consists of a large cylinder in which the slow and forcible movement of a piston is made to drive water into a smaller cylinder and impart a relatively larger stroke to a piston therein. It is the converse of the hydrostatic press. See ACCUMULATOR, Fig. 24; Figs. *C J*, opposite page 1150; *K L M*, page 1157.

Hy-drau'lic In'di-ca'tor. A gage (*B*, plate opposite page 1150) to indicate hydraulic pressure. Water under the pressure to be tested is admitted through the pipe *a* to a cylinder enclosing a piston which tends to depress the short arm of the lever *b*, counterbalanced by the weight *c*; a movable weight slides on the long arm of the lever, and weights *d* are added to its outer end when a very great pressure is to be measured.

Hy-drau'lic Lift. (*Hoisting.*) An apparatus (*K*, page 1157), on the principle of the hydraulic press, is enclosed within the casing *a*, and is by means of a lever *h* caused to draw upon the chain *c*, which passes over two sets of pulleys, in the example twelve in number, and is thence conducted by leading pulleys over the jib *d*. The weight *c* is by this arrangement raised twelve times the stroke of the ram at each movement of the latter. There is, of course, a corresponding loss of power, but this is of less moment than the increased speed attained.

Hy-drau'lic Lift'ing-jack. (*Hoisting.*) A portable lifting apparatus in which the power is a form of the hydrostatic press (*M*, in same plate). In this form of the machine, the reservoir *a*, pump *b*, and pressure cylinder *c* are above the ram *d*, and maintained in line therewith by the tubular casing *c*. The plunger *f* is operated by the lever *g*. Water is admitted to the reservoir *a* through the screw-fitted opening *h*, and flows through the valve *i* into the pump-cylinder *b*, when the piston *f* is raised. The downward motion of the piston forces the water through a suitably arranged valve into the lower cylinder *c*, where the pressure it exerts between the head of the immovable ram and the movable pump and reservoir causes them to raise a weight placed either on the head *k* or projecting foot *l*. The machine is re-adjusted for lifting by the screw-valve *m*, which opens a communication between the upper and lower chambers.

M′ and *M″* are perspective views of a similar machine.

M‴ has a hollow base and a stationary ram which acts as a guide-post. The cylinder with a protruding claw slides upon the ram.

Hy-drau′lic Lime. A kind of lime which has the capacity for hardening under water. See Hydraulic Cement.

Hy-drau′lic Main. (*Gas.*) A strong, cast-iron pipe, usually about 12 inches in diameter, and of a length sufficient to receive all the perpendicular pipes that convey to it the gas generated in the several retorts. The main is horizontal, and is supported on the brick-work that covers the ovens.

The hydraulic main contains a certain quantity of water, and the mouth of each gas-tube is submerged in the water, so that the gas flows through water and parts with a portion of its ammonia at this stage of the process. See Dip-pipe; Gas-regulator.

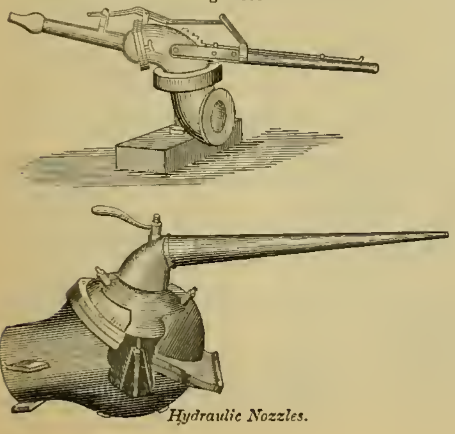
Hy-drau′lic Min′ing. (*Mining.*) A system of mining in which the force of a jet of water is used to wear down a bed of auriferous gravel or earth, which is passed through sluices to detain the particles of gold. See Flume; Hydraulic Nozzle.

Hy-drau′lic Mor′tar. Mortar in which the presence of alumina enables it to harden under water; producing an insoluble silicate of alumina. (See Cement.) It usually contains burned clay along with the more abundant lime, and sometimes oxide of iron. See Hydraulic Cement; Pozzuolana.

Hy-drau′lic Mo′tor. A water-engine.

1. A hydraulic ram having connections which raise a piston that is forced down by atmospheric pressure at each cessation of the downward flow of water. By suitably arranged valves the water may be admitted alternately above and below the piston, causing a reciprocating action similar to that of the steam-engine.

Fig. 2616.



Hydraulic Nozzles.

2. A machine in which a piston is moved in a cylinder by water from a head or stand pipe, in the manner of a steam-engine. Some engines on the Continent of Europe work with a head of 200 feet conducted by a pipe. See Hydraulic Engine.

Hy-drau′lic Noz′zle. (*Mining.*) A device for directing a stream of water upon a bank of auriferous dirt to crumble it down, that it may be passed through a sluice to collect the gold.

The nozzle has universal motion so as to direct the stream in any direction, in one case by two elbows and pairs of rings which slip on each other, and in the other case by a spherical segment and socket. These machines are made to collect the water of a number of hose-pipes into one stream which may be directed in one jet of from 4 to 7 inches in diameter upon a bank at a distance of 200 feet, if necessary to stand at that distance to avoid caving.

Hy-drau′li-con. (*Music.*) A water-organ. This form was known to the Alexandrian Greeks in the time of Hero, 150 B. C. It is supposed that air was forced by means of water. If so, it was rather a *water-bellows*. See Organ.

Hy-drau′lic Piv′ot. (*Machinery.*) A contrivance of Girard by which a film or body of water is introduced below the end of a vertical axis to bear the weight thereof, and prevent the actual friction of the axis on its step.

The hydraulic pivot, or liquid bearing, for stepping vertical shafts, is described in Bramah's planing-machine, English patent, 1802. See Journal-bearing; Palier-glissant.

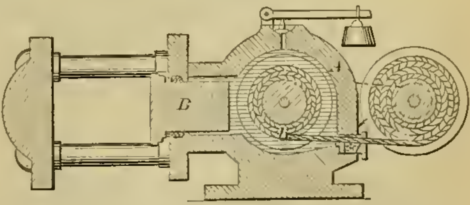
Hy-drau′lic Plat′form-lift. (*Hoisting.*) A form of hoisting-apparatus (*L*, page 1157) in which the small pump *a*, operated by the lever *b*, is caused to force water into the larger cylinder *c*, which contains a piston bearing the upright stem *d*, upon the upper end of which the platform *c c*, sliding upon appropriate guides, is fixed.

Hy-drau′lic Press. Another name for the *hydrostatic press*. *H*, plate opposite page 1150, represents a press for the extraction of liquids from the more solid saturated materials; such as the juices from the woody fiber of herbs in obtaining vegetable extracts.

In this, a horizontal plunger *a*, actuated by a screw *b*, works in a water-chamber *c d* to raise a ram *e*. A vertical screw *f* works in the head *g* on the standards, for raising or depressing the piston, between which and the ram *e* substances are compressed. When the juices of fruits, etc., are to be expressed, the platen is surrounded by a perforated box *j j*. See Hydrostatic Press.

Another form is that in which a cord or rope is drawn into the box to expand the liquid against the sides of the chamber, and thus press outwardly the ram. See Sterhydraulic Press.

Fig. 2617.



Hydraulic Press.

Hy-drau′lic Pro-pel′ler. A mode of propelling vessels by the ejection of a body of water sternward.

It was invented by Dr. John Allen, and described by him in 1730. See his "Specimina Ichnographica." His method was to form a tunnel or pipe, open at the stern of the vessel, and by means of a pump to force water or air through it into the sea. The reaction thus occasioned would drive the ship forward. The design was put into execution upon a canal, with a boat of considerable size, and worked by pumps by manual labor, but he suggested the employment of a steam-engine, and its application to a vessel of 1,500 tons.

The hydraulic propeller of Dr. Allen formed the subject of a patent to David Ramsey, in England, 1738; and Rumsey, of America, 1782. The latter ran a vessel of 50 feet long on the Potomac, and one built on his plan was launched and fitted after his death, and ran on the Thames four miles an hour against wind and tide.

Dr. Franklin planned a boat of this kind in 1785, and it has since been tried on the Scheldt, two turbines being used for pumps.

Linnaker's hydraulic propeller, 1808, had pumps placed horizontally beneath the bottom of the vessel. The pistons were attached to hanging levers which were oscillated by the power of the steam-engine. The pistons reciprocated in longitudinal trunks parallel to the keel.

In a second plan, the pumps were vertical and discharged the water through horizontal trunks.

The "Nautilus," furnished with Ruthven's propeller, had a trial trip on the Thames in the summer of 1868, running in company with paddle-wheel steamers of the class that ply like aquatic omnibuses up and down the river. She ran at the rate of 13.5 and 7.2 miles per hour, with and against the tide, respectively, or at an average speed of 10.35 miles per hour. She then steamed down the river, and when off the Tunnel pier, with both strong wind and tide in her favor, going at full speed, was made, by reversing the valves, to stop dead in less than ten seconds and in about a quarter of her length. Her Majesty's iron-clad gunboat "Waterwitch" was fitted with the new propeller. The water is discharged in a heavy stream on both sides of the vessel, and its direction is under such command that the vessel is independent of her rudder, and is worked under the complete control of the master, officer of the watch, or man on deck, without any communication with the engine. The plan has been tried in the United States without commending itself as against the paddle and screw. Different modes of the application of the hydraulic propeller have been suggested for canal navigation.

Hy-drau'lic Pull'ing-jack. (*Hoisting.*) An application of the hydrostatic press.

A cylinder *a* (*C*, plate on the opposite page) contains a tube *b*, to which the piston *c* is attached. *d* is a smaller tube sliding within the piston and tube *b*. A valve *e* closes the communication between the cistern *f*, which contains a pump *f'* operated by the hand-lever *h*, and the cylinder *a*; two passages *g g* afford communication between the tube *d* and cylinder *a* at the back of the piston *c*. Water is poured into the cistern through an opening closed by a screw, and the jack suspended cistern end downward. Working the hand-lever *h* forces, by means of the plunger *h*, water through the tube *d* and passages *i i*, and depresses the piston to the bottom of the cylinder *a*. The water at the back of the piston returns at the same time to the cistern through the passages *g g*. By unscrewing the stop-valve *e*, the water returns through the tube *d* and passages *i i* to the cistern, relieving the piston from pressure and allowing a suspended weight to fall.

Hy-drau'lic Punch. An application of the hydrostatic press, comprising a force-pump and operating cylinder (*G*, same plate), in which the piston, carrying the punch *b*, is inserted, inclosed in a case *a*. The lever *c* operates the pump to depress the piston, and force the punch through a plate beneath; it is then raised by the lever *d* to punch another hole. A PUNCHING-BEAR (which see).

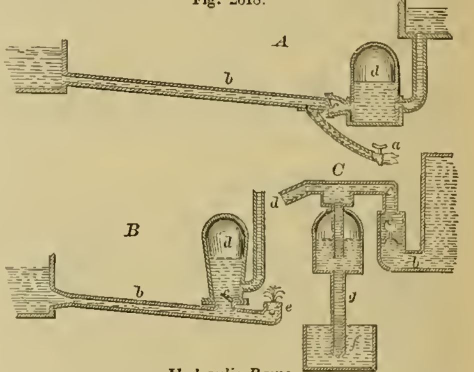
Hy-drau'lic Rail-bend'er. An implement for bending or straightening rails by hydraulic pressure (*E*, same plate). The action of the lever *a* operates a small force-pump within the casing, which is connected with a larger cylinder, the piston of which forces the plunger *d* against the rail midway between the points where it is held by the lips *c c*. Known as a JIM-CROW (which see).

Hy-drau'lic Ram. A device by which the fall of a column of water in a tube is caused to elevate a portion of itself to a hight greater than that of its source.

This depends on the well-known law of mechanical force, that the effect produced by a body is as its weight multiplied into the velocity, its absolute force constituting the momentum.

This principle was first practically applied in the construction of the water-ram by Mr. Whitehurst of Derby, England, in 1772. Whitehurst's ram is shown in *A*, Fig. 2618. It was not automatic, but depended upon the opening and shutting of a cock from which water for domestic purposes was drawn.

Fig. 2618.



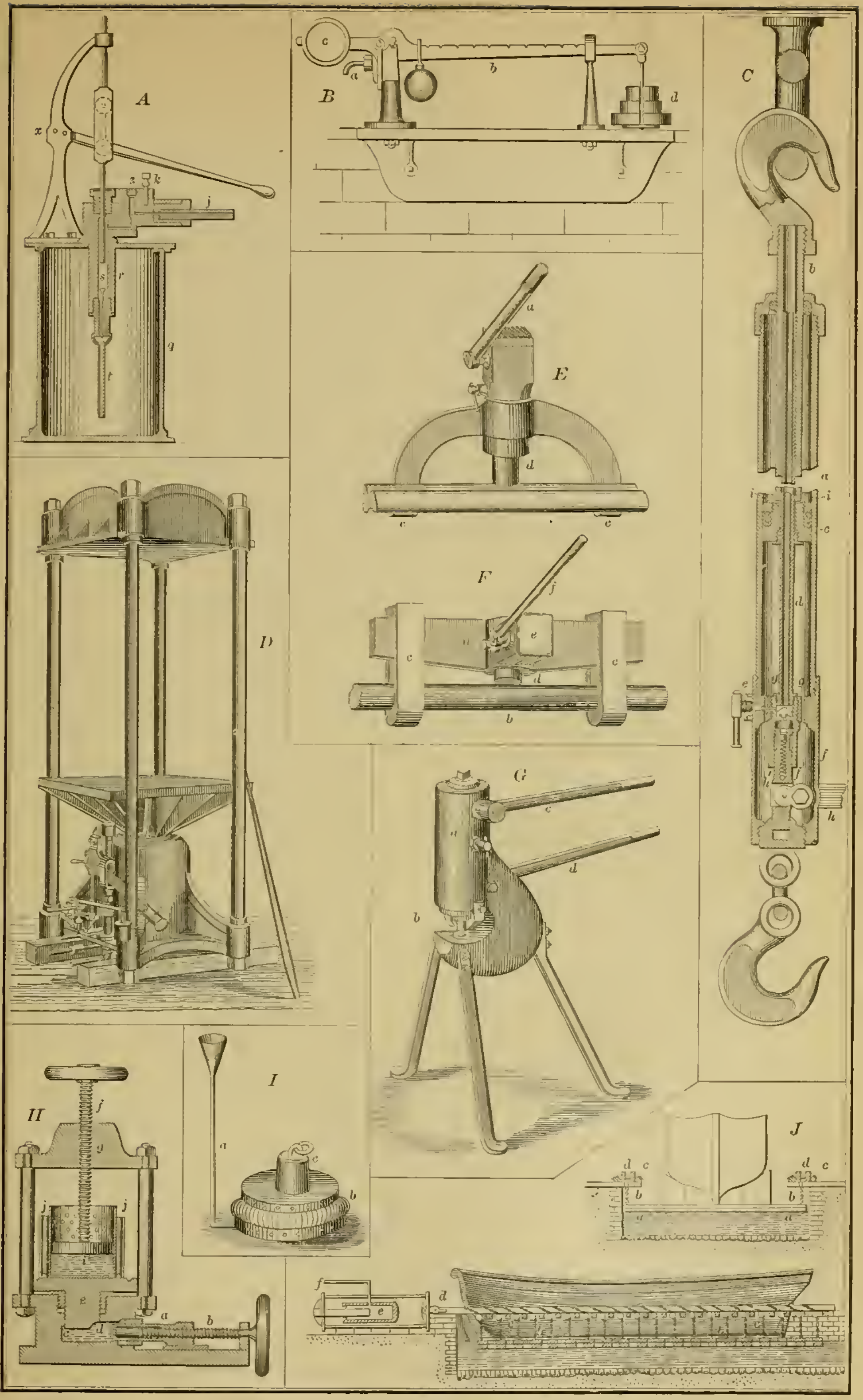
Hydraulic Rams.

The operation is as follows: on opening the cock *a*, water from the cistern flowed down the pipe *b*, and on closing the cock, the sudden stoppage of the water caused the valve *c* to open, and a part to be forced through into the air-chamber *d*; the momentum imparted to the water would be sufficient to carry it to a hight as much greater than that of the descending column as the quantity of water in the former was less than in the latter; being, however, forced into the air-chamber, this effect was exerted intermediately through the compression of the air, rendering it more constant.

In 1796, Montgolfier, one of the inventors of the balloon, invented the self-acting ram, for which he obtained a gold medal at the French Exposition of 1802. This is absolutely automatic, maintaining its action regularly so long as the machine remains intact or the supply of water holds out.

A simple form is represented at *B*. This machine differed from that of Whitehurst merely in the addition of a waste-valve *e*; but this altered its entire character, and rendered it practically efficient as a water-raising machine.

The water, as before, flows down the pipe *b*, but the momentum thus acquired causes it to raise the



HYDROSTATIC PRESSES.

PLATE XXV

See page 1150.

valve *c*, shutting off the water as before and causing it to spend its energy in forcing a portion of itself into the chamber *d* ; but this done the valve drops, causing a flow through the pipe until the water has gained energy to again raise the valve, when the same series of events is repeated.

C represents the suction-ram ; in this the water flows from the reservoir along the pipe *b c d*, having a ball-valve *e* ; the water flowing from the reservoir through the pipe finally lifts the valve sufficiently to close the aperture *c*, stopping the flow while the pipe is discharged through *d* and creating a vacuum therein ; the atmospheric pressure on the water in *f* now causes it to rise through the pipe *g* and be discharged by *d*. The ball-valve then drops by its gravitation to be again elevated by the current through the pipe, and the series of operations is continued.

The water-ram is only efficacious where there is a larger supply of water at command than is necessary to be raised, but in certain cases its power and constant and unfailing action render it very valuable.

Hy-drau'lic Shaft-straight'en-er. An hydraulic implement for straightening metallic bars and shafts (*F*, plate opposite page 1150). The beam *a* and shaft *b* are each inserted within the collars *c c*, and pressure applied through the plunger *d*, operated by a small hydraulic press enclosed within the casing *c* and worked by the lever *f*.

Hy-drau'lic Shears. A machine for shearing metals, etc., by the force of water-pressure (*O*, page 1157). The cutting-blade *a* is forced toward and drawn away from the stationary blade *b* by its attachment to the piston of a cylinder connected with a force-pump contained within the casing *c* and operated by a lever *d*.

Hy-drau'lic Slip. A slip-dock in which the cradle and its load, the ship, are hauled up the rails or ways, for the purpose of cleaning or repair, by the power of an hydraulic press. See Slip-dock.

The cylinder of the press lies on a strong foundation at the upper end of the slip-way ; its plunger has a *cross-head* connected by means of side-rods with a *cross-tail*, to which is attached the chain for hauling up the cradle. The chain consists of a series of long, straight links, or traction rods, each equal in length to the stroke of the plunger and connected together by pins. The plunger is driven by water, forced in by a set of pumps worked by a steam-engine. After a forward stroke of the plunger has been completed, an escape-valve is opened for the water, and the plunger is drawn back by a counterpoise ; one length of traction rod is disconnected and taken out ; and when the plunger has completed its return stroke, the shortened chain of traction rods is again connected with the cross-tail, to be ready for the next forward stroke, and so on. The operation of disconnecting the traction rods, taking out a length and reconnecting them, is called *fleeting*. The usual speed with large ships, including stoppages for *fleeting*, is about 4 feet per minute.

Hy-drau'lic Spring-test'er. An application of the hydrostatic press to testing the strength of springs (*P P'*, page 1157). *a* is a side view and *b* the plan of this device. It has an accumulator, into which air is forced by means of a hand-pump until the pressure is about 100 pounds per square inch. Power-pumps working in a cistern are then set in motion, pumping water into the cylinder until a pressure of about 300 pounds per inch is attained ; by opening a stop-valve, this accumulated pressure is at once allowed to act on the ram and compress the spring to be tested. The ram is retracted by counterbalance weights when the pressure is removed.

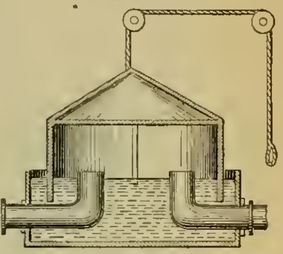
Hy-drau'lic Tel'e-graph. A mode of communication by means of a column of liquid in a pipe, which is caused to move so as to actuate a hand, or by different levels to indicate messages or letters on a graduated or written scale against the fluctuating column. The plan was tried in France by Bossuet over a century since, with a pipe about three miles long.

Vallance's hydraulic telegraph was described by the inventor in a pamphlet in 1825.

Hy-drau'lic Valve. (*Pneumatics.*) An inverted cup which is lowered over the upturned open end of a pipe, the edge of the cup being submerged in water and closing the pipe against the passage of air.

The hydraulic valve of the gas-works governs the communication between the gas-holder and the main. When the valve is raised the communication is free between the two pipes ; but when the valve is depressed the division plate descends into the water and closes the connection.

Fig. 2619.



Hydraulic Valve.

Hy-drau'lic Wheel. One for raising water by applied power, as the Noria, Scoop-wheel, Tympanum, etc. (which see). The wheel shown in the example is driven by steam or wind power, having buckets on its internal perimeter which raise water from the stream and discharge it right and left into the branches of the elevated gutter. It is intended for irrigating cotton, coffee, indigo, rice, and sugar lands, and for other purposes. See Fig. 2620.

Hy'dro-ba-rom'e-ter. An instrument for determining the depth of sea-water by its pressure.

In the United States Coast Survey Report, 1857, pp. 398 – 403, is an account of the sounding-apparatus of Lieutenant E. B. Hunt : "Arrange a weighted india-rubber air-vessel for dragging on the bottom ; connect this with a boat or surveying-vessel by an air-tight tube of small bore ; let this tube open in a cistern of mercury made air-tight ; and from this cistern arrange a vertical glass column, open at the top, through which the mercury can rise to any hight required by the pressure due to the depth."

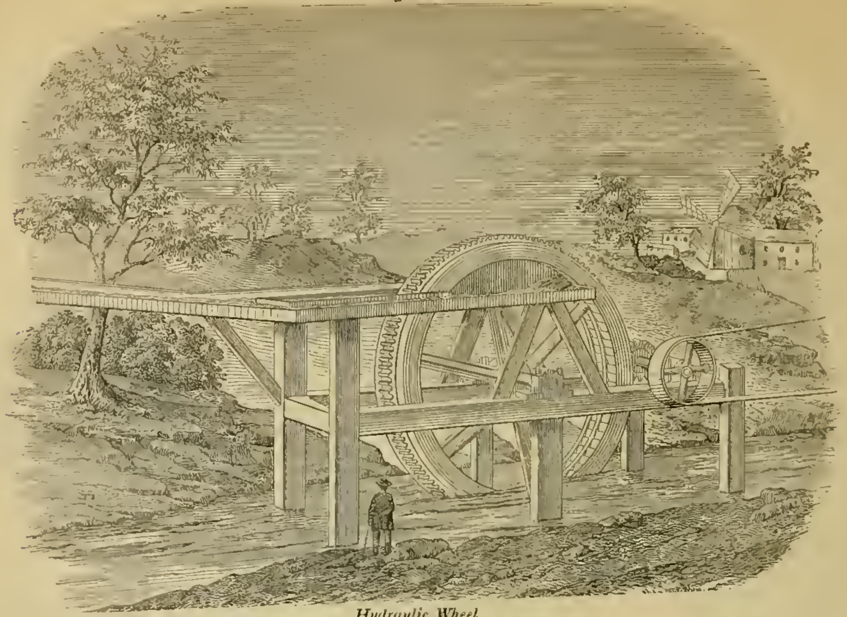
See also Ericsson's patent, September 22, 1863. Also McCord's, September 20, 1859, in which latter the pressure of the water pushes up a piston into a graduated cylinder, where the acquired elevation is registered.

Hy'dro-car'bon-burn'er. One in which liquid fuel is used beneath a steam-boiler, cooking-vessel, or otherwise. It usually has a jet of air or steam, frequently both, which carry with them a quantity of petroleum or coal oil in the form of spray which is ignited and burns below the boiler. Ingenuity is exercised in so arranging the burners that the jets in sufficient number are so disposed as to apply the flame to the surfaces of the boiler.

In Fig. 2621, the pipe *B* is a receptacle in which the oil is mixed with air, and the gases evolved. A small stream of oil enters by the pipe *i*, a current of air by opening *r*, and a jet of steam from the boiler by pipe *S*. Pipe *B*, containing steam, air, and gas, passes through the furnace, and on its return empties its heated contents in the midst of the fire.

In heating or cooking stoves, the burner may consist of a vaporizer in which a jet heats a small retort from which the coal oil issues in a vapor ; or

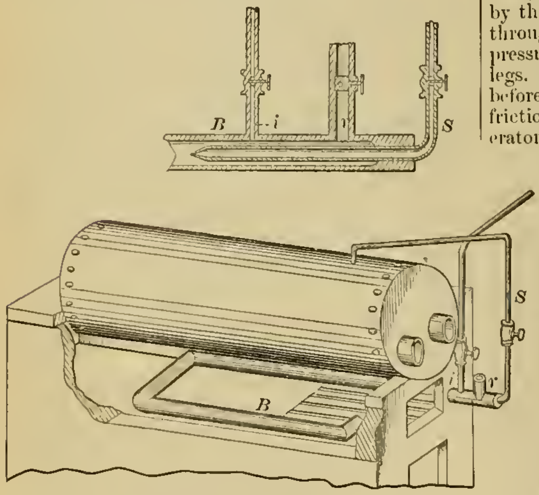
Fig. 2620.



Hydraulic Wheel.

it may be pan of sand upon whose surface the oil is ignited. See GAS-HEATER; GAS-STOVE.

Fig. 2621.



Hydrocarbon Boiler-Furnace.

Hy'dro-car'bon-fur'nace. One specially adapted to the use of liquid fuel either beneath a steam-boiler or a metallurgic furnace. See HYDROCARBON-BURNER.

Hy'dro-car'bon-stove. A heating or cooking stove in which liquid fuel is burned within the furnace chamber. See GAS-STOVE.

Hy'dro-e-lec'tric Bat'ter-y. (*Electricity.*) An apparatus in which dynamic electricity is produced by means of two different metals connected together by a conductor, and immersed in a solution which causes a flow of electricity from the positive to the negative metal. See GALVANIC BATTERY.

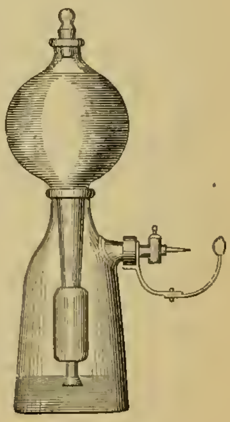
Hy'dro-e-lec'tric Ma-chine'. (*Electricity.*) A machine invented in 1840 by Mr. (now Sir William) Armstrong, in which electricity is generated by the friction of steam against the sides of orifices through which it is allowed to escape under high pressure. A steam-boiler is supported on four glass legs. The steam is conducted over wet cotton wicks before escaping, in order to take up water whose friction against the sides of the orifice is the generator of the electricity, the steam being the driving power. The positive electricity is collected by directing the jet of steam upon a metallic comb communicating with an insulated conductor.

Hy'dro-ex-tract'or. A form of filter or dryer in which a liquid is driven by centrifugal force from or through a mass deposited in a chamber rotating at high velocity. See CENTRIFUGAL MACHINE.

Hy'dro-gen-lamp. About 1825 a German named Döbereiner discovered that spongy platinum became incandescent when a mixture of hydrogen gas and atmospheric air was passed through it, and thence devised his self-lighting lamp, which was long in favor and known as the hydrogen-lamp. It formed an instantaneous light apparatus, and was especially useful for lighting at intervals during the day.

It has lately been applied to gas-burners,

Fig. 2622



Hydrogen-Lamp.

which are self-igniting as the jet of carburetted hydrogen is ejected upon a piece of spongy platinum suitably placed in proximity to the orifice.

Hy′dro-met′al-lur′gy. The wet process of extracting metals from ores; in contradistinction to the hot process. See list under METALLURGY.

Hy-drom′e-ter. 1. An instrument for determining the relative densities of liquids. Distilled water is usually referred to as the standard of comparison. It consists essentially of a bulb or float weighted at bottom so as to float upright, and having an elongated stem graduated to indicate the density of the liquid by the depth to which it sinks therein. Hydrometers may be divided into two classes; those with which weights are used and those in which they are dispensed with. Among the former are Sykes's, Jones's, and Siemen's, while Tralle's and many others are of the latter description.

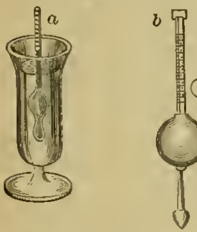
In all, a correction must be applied to the observed indication when the temperature is above or below a certain standard (usually 60° Fah.), in order to obtain the true result.

Many instruments are only constructed with reference to liquids heavier than water; such are *saccharometers*, *salinometers*, and *acidimeters*, which, though bearing names, specifically indicating the particular kinds of fluids they are designed to test, are embraced in the general class hydrometer; such also are those adapted for fluids lighter than water, as *alcoholometers* and *oleometers*; all depend on the same principle, but greater delicacy is secured by confining the measuring capacity of the instrument within comparatively narrow limits, allowing it much greater vertical ranges for equal variations in specific gravity, so that extremely small differences become sensible. The different weights in those of the weighted class are also intended for this purpose.

Hydrometers are made and specially graduated for testing spirits, petroleum, oil, milk, cream, vinegar, lye, lime-water, acid, ether, alcohol, silver solution, dye solutions, salt water, lime, alkali, sirup, ammonia, beer, bark ooze, cider, shellac, glue, wine, must, urine. See list under METERS.

Sykes's hydrometer is that legally employed in the collection of the revenue in Great Britain. It has a flat stem graduated into eleven equal parts, which are again subdivided into two.

Fig. 2623.



Sykes's Hydrometer.

Eight different weights, numbered respectively 10, 20, 30, 40, 50, 60, 70, 80, are employed in connection with the instrument.

The proper one to be used depends on the strength of the spirit to be tested. It is placed on the lower projecting stem, sinking the instrument to a depth corresponding or nearly so to some one of the graduations on the upper stem; this is noted, and also the temperature of the liquid, and the corresponding strength per cent of spirit is then found from tables constructed for the purpose.

Jones's hydrometer is a modification of Sykes's. It has a square stem, differently graduated on each of its four sides, and three weights which, with the unweighted instrument, correspond to the four scales.

Among those in which weights are dispensed with are Beaumé's, the centigrade, etc.

Beaumé's is in very general use in France and on the Continent of Europe. Its scale is based upon a solution containing 10 per cent of chloride of sodium (common salt).

The following table shows the specific gravity corresponding to different degrees of Beaumé: —

For Liquids heavier than Water.

Degrees Beaumé.	Specific Gravity.	Degrees Beaumé.	Specific Gravity.	Degrees Beaumé.	Specific Gravity.
0	1.000	26	1.206	52	1.520
1	1.007	27	1.216	53	1.535
2	1.013	28	1.226	54	1.551
3	1.020	29	1.236	55	1.567
4	1.027	30	1.246	56	1.583
5	1.034	31	1.256	57	1.600
6	1.041	32	1.267	58	1.617
7	1.048	33	1.277	59	1.634
8	1.056	34	1.288	60	1.652
9	1.063	35	1.299	61	1.670
10	1.070	36	1.310	62	1.689
11	1.078	37	1.322	63	1.708
12	1.086	38	1.333	64	1.727
13	1.094	39	1.345	65	1.747
14	1.101	40	1.357	66	1.767
15	1.109	41	1.369	67	1.788
16	1.118	42	1.382	68	1.809
17	1.126	43	1.395	69	1.831
18	1.134	44	1.407	70	1.854
19	1.143	45	1.421	71	1.877
20	1.152	46	1.434	72	1.900
21	1.160	47	1.448	73	1.924
22	1.169	48	1.462	74	1.949
23	1.178	49	1.476	75	1.974
24	1.188	50	1.490	76	2.000
25	1.197	51	1.505		

For Liquids lighter than Water.

10	1.000	27	.896	44	.811
11	.993	28	.890	45	.807
12	.986	29	.885	46	.802
13	.980	30	.880	47	.798
14	.973	31	.874	48	.794
15	.967	32	.869	49	.789
16	.960	33	.864	50	.785
17	.954	34	.859	51	.781
18	.948	35	.854	52	.777
19	.942	36	.849	53	.773
20	.936	37	.844	54	.768
21	.930	38	.839	55	.764
22	.924	39	.834	56	.760
23	.918	40	.830	57	.757
24	.913	41	.825	58	.753
25	.907	42	.820	59	.749
26	.901	43	.816	60	.745

In Gay Lussac's centigrade hydrometer the specific gravity of a liquid heavier than water is found by subtracting the indication from 100 and dividing 100 by the remainder; if lighter than water, add the indication to 100 and divide 100 by the sum, thus 10° below $0° = \frac{100}{90} = 1.111$ specific gravity; 10° above $0° = \frac{100}{110} = 0.909$ specific gravity.

The hydrometer of Brix is that legally used in Prussia; to ascertain the specific gravity the constant number, 400, is divided by 400 + the indication for liquids lighter than water, and by 400 − the indication for those heavier than water.

The formula for Beck's instrument is precisely similar, substituting 170 for 400.

Tralle's and Gendar's are used in the United States, the former being adopted by government for ascertaining the duty on distilled spirits. It is graduated from 0°, the indication in water, to 100°, alcohol, 50° being proof spirit. A correction is required for temperatures above or below 60° F.

The volume of pure spirit is ascertained (1) when above proof by multiplying the indication by 2 and subtracting 100; and (2) when below proof by multiplying the indication by 2 and subtracting the product from 100.

The commercial hydrometer, Gendar's, is graduated to 100° each way from proof. To ascertain the per cent of pure spirit: when the liquor is above proof, add 100 to the indication and divide the sum by 2; when below proof subtract the indication from 100 and divide the remainder by 2.

Rousseau's hydrometer, designed for ascertaining the specific gravity of very small samples of liquids, has a cup on the upper part of the stem in which a known amount, as one gramme, of the fluid is placed; the degree of submergence of the stem compared with that caused by an equal volume of distilled water gives the density of the fluid.

There are also hydrometers which indicate the density by means of a steelyard, having on one arm a vessel which is *in equilibrio* in a tank when empty. The mark on the other arm of the scale, at which the weight must be placed to maintain the equilibrium when the vessel is filled with liquid, determines its specific gravity.

Twaddel's hydrometer is used in England for liquids heavier than water. Its degrees are converted into specific gravities by multiplying them by 5, adding 1,000, and dividing the sum by 1,000. Thus, —

$$20° \text{ Twaddel} = \frac{20 \times 5 + 1{,}000}{1{,}000} = 1.100$$

The density of liquids may also be determined by means of a series of glass beads of different specific gravities; the heavier sink and the lighter float on the surface, while one that indicates the precise specific gravity, which is marked in thousandths on its surface, remains in equilibrium at any depth in the liquid.

The subject is fully discussed in Kuppfer's "Handbuch der Alkoholometrie," Berlin, 1865.

See also ALCOHOLOMETER, ACIDIMETER, AREOMETER, SACCHAROMETER, etc. See list under METER; see also UNIT.

The most familiar hydrometer, to many, is a hen's egg, used by a farmer's wife to test the strength of lye for making soap. When it floats as large as a quarter-dollar above the liquid the strength is satisfactory. Others test it by its action on a feather.

Small hollow glass spheres called bubbles are also used in testing spirits, the rate at which they ascend therein being a gage of the gravity of the liquid.

The hydrometer was in all probability invented by Archimedes, who was killed in the storming of Syracuse, 212 B. C. His discovery of the mode of ascertaining specific gravity by displacement of liquid is referred to by many writers of Europe, Asia, and Libya.

Seneca, Pliny, and Galen, who flourished during the first and second centuries of our era, and whose writings refer to the methods then in use of ascertaining the specific gravity of solids and fluids, appear unacquainted with the hydrometer, though the instrument is clearly described by Priscian, who died about A. D. 528.

Synesius of Ptolemais wrote to Hypatia that he wished to use a *hydroscopium*, and requests that she would cause one to be constructed for him. He says, "It is a cylindrical tube, the size of a reed or pipe, a line is drawn upon it lengthwise, which is intersected by others, and these point out the weight of water. At the end of the tube is a cone, the base of which is joined to that of the tube, so that both have but one base. This part of the instrument is called *baryllion*. If it be placed in water it remains in a perpendicular direction, so that one can readily discover by it the weight of the fluid."

Hypatia was brutally murdered by a mob of Alexandrine monks, instigated by Cyril, A. D. 414. With the death of Hypatia expired another period of intellectual research. Cyril was the president of the council which condemned Nestorius. After a dreary interval of several centuries, philosophy again revived in the city of Alexandria, while the Papacy shrank out of Asia and Africa, ejected from the great capitals Antioch, Jerusalem, and Alexandria; the Nestorians became the tutors of Mesopotamia and Chaldea, and in connection with the Jews founded colleges. Among these, that of Djondesabour first instituted a system of academical honors which has descended to our time. This college was patronized by the Khalif Haroun al Raschid, who forbade any one practicing medicine until after a satisfactory examination at the college of Djondesabour or that of Bagdad.

The areometer used by the Saracens about A. D. 1000, and for many centuries, was a form of hydrometer. It is described by Abu-Jafar Al-Khâzini, an eminent Saracenic writer of the twelfth century, and is credited to Pappus, a Greek philosopher, who was contemporary with Theodosius the Great, A. D. 379-395. Al-Khâzinî refers to the original discovery of Archimedes, upon which the instrument is based, and takes a very pious view of the line of discovery. See the "Book of the Balance of Wisdom," in Vol. VI. of the "Journal of the American Oriental Society," New Haven, 1860. See *supra*, pp. 141, 142.

In the sixteenth and seventeenth centuries, the salinometer was used in the salt-works of Germany, and is referred to as a well-known invention. Pepys, in his "Diary," December 10, 1668, refers to Boyle's hydrometer as "a bubble to try the strength of spirits with."

2. A current gage; known also as a *tachometer, rheometer, hydrometric pendulum, Woltmann's mill*, etc.

Hy′dro-met′ric Pend′u-lum. A *current-gage.* An instrument consisting of a ball suspended from the center of a graduated quadrant, and held in a stream to mark by its deflection the rate of motion of the water.

Hy′dro-met′ro-graph. An instrument for determining and recording the amount of water issuing from a pipe, etc., in a given time.

Hy′dro-phore. An instrument for obtaining specimens of water from any given depth below the surface.

Hy′dro-scope. 1. An instrument anciently used for measuring time by the trickling of water from an orifice in the lower end of a graduated tube. The hight, diameter, and graduation of the tube, and the size of the opening, being properly proportioned, the subsidence of level of the water indicates the passage of time. See CLEPSYDRA.

2. An instrument to detect the presence of moisture in air. See HYGROMETER.

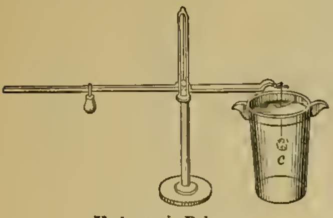
Hy′dro-stat. A general term, signifying an apparatus or contrivance to prevent the explosion of steam-boilers. The devices are numerous, and have specific names.

Hy′dro-stat′ic Arch. (*Architecture.*) A linear arch suited for sustaining normal pressure at each point, proportional — like that of a liquid in repose — to a depth below a given horizontal plane. It is sometimes called the "Arch of Yvon-Villaceaux," from the name of the mathematician who first demonstrated its properties. — RANKINE.

Hy'dro-stat'ic Bal'ance. A balance for weighing substances in water for the purpose of ascertaing their specific gravities.

When unloaded, the arms are equipoised. *c*, the body to be weighed, is suspended from the shorter arm. On the longer arm the movable weight indicates the weight of the object in air or water. A *specific-gravity balance.* See AREOMETER.

Fig. 2624.

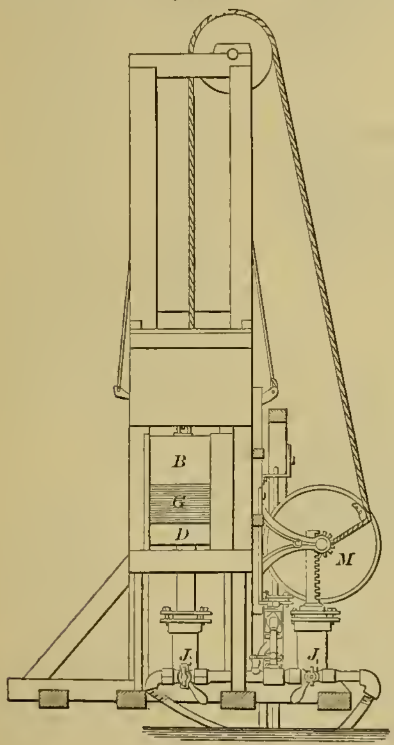


Hydrostatic Balance.

Hy'dro-stat'ic Bal'ing-press. One in which the force of water under pressure is made to compress the fibrous material to be baled.

In the example shown, the beater *B* is first operated, and, when the process has gone to a certain extent, the beater is made stationary, and the follower *D* raised. Both operations are effected by hydraulic operation. The suspension rope of the beater winds on the wheel *M*, which is rotated by pinion and rack, the latter being depressed by a piston in cylinder *J*. The rope is tripped off the wheel from time to time, automatically, allowing the weight *B* to fall, and again and again re-winds and slips off. At the proper time the cock is turned and the water turned on to the other cylinder *J*, beneath the follower *D*, and the latter is raised by the pressure of water beneath the piston in said cylinder. *G* represents the material under pressure.

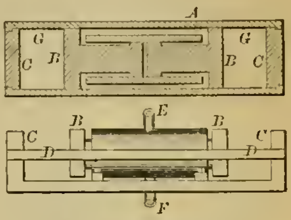
Fig 2625.



Hydrostatic Baling-Press.

In Fig. 2626 the motive-power is water under pressure. The cylinder *A* is open at both ends, has two ports, *E* and *F*, at the center, to receive and discharge respectively the water from the pump or head. There are two rams *B* in cylinder *A*, working in opposite directions toward heads *C*. *G* is the space for the material to be pressed. *D* are connecting-rods, connecting the heads *C* together to resist the strain of the rams *B*, and forming guides for the rams.

Fig. 2626.



Hydrostatic Baling-Press.

Hy'dro-stat'ic Bed. A bag of india-rubber cloth inflated with water. Intended for bedridden or wounded persons; invented by Dr. Arnott, and described in his "Elements of Physics."

Hy'dro-stat'ic Bel'lows. An instrument for illustrating the fact that the pressure of a small column of water balances that of another column of water, no matter how large. Water poured into the funnel-mouthed tube *a* (*I*, plate opposite page 1150) flows into the flexible-sided box *b*, and raises a weight *c* many times greater than its own. The weight may be lifted in this way until the combined pressure of it and the column of water in the bellows *b* is equal to that of a column of water having an equal surface and as high as the column in the tube *c*.

Bramah's and other hydrostatic or hyraulic presses depend on this principle.

Hy'dro-stat'ic Lamp. A lamp in which a supernatant stratum of oil is sustained by water or other fluid of greater specific gravity than the oil. Salt and water, sirup, honey, mercury, and sulphate of zinc in solution, have been employed for this purpose.

Hy'dro-stat'ic Lev'el. (*Civil Engineering.*) A water-level. See LEVEL.

Hy'dro-stat'ic Press. A machine in which the pressure of a piston on a body of water of relatively small sectional area is made to propagate the force to a cylinder of multiple area, where the force is directly as the difference and the speed inversely as the difference.

Pascal (1650) demonstrated the power of a column of water in a vertical pipe inserted into a barrel. In filling the barrel and pipe, he found the pressure to be as the hight of the column and the area of the base, as if the cask had preserved its diameter throughout the whole length of the column. Supposing the barrel to have an area of three square feet, and the pipe of twelve feet length to have a capacity of two pints, the effective pressure of the quart of water on the heads of the cask is equal to a cylinder of water containing thirty-six cubic feet.

If a properly fitting piston of a weight equal to the quart of water be placed in the pipe, it will have the same effect as the water for which it is a substitute.

If, instead of the mere weight of the piston, it be loaded with a weight nine times that of its own, the bursting pressure in the barrel will be tenfold greater than before.

If, instead of a weight upon the piston, a lever be placed above it, the increased force may be immensely multiplied and a power obtained which is beyond all others of equal compactness and facility of manipulation.

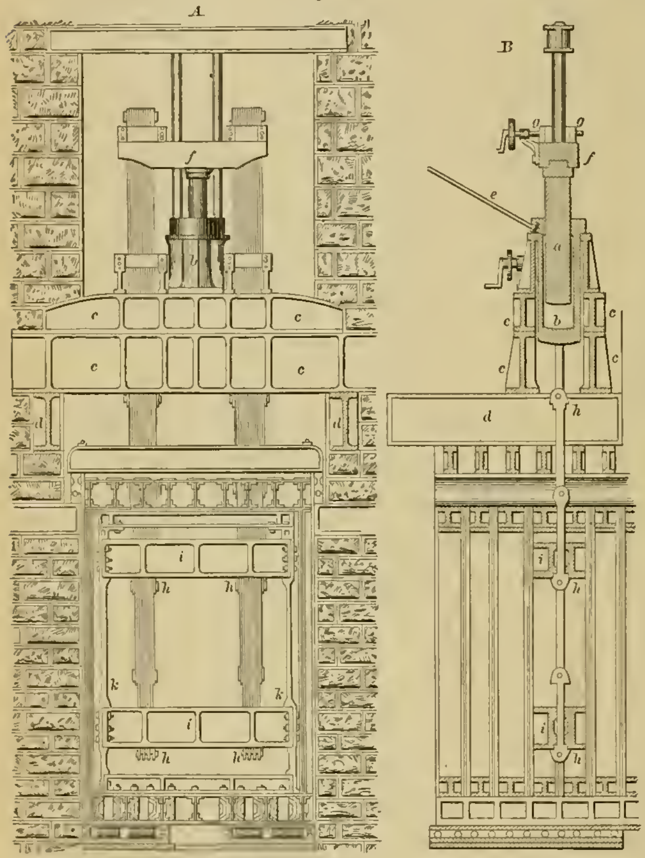
This is the Bramah hydraulic press.

The first one ever made is in the museum of the Commissioners of Patents (England), and is inscribed, "Bramah, Inv^t. et fec^t. 1796."

The celebrated Maudslay was mechanically educated in Bramah's shop.

In *N* (page 1157) the operation of this machine may be readily understood. *a* is a reservoir of water on which is a pump, the piston-rod *b* of which is worked by the hand-lever *c*. The water is conveyed by the pipe *d* to the cylinder *e*, where it elevates the piston *f* and table *g*, which rises between the guides that hold the upper plate, against which the object under pressure is driven. The elevation of the table *g* is proportionate to the quantity of water injected. The power is proportionate to the respective areas of the pump and the cylinder *a*.

Fig. 2627.



Conway Bridge Hydrostatic Press.

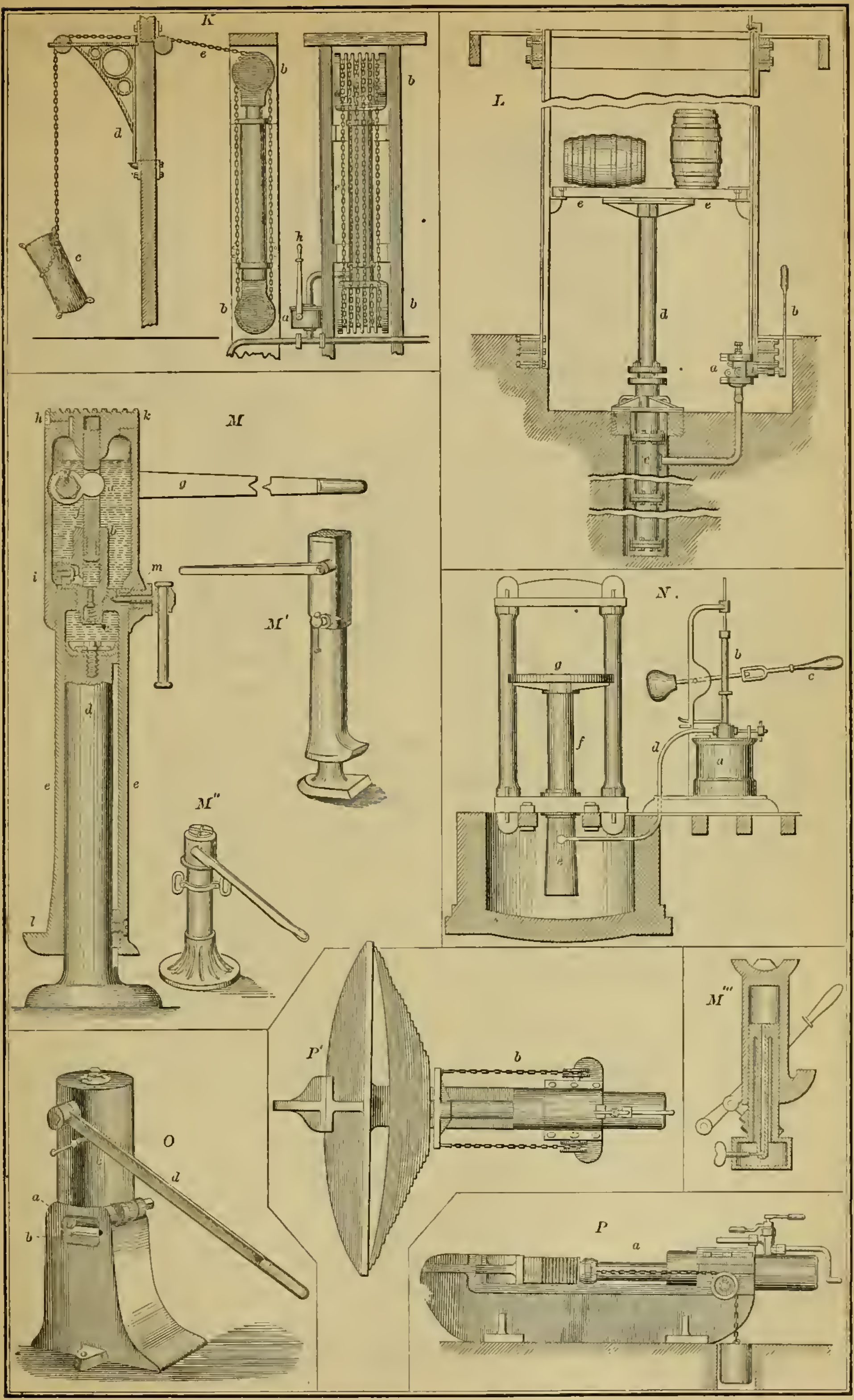
Fig. 2627, *A* is an elevation of the press and cross-section of the tube employed in the Conway tubular bridge, and *B* a vertical section of the press and a portion of the tubing. *a* is the pump piston and *b* the cylinder, which is supported upon double iron girders *c c*, resting on girders *d*, built in the masonry. Water is forced through the pipe *e* into the cylinder by an engine of 40-horse power. The piston has a cross-head *f* provided with clamps *g* which hold the ends of the lifting chain links and are screwed up firmly against them. The alternate links are notched, as shown at *h h*, so as to fit into corresponding grooves in the cross-girders *i i*, which are temporarily bolted to the walls *k k* of the tube. The force actually exerted by the pump in raising one end of the tube, a weight of 900 tons, was two and a quarter tons per square inch.

Three hydrostatic presses were used at the raising of the tubes of the Menai Railroad Bridge. One of them worked at one end of the tube and two smaller ones at the other end. The larger one had a cylinder 11 inches thick and 20 inches in internal diameter. Its lift was 6 feet. The weight of the cylinder was 16 tons, and of the machine 40 tons. Its power was estimated as equal to that of 30,000 men. The smaller presses had rams 18 inches in diameter.

The presses stood on the summits of the piers, and lifted by means of chains having alternately eight and nine links. The weight of a chain was 224,000 pounds. They were attached to the rams by iron cross-heads of great thickness. The two chains passed through square holes at each end of the cross-head, and were gripped above by clamps of wrought-iron, screwed like a vise. At the lower end, the chains were attached to the tube, or rather to lifting-frames within its extremities, by three sets of massive cast-iron beams, crossing one above another, and secured by wrought-iron straps passing over the upper pair and descending into the bottom cells where they were keyed. The ends of the chains fitted under deep shoulders or notches in the lifting-frames, where they were secured by screw-bolts; these lifting-frames and beams added 448,000 pounds to the weight to be lifted. Each of the middle tubes weighed 4,032,000 pounds (1,800 English tons), and they were lifted by successive lifts of 6 feet to a hight of 100 feet above tide-water. The motive force was two steam-engines of 40-horse power each, and the water was delivered through a ½-inch pipe into the cylinder below the ram.

That shown at *D*, plate opposite page 1150, is adapted for pressing the printed sheets of books, etc. It is arranged with either one or two pumps for forcing water into the lifting-cylinder, whose piston raises the platform on which the sheets are placed. This is kept in horizontal position by upright standards, and between it and the head of the press the sheets are compressed.

In the *sterhydraulic* press of MM. Desgoffe and Olivier, a coil of gut-rope passing through a stuffing-



APPLICATIONS OF THE HYDROSTATIC PRESS.

Plate XXIV ·

See page 1156.

box into the cylinder is wound upon an interior pulley, displacing part of the fluid (oil) and causing the piston to rise. See HYDRAULIC PRESS, Fig. 2617. Among the applications of the hydrostatic press may be found : —

Accumulator.
Boiler-power.
Coal-breaking jack.
Crank-puller.
Hydraulic crane.
Hydraulic dock.
Hydraulic elevator.
Hydraulic hoist.
Hydraulic lift.
Hydraulic lifting-jack.
Hydraulic platform-lift.
Hydraulic press.
Hydraulic pulling-jack.
Hydraulic punch.
Hydraulic shaft-straightener.
Hydraulic shears.
Hydraulic slip.
Hydraulic spring-tester.
Hydrostatic baling-press.
Hydrostatic bellows.
Jim-crow.
Pipe-prover.
Punching-bear.
Rail-bender.
Rail-punch.
Shaft-straightener.
Ship-jack.
Spring-tester.
Testing-machine.
Traversing-jack.
Wagon-tipper.
Wheel-jack.
Wheel-press.

Hy'dro-stat'ic-press Pump. A pump used in hydrostatic presses. The example (*A*, plate opposite page 1150) gives one form. *q* is the water-cistern and *r* the pump-barrel, which has a sucking tube *t* and a conical valve *s*. The plunger is operated by the lever, which may be pivoted in either of the holes shown at *x* on the standard, to obtain greater or less quickness of stroke ; it is connected with the standard by a link. *k* is a safety-valve and *z* the discharge-valve, the rise and fall of which is regulated by a screw placed over it. On lifting the plunger, water is drawn into the barrel *r* through the tube *t*, and by depressing it the water is forced out through the pipe *j*, the valve *z* rising to permit its passage. See also *C D*, same plate.

Hy-et'o-graph. A chart indicating the comparative distribution of rain over a given geographical surface. See list under 'GRAPH. See also MAP, for list of lines indicating equal conditions of natural phenomena.

Hy'gro-graph. A recording hygrometer.

Hy'grom'e-ter. An instrument for measuring the comparative moisture of the air.

They are of three kinds : —

1. Those which act on the principle of *absorption*.
2. Those which act by *condensation*.
3. Those in which the hygrometric condition is deduced from observations of a wet and a dry bulb.

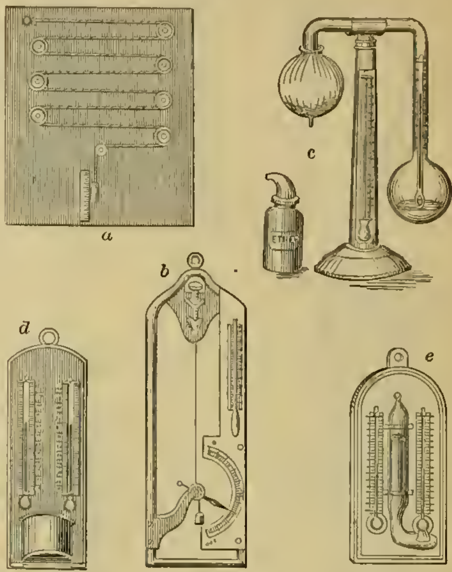
1. *a.* Of the first class is the *hygrometer* of Saussure (died 1799). It consists of a human hair boiled in lye, and acts by absorption and evaporation, as shown at *a*, Fig. 2628. A piece of catgut may be made to extend from a pin at one end, over a number of pulleys, and terminate at the lower end with a small weight, which rises and falls with changes in the length of the cord, induced by hygrometric changes in the atmosphere.

A hygrometer, or *weather prophet*, may be constructed by taking a cigar-box and inserting at its center an upright pivoted shaft with two horizontal arms. Around this are wound two turns of a catgut string, one end of which is fastened to a staple at one end and the other to a spiral spring at the other end of the box.

Fluctuations in atmospheric humidity cause the string to extend or contract, as the case may be, turning the shaft partially round. If to the end of one arm a toy figure of a mower be attached, and to the other a figure holding an umbrella, openings being cut to represent doors in the side of the box, fronting each figure, the figure holding the umbrella will come out when the air is moist and retire as the weather becomes dry, allowing the mower to come forth.

In *b*, a human hair is fastened at the upper end to a screw, and at the lower end passes over a pulley which has a radial pointer. A weight keeps the hair tight, and its expansion or contraction causes the pointer to traverse on the graduated arc. Moisture makes the hair longer, and allows the pointer to rise, and dry weather has the reverse effect. The 0° and 100° form the extremes of dryness and wetness: one is obtained from an atmosphere artificially dried, and the other by the absolute saturation of the air with moisture. The intervening space is then divided into 100 equal parts.

Fig. 2628.



Hygrometers.

b. An alcoholic solution of camphor, saltpeter, and muriate of ammonia, in a glass tube, has been suggested for a weather guide. Changes of weather are stated to render the solution turbid, or clear it, as the condition may be. Its value is doubtful.

c. An arm is balanced upon an axis so as to be horizontal at the zero point, and provided at one end with an absorbent substance, such as a piece of sponge. When the air is relatively moist the sponge will absorb water and become heavier, so that the pointer rises against the graduated arc and indicates rain ; conversely, dry air causes the sponge to part with some of its moisture, and, becoming lighter, the pointer falls.

2. Daniell's hygrometer *c* determines the moisture of the air by indicating the dew-point, or the temperature at which moisture is deposited by the air. It consists of a bent tube of glass with a bulb at each end. The legs of the tube are of unequal length, and the lower one, which is of black glass, contains a little ether, into which dips the bulb of a small and delicate thermometer, whose stem occupies the cavity in the leg of the tube. The whole tube contains ether and its vapor, the air having been removed. The upper bulb is covered with a piece of muslin. The support of the instrument has another thermometer by which the temperature of the air is denoted.

When an observation is to be made, a little ether is poured upon the muslin; this evaporates and cools the contents of the tube, abstracting heat from the lower bulb by the vaporization of its contents. As soon as the lower bulb has cooled sufficiently to condense the moisture of the atmosphere, dew will be observed to condense upon it, and the temperature is to be noted as indicated by the thermometer in the tube. If the air be moist, dew will commence to deposit on the lower bulb on a slight reduction of temperature; if the air be dry, it will require a relatively greater reduction of temperature. The point at which moisture commences to form on the bulb is the "dew-point," and this ascertained, in connection with the temperature of the air, will enable the hygrometric condition of the air to be determined by tables prepared for the purpose; as to the elasticity and density of the aqueous vapor, its weight in a cubic foot of air; the degree of dryness either upon the scale of the thermometer or the hygrometer, and the rate of evaporation.

In the climate of England the dew-point is seldom more than 30° below the temperature of the air, but in the Deccan, in India, with the temperature of the air at 90°, the dew-point has been seen at 29°,—making the degree of dryness 61° thermometric.

Professor Daniell states that "the more accurate mode of expressing the moisture of the air from an observation of the temperature and dew-point is by the quotient of the division of the elasticity of the vapors at the real atmospheric temperature, by the elasticity at the temperature of the dew-point; for, calling the term of saturation 1,000, as the elasticity of vapor at the temperature of the air is to the elasticity of vapor at the temperature of the dew-point, so is the term of saturation to the observed degree of moisture.

"Thus with regard to the observation in the Deccan — 1.430 : 0.194 : : 1000 : 135, — the fourth term is the degree of moisture on the hygrometric scale."

3. *d e* are two different forms of Mason's hygrometer. In this two thermometers are placed side by side, the bulb of one being covered with muslin or similar material, and wetted with water when an observation is to be made. The diminished temperature of the wet bulb, due to the evaporation of the moisture, is compared with the natural temperature of the other bulb; the temperature and the difference afford the data for determining the hygrometric conditions.

In *e* the bulb of one thermometer is kept constantly moist from a cistern fixed on the plate, to which the two are attached.

This is the most useful form of hygrometer. The theoretical relation between the indications of the two bulbs and the humidity of the air is rather complex and has given rise to much debate; it is usual to effect the reduction by tables which have been empirically constructed by comparison with the indications of the *dew-point* instrument of Daniell. The British tables for this purpose were constructed by Glaisher; edition of 1856 preferred. They are based upon a comparison of the simultaneous readings of the wet and dry bulb thermometers, and of Daniell's hygrometer, taken for a series of years in Greenwich Observatory, in Toronto, and in India. The ratio between the two readings is not equal at all degrees of temperature as marked on the dry bulb. When this temperature — the *natural*, it may be called — is 53° F. the *dew-point* is as much below the *wet bulb* as the latter is below 53° F., the temperature of the air. At higher temperatures the wet-bulb reading is nearer to the dew-point than to the air-temperature, and the reverse is the case at temperatures below 53° F. See PSYCHROMETER.

Two citations from "Cosmos" are not irrelevant: "In the brilliant period of the foundation of 'mathematical natural philosophy,' attempts to investigate the moisture of the atmosphere in its connection with variations of temperature and with the direction of the wind were not wanting. The Academia del Cimento conceived the happy idea of determining the quantity of vapor by evaporation and precipitation. The oldest Florentine hygrometer was accordingly an apparatus in which the quantity of precipitated water run off was determined by weight. To this condensation hygrometer, which, aided by the ideas of LeRoy, has gradually led in our own days to the exact psychrometric methods of Dalton, Daniell, and Auguste, there were added, according to the example previously set by Leonardo da Vinci, the absorption hygrometers, made of animal or vegetable substances, of Santorio (1625), Torricelli (1626), and Molyneux. Catgut and the beard of the wild oat were used almost at the same time. Instruments of this kind, founded on the absorption of the aqueous vapor contained in the atmosphere by organic substances, were provided with indexes and counterpoises, and were very similar in construction to Saussure's and Deluc's hair and whalebone hygrometers; but the instruments of the seventeenth century were deficient in the determination of fixed wet and dry points, so necessary for the comparison and understanding of the results. This desideratum was at last supplied by Regnault, but without reference to the variation which might be occasioned by time in the susceptibility of the hygrometic substances employed. Pictet, however, found that the hair of a Guanche mummy from Teneriffe, which might be a thousand years old, employed in a Saussure's hygrometer, still possessed a satisfactory degree of sensibility."

"'The admiral' [Columbus], says Fernando Colon, ascribed the many refreshing falls of rain which cooled the air whilst he was sailing along the coast of Jamaica, to the extent and density of the forests which clothe the mountains. He takes this opportunity of remarking, in his ship's journal, that 'formerly there was much rain in Madeira, the Canaries, and the Azores; but since the trees which shaded the ground have been cut down, rain has become much more rare.' This warning has remained almost unheeded for more than three centuries and a half."

Hy'gro-met'ric Bal'ance. An instrument for indicating the relative density of the air, and consequent chances of rain or dry weather. It consists of a balance, from one arm of which is suspended a brass weight and from the other a large, thin, hollow cylinder. The two are arranged so as to be in equilibrium at a given density of the atmosphere, and it is evident that if the air become heavier, the large cylinder, displacing more air than the solid weight, will become more buoyant and ascend. If, on the contrary, the air become lighter, it will sink. A rod descending from the scale-beam serves to indicate, on the graduated arc below, the comparative density of the air at the time of making the observation.

If the air be heavy, fine weather may be expected; but if the cylinder sink, rain usually follows.

Hy'gro-scope. An instrument for indicating the degree of moisture of the atmosphere. See HYGROMETER; Deschanel's "Nat. Phil.," Part II., p. 367. See PSYCHROMETER.

Hy-pæ'thrum. (*Architecture.*) That portion of the interior of a building which is not protected by a roof. The ancient temples, which were entirely uncovered, were said to be hypæthral.

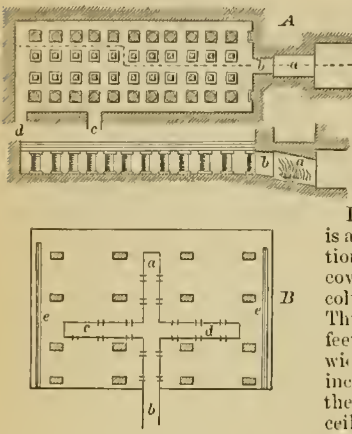
Hy′per-thy′rum; Hy′per-thy′non. (*Architecture.*) That part of the architrave which is over a door or window. See Head-molding.

Hy′phen. A mark (-) for joining the parts of a compound word, or indicating a break in a single word at the end of a line.

Hy′po-caust. (*Building.*) A furnace for heating a building by hot air conducted under the floor and through the walls.

They were used by the Romans for heating their baths. One kind was constructed with flues running under the floor, and was heated from the outside of the building, and another was formed like a low chamber, its ceiling supported by small pillars or dwarf walls. This was immediately beneath the baths to be heated, and sometimes had flues leading to other apartments.

Fig. 2629.



Hypocausts.

Fig. 2629, *A*, is a plan and section of one discovered at Lincoln, England. This was 24½ feet long, 9¼ feet wide, and 26 inches high in the clear. The ceiling, which formed the floor of the apartment above, was of large bricks laid in mortar, over which were tiles covered with stucco, the whole being about 10 inches thick. The products of combustion from the fire-chamber *a* passed through the arched opening *b* into the hypocaust, and were, it is supposed, discharged at *d*; *c* is believed to have been a flue leading to another apartment. The large fire space was necessary, as the Romans did not employ chimneys for increasing the draft.

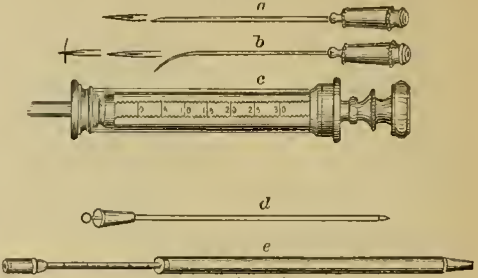
Hypocausts are in general use in Northern China, where the winters are severe. *B* illustrates their mode of construction. They are located beneath the floor of the house, and have two flues *a b*, *c d*, at right angles. These have a number of openings, which distribute the heat to all parts of the floor, which is paved with tiles or flagstones. *e e* are flues for carrying off smoke. The seats and sleeping-places are also heated by this arrangement. They are built of brick and are hollow, communicating with the hypocaust below. The fuel employed is composed of a mixture of fine coal, clay, earth, cow-dung, or refuse vegetable matter, formed into balls and dried. In houses of an inferior class, a sort of stove, built into one corner of the room, is used.

Hypocausts were in use by the emirs of Cordova, from the ninth to the thirteenth century, the heat being conveyed by caliducts to the winter apartments. See Bath; Heating-apparatus.

Hy′po-der′mic Syr′inge. (*Surgical.*) An instrument for administering subcutaneous injections of solution of morphia, for the purpose of relieving pain. It consists of a syringe with graduated barrel or rod, and a canula of silver or steel which has a point for penetration and an opening for ejection of the liquid. The illustration *a b c* shows a form with a glass tube, a graduated rod, and detachable points of two shapes.

d e is a form of hypodermic syringe to be carried in a pocket-case. The point, inclosing the wire-cleaner, fits into a hollow graduated piston. The barrel is an ordinary silver tube, the size of No. 10 catheter, and is six inches long. See also Acupuncturator.

Fig. 2630.



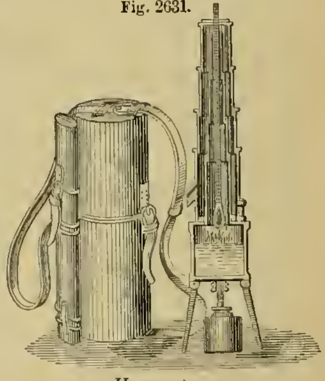
Hypodermic Syringe

Hy′po-tra-che′li-um. (*Architecture.*) The necking of a column in the classical orders, consisting of several narrow cinctures cut into the shaft at the base of the echinus.

Hyp-som′e-ter. An instrument for measuring hights by observing differences in barometric pressures at different altitudes.

Notably, an instrument for determining altitudes by observation of the boiling-points of water. It has a water-vessel, lamp, and thermometer. The example shows the instrument and the case in which it is packed for transportation on the back of a tourist or attendant.

Fig. 2631.



Hypsometer.

Wollaston's apparatus for measuring hights by the temperature of boiling water has a mercurial thermometer with a very large bulb and a stem, which has a length of one inch for every degree of the scale. This is read by a vernier to thousandths. It is found that a difference of barometric pressure of 0.589 inches is equivalent to 1° in the boiling-point, or 530 feet of ascent at moderate elevations.

Tables have been constructed for use with the apparatus, showing the precise elevation corresponding to different temperatures of boiling water.

Hys′ter-om′e-ter. An instrument for ascertaining the size of the uterus.

Hys′ter′o-tome. (*Surgical.*) A knife for operations upon the womb; notably the Cæsarian section.

I.

Ice-an'chor. (*Nautical.*) A bent bar whose prong enters a hole in the ice; to the other end a mooring-hawser is bent.

Ice-ap-pli'an-ces. See: —

Ice-anchor.
Ice-apron.
Ice-beam.
Iceberg-alarm.
Ice-boat.
Ice-box.
Ice-breaker.
Ice-calk.
Ice-carriage.
Ice-chain.
Ice-chest.
Ice-chisel.
Ice-claw.
Ice-cream freezer.
Ice-creeper.
Ice-crusher.
Ice-cutter.
Ice-cutting machine.
Ice-elevator.
Ice-hook.
Ice-house.
Ice-leveler.
Ice-locomotive.
Ice-making.
Ice-marker.
Ice-pick.
Ice-pitcher.
Ice-plane.
Ice-plow.
Ice-preserver.
Ice-safe.
Ice-sandal.
Ice-saw.
Ice-scraper.
Ice-shaver.
Ice-spade.
Ice-tongs.
Ice-tools.

Ice-a'pron. (*Hydraulic Engineering.*) An ice-breaker or *starling* to protect the upper end of a bridge-pier. It presents an inclined edge up stream to break a field or cake of floating ice, or to sustain the pressure of a gorge of ice, and prevent the direct dislodging push of the ice upon the pier.

The ice-aprons of the Eads's St. Louis Railway Bridge are 200 feet long and 60 feet wide, and present an angle of 45° to the current. The frames are of squared oak timber, with three-inch oak planking and No. 16 sheet-iron skin.

Ice-beam. A guard-plank at a ship's bow to fend off ice.

Ice'berg-a-larm'. A thermometrical device to indicate the vicinity of icebergs by the cooling of the water, which is made to spring an alarm.

Ice-boat. 1. One employed for traveling on ice.

The *ice-boats* on the Maeze and Y, in Holland, consist of ordinary boats mounted on runners. The boat rests on transverse pieces, which are secured to a pair of parallel runners resembling those of skates. The extremities of the transverse pieces serve as outriggers, from which stays pass to the mast-heads of the craft to preserve the boat from being careened in its cradle when the sails are spread. The lower edge of the rudder is sharpened, to give it a sufficient adhesion to the ice to enable it to swerve the boat.

A boat can be made of a few planks, three skate-irons, a mast and sail, at a cost of a few dollars. The boat is V-shaped, composed of three planks, two forming the sides and one the base, which is the stern. Under each angle are skate-irons hung on pivots to allow swing. The craft is steered by the iron at the apex or bow. The rigging is usually sloop or yacht rig. These boats sail admirably, and may be numbered on the Hudson by scores; something over a hundred being owned by the various clubs and by private persons. Regattas take place on this river during the winter season when the condition of the ice and state of the wind invites. Attempts to utilize ice-boats for passenger and freight travel have not as yet been successful, owing to several uncertainties in themselves and their mode of going, the state of the ice, the state of the wind, and the probable condition of the cargo if the ice break.

2. A steamboat having a sharp and heavily strengthened prow and bow for forcing its way through ice in a harbor to keep a passage open for vessels. A favorite form of prow is a long ram, presenting an inclined edge to the ice, which is lifted by and broken across the sharp back of the ram.

Ice-box. A chest for domestic use for keeping cool provisions liable to spoil in warm weather.

Ice-break'er. 1. *a.* A structure for the protection of bridge-piers, etc. It is of masonry or timber. In the Victoria Bridge across the St. Lawrence at Montreal it is a long, sloping ridge of stone presented up stream, and forming a wedge-shaped starling.

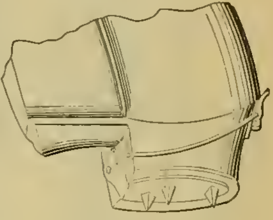
Other ice-breakers are starlings of *piles* or *cribs*. See ICE-APRON. See also PIVOT-BRIDGE.

b. A pier arranged with reference to the current, to prevent access of ice to the vessels in a harbor.

2. An *ice-breaker* for harbors is a steam-vessel provided with means for opening or keeping open a channel for ships.

Ice-calk. A spiked plate to be worn on the heel to keep the wearer from slipping on ice.

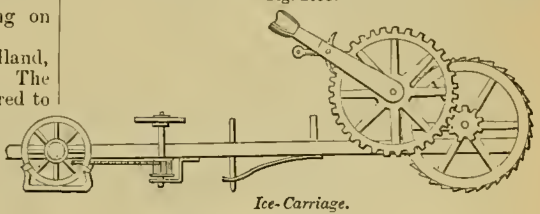
Fig. 2632.



Ice-Calk.

Ice-car'riage. A platform on runners, and with a means for propulsion on ice. The toothed wheel holds to the ice, and is turned by a small spur-wheel, which is engaged by a larger wheel actuated by a double-ended pawl lever. The brake consists of a pointed, vertically moving bar, which is ordinarily kept free from the ice by a spring.

Fig. 2633.



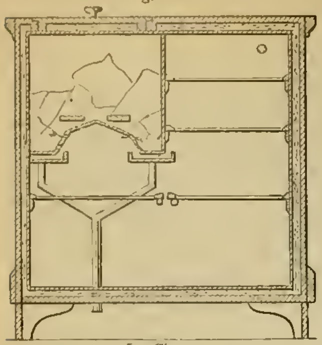
Ice-Carriage.

Ice-chair. A chair on runners to hold a lady who is pushed along by a skater in the rear.

Ice-chest. A form of domestic ice-chamber having apartments for the ice and the provisions, the food-chamber being cooled by air conducted to it from the ice-box or by the cold side of the latter, which forms a part of the inclosure of the food-chamber. In the example, the ice-box has an arched bottom and perforated depressions that connect with the drip-pans. A large refrigerating surface is thereby exposed to the air of the preserving chamber, and the temperature is reduced by contact of the drip.

Ice-chis'el. A socket chisel with a long handle, used in cutting holes in ice, either in Arctic explorations or as a starting-point for the saw in gather-

Fig. 2634.



Ice-Chest.

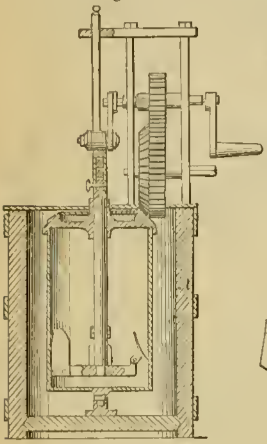
ing ice for use. Also for striking off blocks after they are partially detached by the cutter. See *c f*, Fig. 2658.

Ice-claw. A rope and pair of claws, for grappling ice-blocks. See *k*, Fig. 2658.

Ice-cream Freez'er. A machine in which cream, custard, or lemonade is stirred within a metallic vessel which is plunged in a tub of mingled broken ice and salt.

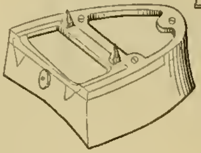
The dasher has vertical reciprocation by the play of a crank-pin in a horizontal slot of its cross-head. The vertical and pivoted scrapers have rotary and reciprocating motions respectively to clear the can sides. The paddles throw the cream outward. The can may be rotated or the dasher reciprocated singly, if desired.

Fig. 2635.



Ice-Cream Freezer.

Fig. 2636.

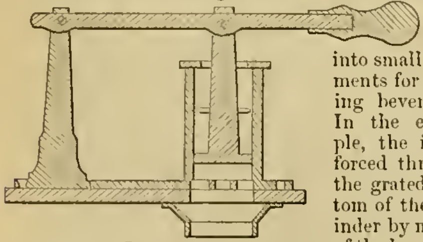


Ice-Creeper.

Ice-creep'er. A socket for the heel of a boot, having spurs to prevent slipping on ice. In the illustration, it is shown inverted.

Ice-crush'er. An implement for breaking ice into small fragments for cooling beverages. In the example, the ice is forced through the grated bottom of the cylinder by means of the lever piston.

Fig. 2637.

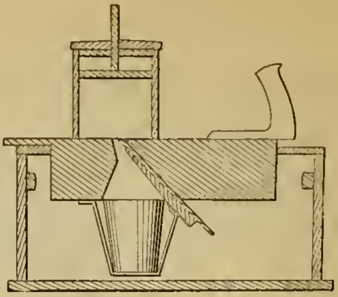


Ice-Crusher.

Ice-cut'ter. A plane for shaving ice for cooling beverages.

In the example, a reciprocating plane moves under a hopper in which is a block provided with a rod for pushing the ice against the plane. Under the hopper and below the plane is a spring for holding a tumbler into which the cut ice falls. See also ICE-PLANE.

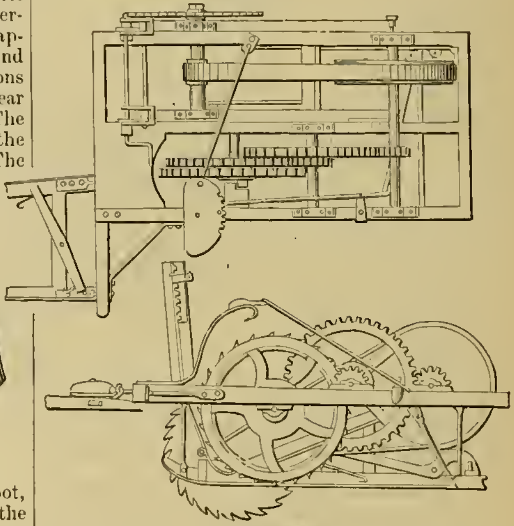
Fig. 2638.



Ice-Cutter.

Ice-cut'ting Ma-chine'. One for cutting kerfs in pond ice, to reduce the surface to strips which are afterwards broken into blocks by the axe or spade. In the example, it is a circular saw on a sled, which is drawn by a horse. The saw receives motion from a serrated wheel which engages the ice, and is vertically adjustable by a rack and pinion operating its journal-frame. See also *b*, Fig. 2658.

Fig. 2639

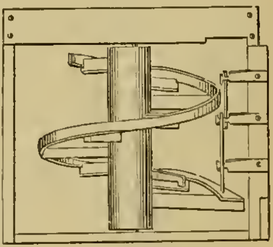


Ice-Cutting Machine.

Ice-el'e-va-tor. A machine for lifting block-ice from one level to another, as from the pond level to the ice-house; in the ice-house from one level to another, and so forth. There are several kinds. In one, the ice is pushed up a spiral incline by the arms projecting radially from a vertical rotating central post.

Fig. 2641 is another form, in which an endless chain has a series of hooks *h* which grab the blocks of ice and draw them up the incline *G E*. This is made in sections hinged together, so as to permit either of the upper sections to be placed at different angles to discharge the ice at different elevations. The frame supporting the driving-wheel of the endless chain has a

Fig. 2640.



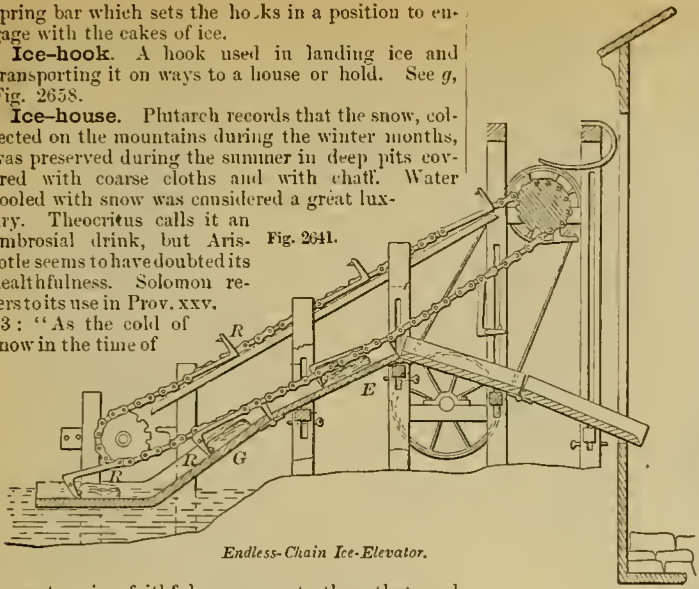
Ice-Elevator.

spring bar which sets the hooks in a position to engage with the cakes of ice.

Ice-hook. A hook used in landing ice and transporting it on ways to a house or hold. See *g*, Fig. 2658.

Ice-house. Plutarch records that the snow, collected on the mountains during the winter months, was preserved during the summer in deep pits covered with coarse cloths and with chaff. Water cooled with snow was considered a great luxury. Theocritus calls it an ambrosial drink, but Aristotle seems to have doubted its healthfulness. Solomon refers to its use in Prov. xxv. 13: "As the cold of snow in the time of harvest, so is a faithful messenger to them that send him; for he refresheth the soul of his master."

Fig. 2641.



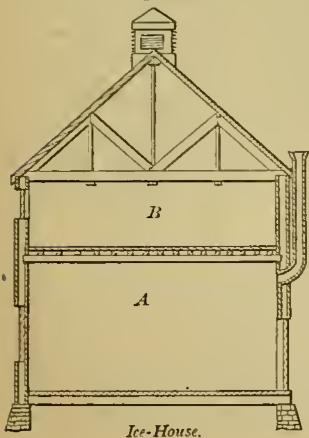
Endless-Chain Ice-Elevator.

When Alexander the Great besieged Patra, he caused thirty trenches to be dug and filled with snow, which was covered with oak branches, and kept a long time.

In Portugal, "snow is collected in a deep gulley, and grass or green sods, covered with sheep-dung, is thrown over it, and under these it is so well preserved that the whole summer through it is sent the distance of sixty Spanish miles to Lisbon"; at least, such was the case in the last century.

In Southern Europe and Asia Minor it may be observed that snow is, and always has been, used instead of ice, being more easily attainable from the summits of the mountains, while ice must be either imported or made artificially. The Appenines, the Sierra Nevada, and other mountains of South Europe, yield an inexhaustible supply in winter in regions where snow seldom or never falls on the plains below, and a very slight protection from the heats of summer suffices to preserve it at considerable elevations above the sea, where the thermometer never ranges very high.

Fig. 2642.



Ice-House.

At least one natural ice-house has been discovered on Mount Etna, where a vast deposit of snow, covered by a mass of ashes and lava, has been preserved for untold ages.

The highest natural temperature authentically recorded was at Bagdad, in 1819, when the thermometer in the shade indicated 120° Fah. On the west coast of Africa the heat is nearly as great. The men employed in the English expedition to Abyssinia think that Aden is the hottest hole on earth.

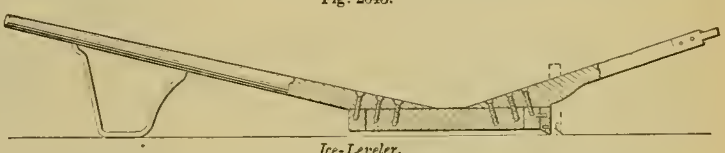
Burckhardt, in Egypt, and Humboldt, in South America, observed 117° Fah. in the shade.

About −70° is the lowest temperature observed by our Arctic navigators. Natterer, a German chemist, obtained −220° Fah. Faraday obtained −166° Fah. Neither succeeded in freezing pure alcohol or ether.

Fig. 2642 is a sectional view of an ice-house for brewers and butchers. It has an ice-chamber *B* and cooling-vault *A*, provided with one or more ventilators *I*.

Ice-lev'el-er. An implement for leveling the surface of pond ice. It has an oblong frame, upon the front side of which is affixed a cutting-edge of steel. From the forward end a tongue projects, and from the rear a guiding-pole with a bent knee, composed of a metallic rod that runs upon the ice. A wide board is adjusted to the front side of the frame for removing snow.

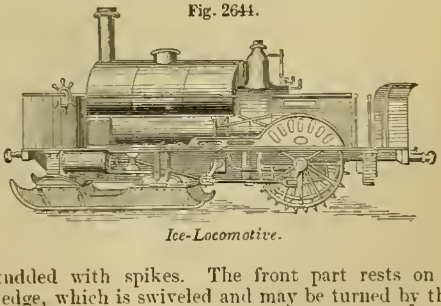
Fig. 2643.



Ice-Leveler.

Ice-lo-co-mo'tive. A traction engine for running on ice; one constructed by Messrs. Neilson of Glasgow, and employed for conveying passengers and freight between St. Petersburg and Cronstadt, has two driving-wheels five feet in diameter and studded with spikes. The front part rests on a sledge, which is swiveled and may be turned by the wheel, which has an endless screw working a pinion that turns a segment rack attached to the sled-body. The cylinders are 10 inches in diameter and

Fig. 2644.



Ice-Locomotive.

22 inches stroke. The weight of the engine is 12 tons, and it attains a speed of 18 miles an hour.

Ice-mak′ing. Evaporation, radiation, liquefaction, and sudden reduction of pressure, are the causes by which the temperature of a body may be depressed.

Class 1. Vaporization.

This includes those processes which depend upon the vaporization of water, ether, ammonia, benzole, etc., which, in assuming the vaporous form, change sensible heat to latent, extracting it from the objects most convenient thereto, — in this case a reservoir of water whose contents are thereby congealed.

In this class are the atomizers or spray apparatus.

One form of this machine is founded upon the old practice in Hindostan, of cooling water by the evaporation from the outer surface of porous vessels through which the contents percolate. A part is thus sacrificed in cooling the remainder, the water in its evaporation rendering latent the heat abstracted from the contents of the jar. The extent to which this process is carried determines whether the water is cooled to the freezing-point or not.

A modification of this device is found in wrapping a non-porous jar or other vessel with a bibulous covering, which is kept wet and subjected to a draft of air. The contents of the vessel part with their sensible heat in furnishing the heat required by the evaporation of the water in the envelope.

"Protagorus, relating the voyage of King Antiochus down the river Nile, says: 'They expose the water in large earthen ewers on the top of the house, and two slaves are kept sprinkling the vessels with water the whole night; and at daybreak they bring them down and immerse the ewers in water, which is used without snow, as it is cool enough.'" — *Deipnosophists.*

The opinion prevailed among the ancients that water previously boiled or heated was more readily cooled, and in Egypt and other warm countries earthen vessels filled with boiled or heated water were exposed to the air during the night, and in the morning placed in a pit or cellar and bound around with fresh or green plants which were moistened with water, and preserved their contents cool throughout the whole day. In the countries of Southern Asia a similar opinion and practice still prevails.

So far, the conditions of evaporation have been the exposure of water in an atmosphere not saturated with moisture and preferably to air in motion. It may also be added that an artificial motion by fans may be made to replace the lack of natural motion by wind or draft. This accelerates the operation as bringing a larger amount of air in contact with the evaporative surface, and also brushing away the saturated atmosphere immediately adjacent.

Under a pressure less than that of the atmosphere, vaporization takes place at a lower temperature. Were two thirds of the atmospheric pressure removed, water would boil at ordinary summer heat. A vessel of water placed under the receiver of an air-pump, which is then exhausted of air, speedily enters into ebullition; but, unless the machine is kept constantly in action, the vapor which is thus formed will restore very promptly the pressure upon the surface which has been removed by the exhaustion. If, however, the pump be powerful enough to carry off the vapor as fast as it is formed, and be steadily worked, the heat which the rising vapor withdraws from the water will presently reduce the temperature to the freezing-point, and the liquid will be converted into ice.

In 1755, Dr. Cullen discovered that removing the pressure of air facilitated evaporation to a degree which enabled him to freeze water even in summer.

In 1777, Mr. Nairne discovered that introducing sulphuric acid into an exhausted receiver absorbed an aqueous vapor from and thereby dried rarefied air; and by an arrangement on these principles, in 1810, by which he got rid of the vapor that rose from the water, he prevented its forming a permanent atmosphere, so as to prevent the continuance of the operation. Professor Leslie succeeded in freezing quantities of water from 1 to 1½ pounds in weight, though he could not effect the congelation of much larger quantities. This method of promoting evaporation John Vallance, in 1824, improved by removing the atmospheric pressure, which enabled him to carry off the vapor from large surfaces of water and consequently freeze large quantities of ice.

The Parisian restaurants have decanters (*carafes frappées*) filled with water frozen by placing them in shallow tanks of sea-water, each of which is provided with a copper reservoir connected with a receiver filled with ether. The air is exhausted from the reservoirs by an air-pump worked by steam, vaporizing the ether and reducing the temperature of the sea-water and that in the decanters below the freezing-point. The water in the decanters usually remains liquid until stirred with a glass rod, when it immediately congeals.

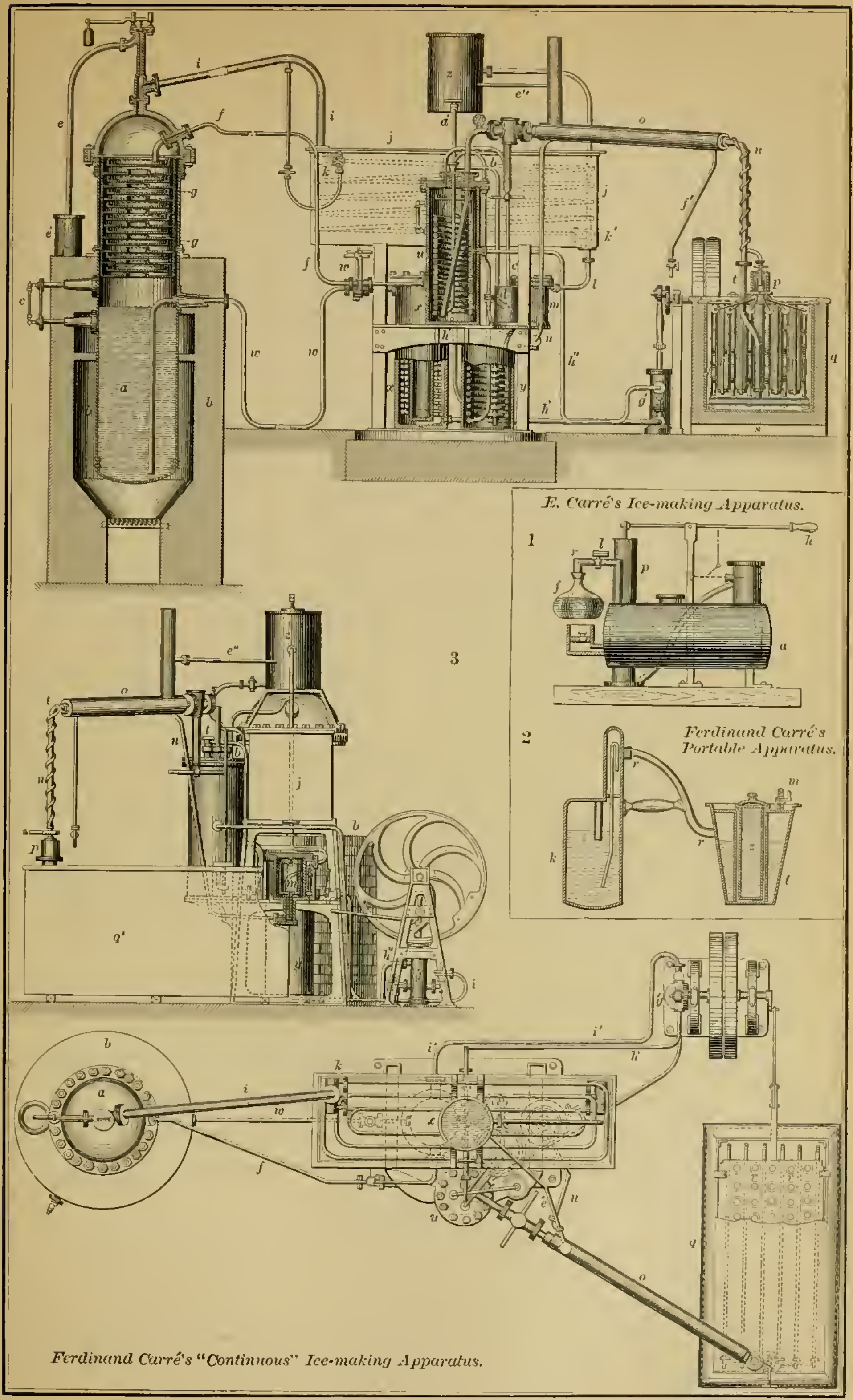
Edmond Carré's sulphuric-acid freezing-apparatus is upon this principle (shown at 1, Plate XXVI.), and is used to produce the *carafes frappées* (frozen decanters) so frequently seen in Paris. It consists of a large vessel, resembling the boiler of a steam-engine, which is designed to contain the concentrated sulphuric acid; of an air-pump with tube connections to be adapted to the wide mouths of the *carafes*, and of a mechanism by which the lever of the air-pump is made to keep the acid in continual agitation. The great volume of the acid renders the loss of absorptive power by dilution very slow, and the constant agitation prevents the formation of a superficial dilute stratum, which would interfere materially with the success.

In the drawing, *a* is the reservoir of sulphuric acid; *f*, a *carafe* of water connected by the tube *r* with the apparatus, and having a stop-cock at *l*. *p* is the barrel of the pump and *h* its lever, which also agitates the oscillator, shown in dotted lines.

We have considered in regular sequence the cooling of water by the access of air under natural conditions; the acceleration of the operation by artificial draft; the facilitating of the operation by the lessening of the atmospheric pressure; the absorption of the evolved vapor by sulphuric acid. We have now to consider the use of materials more volatile than water, notably ether and ammonia, but common alcohol, ether, methylic ether or alcohol, sulphurous or carbonic acid, bisulphide of carbon, gasoline, etc., have each been used.

Liquids.	Boiling-Point Fah.	Latent Heat of Vapor.	Tension of Vapors.
Water	212	966.6	0.623
Alcohol . . .	173.5	376	1.60
Methylic alcohol . .	119.7	475	1.11
Ether . . .	98	164.4	2.58

In Ferdinand Carré's apparatus the efficient cause producing cold is evaporation, but the liquid employed is ammonia, a substance which is not only much more volatile than water, but, under ordinary atmospheric pressure, is indeed permanently gaseous. Gaseous ammonia is liquefied by a pressure of 8½ atmospheres at a temperature of 68° Fah., or of 10 atmospheres at 77°, the pressure required rising very



E. Carré's Ice-making Apparatus.

Ferdinand Carré's Portable Apparatus.

Ferdinand Carré's "Continuous" Ice-making Apparatus.

CARRÉ'S ICE-MAKING MACHINES.

PLATE XXVI. See page 1164.

rapidly with the temperature. To liquefy it by cold requires a very low temperature (−65.5 Cent.), and as its latent heat is great it would become a valuable agent for the purpose of producing cold if its vapor could be removed. To do this with economy it must be saved and recondensed. This may be done mechanically by a pump, but with much greater advantage by water, which has the property of absorbing ammoniacal gas in great volume and with singular rapidity. This fact was first illustrated by Faraday in 1823. He used a bent glass tube, containing at one end a portion of chloride of silver saturated with ammonia at 60° Fah. or lower, and hermetically sealed after the air had been expelled by slightly warming the compound. If the chloride be heated to 100° Fah., the ammonia expelled, and the other end of the tube plunged in a cold bath, the gas becomes liquefied. If now the end containing the compound be plunged in a refrigeratory and the other in water, the liquid ammonia will commence boiling, the chloride will reabsorb the vapor as fast as produced, and by the rapid evaporation the water around the tube will be converted into ice.

For economic reasons (see Professor Barnard's Report on the French Exposition, page 369) water is to be preferred to chloride of silver. Water absorbs at moderate temperature 700 times its own volume of ammoniacal gas, a volume capable of producing a quantity of liquid ammonia equal to two thirds the bulk and one half the weight of its own volume, and capable of converting into ice more than three times its own bulk. On the contrary, a given quantity of chloride of silver will produce only a thirtieth part of its bulk of liquid ammonia, and a fifth part of its bulk of ice at 32° Fah.

F. Carré's intermittent apparatus (2, Plate XXVI.) is similar in its operation to the Faraday experiment, aq. amm. being substituted for the Ag., Cl. + ammonia. In the engraving, *k* is the boiler containing the liquor ammonia, and connecting by the pipe *r r* with the refrigerator *t*, which has a well in which is a pan containing the water *z* to be frozen. The boiler *k* is placed over a portable furnace, and the apparatus purged of air, which is driven by the evolved gas out at the stop-cock *m*. This being closed, and the refrigerator immersed in a tank of cool water, the temperature of the aqua ammonia is raised to 130° or 140° Cent., at which heat the ammonia is expelled and is condensed in a liquid form in the refrigerator *t*. The boiler *k* being now removed from the furnace and placed in the water-bath, the temperature of the water in the boiler will fall and the power of the water to dissolve ammonia will be restored. The gas will be rapidly re-dissolved, reducing the pressure, as the liquid ammonia will evaporate with corresponding rapidity, drawing for its latent heat upon the sensible heat of the water to be frozen. The result will be the complete evaporation of the liquefied ammonia and the restoration of an aqueous solution, in the boiler, of the original strength. Between the ice-pan and the well is a body of alcohol which will not freeze, but will act as a conductor. During the refrigerating, the vessel *t* has a non-conducting envelope.

Ferd. Carré's continuous process (3, Plate XXVI.), like the intermittent of Edmond Carré, depends also for its efficacy upon the evaporation of liquid ammonia. In each process the liquefaction is effected in substantially the same way. Aqua ammonia is introduced into a boiler, and the gas is expelled by heat into a condenser; but in order that the process may not be arrested by the exhaustion of the solution, the impoverished liquid is gradually withdrawn from the bottom of the boiler, while a corresponding volume of a fresh and strong solution is constantly flowing in at the top. The condensation is produced by the united effect of cold and pressure. From the condenser, the ammonia in a liquid state passes on to a refrigerator, in which are placed vessels containing the water to be frozen; and as the boiler and the condenser keep up an unfailing supply of the liquid, so the refrigerator will continue to freeze successive masses, so long as the proper temperature is maintained in the boiler. The ammoniacal vapor which leaves the refrigerator is re-dissolved to form the rich solution which is to supply the boiler; and the water of solution is the same which was previously withdrawn exhausted from the boiler itself. Thus, as there is nothing added to the contents of the apparatus, and as there is no escape of any part of them by leakage or otherwise, the same materials go on indefinitely producing a uniform effect.

a is the boiler, exposed to the heat of the furnace *b*; *c* is an indicator to show the level of the liquid; *i* is a tube conducting gas to the liquefier *j*; the vertical pipe above the branch *i* leads to a safety-valve, and any escaping gas passes by pipe *e* to the water-tank *c′*, where it is absorbed. *f* is a tube which brings back to the boiler saturated solution of ammonia from the absorbing apparatus *u u*; this solution passes downward, trickling through the perforated trays *g*, while the ascending gas rises in a sinuous course alternately around the edge of one tray and through a central hole in the next, and so on. This condenses and carries back the watery vapor which accompanies the gas.

The gas passes by tube *i* to the liquefier *j*, passing through a box *k* and a congeries of zigzag and spiral tubes in a bath of cold water constantly renewed from reservoir *z*, which also supplies other parts of the apparatus. The congeries of tubes terminates in another box *k′*, and the ammonia is by this time in a liquid state under the pressure of 10 atmospheres, which is constantly maintained in the boiler. In the liquid state the ammonia passes by the pipe *l* to the efflux regulator *m*, which is the dividing barrier between the part of the machine in which a regular pressure of 10 atmospheres is maintained and the following part where the pressure does not exceed 1½ atmospheres. The regulating device is a floating cup which opens or closes a hole of influx.

The liquid passes from the regulator *m* by pipe *n* to the distributor *p*, the pipe *n* being wound spirally around the tube *t*, through which the vaporized ammonia is returning from the refrigerator *q q*; the vapors serving to reduce the temperature of the liquid in *n* before it reaches the refrigerator.

The refrigerator itself consists of a number of zigzag or spiral tubes — in the apparatus here represented, six in all — immersed in a tank constructed of non-conducting substances. These zigzags return upon themselves six times, forming so many partitions in the tank, between which vessels containing the substances to be subjected to cold may be placed. Each one of the six zigzags receives an equal supply of the liquid ammonia from the distributor. The small tubes conveying this supply are shown at *p*. The vessels *r* to be refrigerated are sustained on a carriage, which is slid back and forth by the same power that works the pump *g′* by which the re-saturated solution of ammonia is returned to the boiler. The space in the tank surrounding the zigzags and the water-vessels *r* is filled with an uncongealable liquid, such as alcohol or a solution of chloride of calcium. The ammonia in the zigzags *q* discharges in a vaporized form into the *collector s* and passes through the tube *t* to the cylinder *u*, where it extends nearly to the bottom of the vessel, and there discharges the gas into the water which has been brought from the bottom of the boiler *a*, and partially fills the cylinder *u*. From this water the ammonia has been nearly exhausted, and it therefore greedily absorbs the gas ejected into it by pipe *t*. On the left of vessel *u* is a water-level indicator.

Within the vessel *u* is a worm which receives water by pipe a' from the elevated reservoir *z* ; after passing to the bottom of the spiral the pipe curves upward and then (marked *b*) descends nearly to the bottom of the vessel *y*, where it discharges.

The water from the boiler *a* passes by pipes *w w* to the coolers *x y* before reaching the vessel *u*, where it re-absorbs ammonia. Between the boiler *a* and the vessel *u* the water is cooled so as to fit it for absorbing gas more freely. The pressure in the boiler is sufficient to expel it when the stop-cock *w* is opened. The vessel *x* is formed of two concentric cylinders, between which are two spiral tubes formed of the pipe *w* continued, and these spirals are immersed in a liquid which fills the annular space between the cylinders and is the reconstituted ammoniacal solution on its way from the absorber *u* to the boiler *a*. The water from the boiler is hot and that from the absorber is cold, and the two to some extent exchange temperatures to mutual advantage, and with additional effect in that they circulate in opposite directions, the liquid from the absorber entering at the bottom and ascending, while the heated water from the boiler enters at the top and descends. From *x* the water in the spiral is conveyed in the pipe *w*, still continued in a single spiral ascending in the vessel *y*, and continued farther in a pipe *w* alongside of the absorber *u*, into which it discharges into a sieve *v* and from which it descends in a shower.

The exhausted solution from the boiler *a* flows freely, as has been said, from the boiler, by pipe *w*, to the absorber *u*, passing the coolers *x y* as described, but it requires some power to force the reconstituted solution back from the absorber *u* through the pipe *f* to the boiler. This power is a pump g' driven by a steam-engine or other motor, and taking the saturated solution from the absorber by pipe h' and discharging it by pipe i' into the vessel *x*, from whence it passes by pipe *f* to the dome above the boiler, as described some distance above. Gas finding its way into the pump is discharged into the upper part of *u*. e'' is a pipe leading to the enveloping tube *o*, from whence water is conducted by f' for the use of the ice-vessels *r*. As the water passes through *o* it is cooled by the ascending vapors of ammonia.

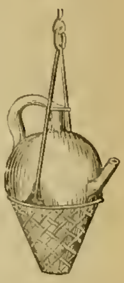
In starting the machine, it is first blown through to expel the air. The air escaping from the vessel *u* passes by pipe *c* to the purger *d* and passes beneath the surface of the water therein, which retains any escaping ammonia.

This apparatus requires a large amount of refrigerating water to maintain at the desired temperature the liquefier and the absorbent vessel, and it also involves a consumption of fuel, not only to heat the boiler containing the ammoniacal solution, but also to work the forcing-pump. The pump may be worked by water-power, if such a power is obtainable, or even in small models by hand ; but for an apparatus producing more than one hundred pounds of ice per hour, a motor is indispensable.

It is stated by Mr. Carré that for every pound of coal burned there are produced from eight to twelve pounds of ice, according to the dimensions of the apparatus. To manage the larger forms of the apparatus, the services of two men are required, and a motor also is necessary, capable of driving two hundred and twenty gallons of liquid per hour into the boiler. The pressure in the boiler must be taken, for the purposes of computation, at not less than ten atmospheres ; and as the machines are adequate to the production of five hundred pounds per hour of ice, they will, within the same time, liberate from solution, liquefy, evaporate, and re-dissolve one hundred pounds of pure ammonia.

On the evaporating principle are the water-jars, or *monkeys*, used in tropical countries and the east of Europe. These are merely unglazed earthenware jugs having a small neck and a spout, and suspended in a current of air or in a doorway. The Australian device for the same purpose is a bucket of canvas, nearly waterproof, and having a flannel cover to form a sieve, and a spout below to draw off the water. Evaporation proceeds rapidly from the wet surface. The East Indian *tatta* (Hind. *tattah*, a screen) is a curtain of bamboo placed in front of a window or doorway and kept wet by a trickling stream of water so as to cool the air passing through its meshes into the apartment.

Fig 2645.



Hindoo Gurglet.

The mode of procuring ice by exposure in shallow, porous vessels, laid on straw and exposed to the night air, is stated to be practiced in India. The small crust of ice is carefully removed and stored in a straw-lined pit, before sunrise. A large plain, unobstructed as much as possible by trees or buildings, is selected for the purpose, in which pits or excavations twenty or thirty feet square and two feet deep are sunk, the floors being covered with dry stalks of corn or sugar-cane. Upon these are placed the water-vessels, constructed of porous earthenware, and not much more than an inch deep. In the morning, if the sky has been clear, the vessels are found to contain thin plates of ice, which are carefully gathered and stored away. This process was successfully imitated in England in the latter part of the last century by Dr. Wells, author of the Essay on Dew ; and soon afterward an attempt was made in France to employ it for the systematic manufacture of ice, but the undertaking proved to be economically a failure.

Many of the modern ice-machines depend upon the conversion of sensible heat into latent by evaporation, liquids which vaporize at low temperatures being selected.

Harrison's Australian machine used ether evaporating into a partial vacuum produced by an air-pump, and instead of acting directly upon the water to be frozen it was made to reduce the temperature of a solution of salt, which does not congeal at the freezing-point of water, and the solution, thus made extremely cold, was then made to pass between cases containing the water, and, by reducing the temperature, secured the requisite congelation of the same. Twining's patent of 1862 is of this class.

Next in sequence may be considered a French invention, in which the freezing agent employed was amylic ether, which is capable of being dissolved by sulphuric acid. The ether being expelled from the acid by heat, under a pressure of several atmospheres, was liquefied, and passed in this condition to a suitable reservoir, from which, by turning a valve or stop-cock, it was allowed to expand and pass through spiral ducts arranged around a cylinder containing the water to be congealed ; the expansion of the fluid to a gaseous condition acting, as in the other ether machines, to abstract the heat from the water and freeze the same. After having thus accomplished its work, the ether passed to vessels of sulphuric acid by which it was absorbed, to be expelled therefrom by heat on a repetition of the process.

Twining's apparatus, patented in the United States, November 8, 1853, and subsequently extended for seven years, embraces an exhaust vessel, a pump, and a condensing vessel or "restorer." The water to be frozen is placed in chambers enclosed between thin metallic pipes, plates, or partitions, through which the vapor of a volatile liquid, as ether, sulphide of carbon, etc., is drawn by an air-pump. The vapor is condensed in a coil of pipe surrounded by cold water, and is returned to the reservoir from whence the liquid originally came. Four different modes of applying this principle, substantially the same but varying in details, are specified in the patent.

In Siebe's apparatus an air-pump is employed to vaporize the ether, the vapor of which is then conveyed into the refrigerator, which is surrounded with strong brine. The water to be made into ice is put in metallic troughs, and the brine surrounding them is, by means of the exhaustive process above referred to, cooled down to from 10° to 18° Fah., freezing the water to a depth determined by the time it is subjected to the process.

In Van der Weyde's machine are employed an exhaust and force pump, a cooling coil, and two refrigerators, which act as reservoirs for the condensed liquid. Naphtha, gasoline, rhigoline, or chimogene, are preferred. These are evaporated by an air-pump and forced through a freezer, in which are vessels containing water, surrounded by enclosing vessels filled with glycerine, the outside being surrounded by cryogene. The evaporation of the cryogene causes the refrigeration of the water to a sufficient extent to crystallize it; that is, form it into ice.

Reece's apparatus operates substantially on the Carré principle. The ammoniacal gas employed passes under considerable tension from the refrigerator into a cylinder having a slide valve, entry and exhaust ports, similar to those of a high-pressure engine, so that the gas is utilized to drive the pumps of the apparatus. From the cylinder it passes to the absorber and is returned to the reservoir.

Seely employs anhydrous ammonia. The generators are filled, or partially so, with dry, pulverized chloride of calcium. One of the generators is heated by steam coils, the generated gas passing through the condenser, evaporating in the refrigerator, and is finally absorbed by the dry chloride in the other receiver, to which heat is then applied in its turn, the other reservoir now becoming the condenser.

In Johnston and Whitelaw's, the liquid, bisulphide of carbon, after being vaporized is, with the air forced in by the air-pump, conducted through chambers containing oil, which absorbs the greater part of the moisture of the gas, the moisture of the air being taken up by chloride of calcium, in a pipe leading to the air-pump. The freezing arrangements are similar to those generally employed in machines of this class.

In Charles Tellier's machine, the liquid employed is methylic ether in a volatile state, not requiring to be subjected to heat. It comprises a congealer, compressing-pump, condensing-coil, and reservoir. The congealer consists of five or more receivers of a flat form connected by tubes. The apparatus is placed in a tank containing the water to be congealed. The fluid from the reservoir passes to the congealer, and the vapor exhausted therefrom by the air-pump is conveyed back to the reservoir through a worm.

The novelty of this apparatus consists in freezing the water by immediate contact with metallic plates forming a closed chamber.

For use on shipboard, the congealer is provided with four outlets terminating in a trap. Late attempts at transportation, on shipboard, of fresh meat in ice, from Australia, Buenos Ayres, and Texas to European and United States ports, have given a fillip to this class of machinery.

2. *Radiation.* This does not affect the subject from a mechanical point of view, and we therefore dismiss it.

Class 3. Liquefaction.

Machines and apparatus for icing cream, custard, lemonade, etc., may be classed under this head, and generally operate by means of a frigorific composition of pounded ice and chloride of sodium, in a vessel which surrounds the chamber in which the article to be frozen is placed. The tub containing the ice and salt is of wood, a poor conductor of caloric; and as the ice in liquefaction converts a large quantity of sensible heat into latent, the heat of the cream is carried off to supply the demand of the melting ice, and the cream becomes frozen. When ice or snow is not available, the combination of certain chemicals may produce the same result. The cream is stirred to constantly expose fresh material to the sides of the vessel exposed to the cooling compound. See tables below. See also ICE-CREAM FREEZER.

The use of saltpeter for cooling liquids was known at a remote period in India. It was probably used anciently as it was, in more modern times, in Rome. "The wine to be cooled was put in a long-necked bottle, which was immersed in another vessel filled with cold water; saltpeter was then gradually thrown into the water, and while it was dissolving a quick rotary motion was imparted to the bottle."

Freezing water by a mixture of snow or ice and saltpeter is first mentioned by Tancredus, a physician of Naples, 1607, who says that, by means of it, a tumbler of water may be converted into a block of solid ice. Santorio, in 1626, speaks of freezing wine by a mixture of snow and common salt.

Orosius (King Alfred's version), about A. D. 400, wrote: "And there is among the Esthonians a tribe that can produce cold, and therefore the dead in whom they produce that cold lie so long there and do not putrefy; and if any one sets two vessels full of ale or water, they contrive that one shall be frozen, be it summer or be it winter."

Freezing-Mixtures.

	Thermometer sinks.		Degrees of Fall.
	From	To	
With Ice.		Degs.	
Snow or pounded ice, 2 parts; muriate of soda, 1 part		— 5	
Snow, 5; mur. soda, 2; mur. ammonia, 1		—12	
Snow, 24; mur. soda, 10; mur. ammonia, 5; nitrate of potash, 5		—18	
Snow, 12; mur. soda, 5; nit. amm, 5		—25	
Snow, 3; dilute sulphuric acid, 2	+32	—23	55
Snow, 8; muriatic acid, 5	+32	—27	59
Snow, 7; dilute nitric acid, 4	+32	—30	62
Snow, 4; mur. of lime, 5	+32	—40	72
Snow, 2; crystallized mur. lime, 3	+32	—50	82
Snow, 3; potash, 4	+32	—51	83
Without Ice.			
Mur. amm., 5; nit. pot., 5; water, 16	+50	+10	40
Nit. amm., 1; water, 1	+50	+ 4	46
Mur. amm., 5; nit. pot., 5; sulph. soda, 8; water, 16	+50	+ 4	46
Nit. amm., 1; carb. amm., 1; water, 1	+50	— 7	57
Sulph. soda, 3; dilute nit. acid, 2	+50	— 3	53
Sulph. soda, 6; mur. amm., 4; nit. pot., 2; dilute nit. acid, 4	+50	—10	60
Sulph. soda, 6, nit. amm., 5; dilute nit. acid, 4	+50	—14	64
Phosphate of soda, 9; dilute nit. acid, 4	+50	—12	62
Sulph. soda, 8; mur. acid, 5	+50	0°	50
Sulph. soda, 5; dilute sulph. acid, 4	+50	+ 3	47
Phos. soda, 9; nit. amm. 6; dil. nit. ac., 4	+50	—21	71

	Thermometer sinks.		Degrees of Fall.
	From	To	
Sulph. soda, 8; mur acid, 5	+50	0°	50
Sulph. soda, 5; dilute sulph. acid, 4	+50	+ 3	47
With Materials previously cooled.			
Phos. soda, 5; nit. amm., 3; dil. nit. ac. 4	0	—34	34
Phos. soda, 3; nit. amm., 2; dilute mixed acid, 4	—34	—50	16
Snow, 3; dilute nit. acid, 2	0	—46	46
Snow, 8; dil. sulph. ac., 3; dil. nit. ac., 3	—10	—56	46
Snow, 1; dilute sulph. acid, 1	—20	—60	40
Snow, 3; mur. lime, 4	+20	—48	68
Snow, 3; mur lime, 4	+10	—54	64
Snow, 2; mur. lime, 3	—15	—68	53
Snow, 1; cryst. mur. lime, 2	0	—66	66
Snow, 1; cryst. mur. lime, 3	—40	—73	33
Snow, 8; dilute sulph. acid, 10	—68	—91	23

By the evaporation of a mixture of solid carbonic acid and sulphuric ether a temperature of 166 degrees below the freezing-point has been produced. By means of this intense cold, assisted by mechanical pressure, several of the gaseous bodies have been condensed into liquids and in some instances solidified.

Class 4. Reduction of pressure.

Machines in which the absorption of heat from the water is accomplished by the expansion of air or gas, or of a liquid into a gaseous condition.

In this division are one class, the carbonic-acid, ether, and ammonia engines, those materials being used as a convenient fluid for the purpose.

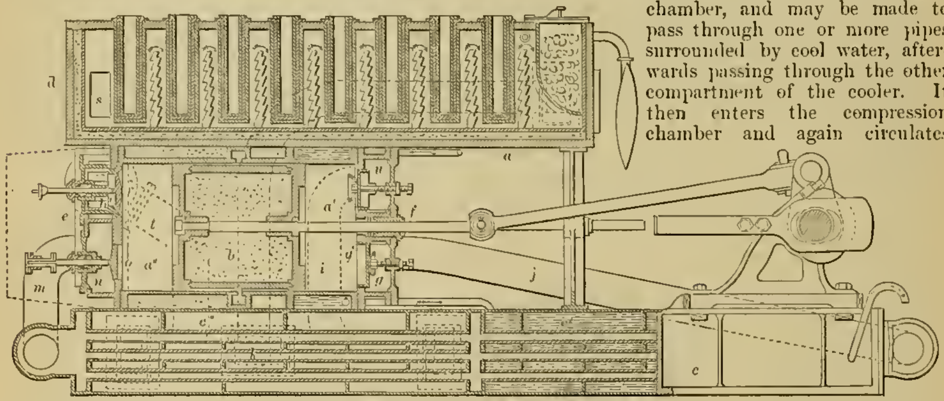
The effect of the rapid dilatation of fluids under a sudden reduction of pressure is strikingly illustrated in the hydraulic machine of Chemnitz, Hungary (see page 28), in which air is highly compressed in a closed reservoir under a column of water. If a stop-cock in this reservoir be suddenly opened, the expanding air rushing out produces a degree of cold sufficient to freeze the drops of water which it brings with it into pellets of ice.

Machines acting by expansion of air-envelope.

Kirk's apparatus (English) was of this character; that is, it absorbed heat by the expansion of air when liberated after compression by suitable mechanical means, the expansion of the air rendering latent the heat in the same manner as the expansion or vaporization of the ether or equivalent fluids in the cases hereinbefore described.

Windhausen's machine has one or two double-acting cylinders with pistons. In case a single cylinder is employed, the air is condensed on one side of the piston and expanded on the other. When two cylinders are used one serves as a condenser and the other serves to expand the air. From the condensing chamber the air passes into a cooler having two compartments, in one of which it is cooled by air and in the other by a constant flow of cool water. From the cooler it passes into the expansion chamber, whence it escapes through a temperature regulator into the refrigerator, in which the vessels containing the water are placed. By means of this regulator a portion of the air from the expansion chamber may be admitted to one compartment of the cooler for the purpose of reducing its temperature. When the air in the refrigerator has become too much heated to be of farther service there, though still at a low temperature, it passes through this compartment of the cooler on its way back to the compression chamber, and may be made to pass through one or more pipes surrounded by cool water, afterwards passing through the other compartment of the cooler. It then enters the compression chamber and again circulates through the apparatus as before. The operation is thus rendered continuous.

Fig. 2646.



Windhausen's Ice-Machine.

The machine is provided with suitable valves and connections, and may be operated by hand or power.

The operation is as follows: —

During the forward stroke of the piston — that is to say, its movement toward the front cylinder head *f* — the air is compressed in the compressing-chamber *a'*, and by its pressure caused to open the valve and pass out through the compartment *g* of the head and through the pipe *j* to the cooler, in which it passes first through the pipes *c'*, and afterward through the pipes *c''*, and is thereby cooled. From the cooler the compressed air passes through the pipe *m* into the compartment *n* of the back cylinder-head *e*, whence it passes through the valve *o* into the expansion-chamber *a''* of the cylinder during a portion of the stroke, and until the valve *o* is closed, after which the air in the latter chamber expands during the remainder of the stroke. During the whole return or back-stroke of the piston, the expanded and cooled air from the expansion-chamber passes out through the open valve *r* into compartment *b'* of the cylinder-head *e*, and thence to the temperature-regulator, whence a portion of it passes through the pipe *s* to the refrigerator, and a portion through the pipe *t* into the space surrounding the pipes *c''* in the left compartment of the cooler. At the same time the air displaced from the refrigerator by the incoming cold air passes out through the pipe *k* into the aforesaid space of the cooler. The air all passes out from this space of the cooler, through the pipe *i*, into the compartment *u* of the front cylinder-head, whence it is drawn by the piston, through the inlet-valve into the compression-chamber of the cylinder.

The refrigerator *d* consists of a double-cased rectangular wooden chamber, the space between the casings being filled with loose cotton or other non-conductor of heat. Its cover has rectangular openings for the insertion of metallic cases for containing the vessels in which the water to be frozen is placed. To insure the air coming fully in contact with all parts of the cases, zigzag partitions are placed in the compartments between them. The air in the refrigerator, expanded to atmospheric pressure, abstracts heat from the metallic cases, becoming gradually warmed itself, and is finally, through a pipe *k*, returned to the cooler. A uniform pressure is maintained within the refrigerator by means of an india-rubber bag, which admits or gives out air, according as the pressure is in excess of or below that of the atmosphere.

In Gorrie's apparatus, air is compressed by a double-acting pump into which water is injected on that side of the piston on which condensation is taking place. The condensed air passes through a worm surrounded by cold water to a reservoir, whence it is admitted to an auxiliary pump driven by the expansion of the compressed air, in which it is expanded, cooling a non-congealable fluid in a jacket surrounding the pump-cylinder. This abstracts the heat from the water contained in a reservoir in a chamber above the pump, causing its congelation.

Lowe uses carbonic-acid gas compressed into a liquid state. The apparatus consists of a gas-holder, a pump, a cooler, a dryer filled with chloride of calcium, a condensing coil placed in a tank and surrounded by water, and an expansion or congealing chamber in which are placed the receptacles containing the water to be frozen. The gas is admitted to the pump, where it is liquefied. The heat thus generated is absorbed by the cooler, and the gas is allowed to expand into the refrigerator, where it performs the office of freezing the water.

Tuttle and Lugo. In this apparatus air is compressed and forced by a pump into a tubular chamber, the tubes of which are surrounded by cold water, and thence through a second chamber, the tubes of which are surrounded by a volatile liquid. It next passes into the refrigerating chamber, rising through a volatile liquid as ether, bisulphide of carbon, etc., contained therein; the air and vapor from the liquid fill the interior of this chamber, surrounding the vessels in which the water is contained and congealing it. They are thence conducted through a cooling chamber back to the pump.

A pipe is provided by which the compressed air may be carried directly to the refrigerator.

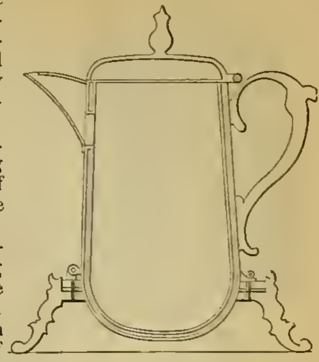
Lugo and McPherson. The air from a blower is forced through a chamber containing porous material saturated with water, and being there cooled is conducted to a condensing-pump, the upper part of which contains water, serving to keep the pump cool and pack the piston. The piston is driven by the epicycloidal combination of La Hire. From the pump the air passes to a cooler, and thence to a reservoir, from which it is conducted to a large congealing chamber or ice-house, which has non-conducting walls and a track for cars carrying pans of water.

Ice-mark'er. A species of plow for grooving pond ice in the line of the future lines of separation by the saw, or fracture by spades and axes. See *a*, Fig. 2658, ICE-TOOLS.

Ice-pick. (*Domestic.*) An awl-shaped tool to break ice into fragments.

Ice-pitch'er. A metallic pitcher with non-conducting interval between its double sides. In the example, it is supported in a stand in which it may be rotated or tilted forward.

Fig 2647.



Ice-Pitcher.

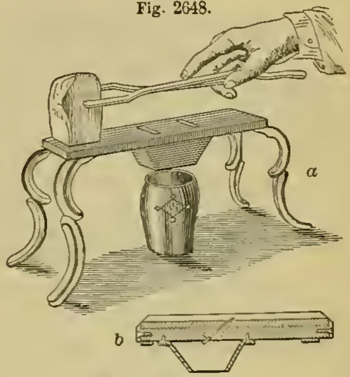
Ice-plane. 1. A tool for dressing the surfaces of ice-blocks before stowage in bulk.

2. An instrument for shaving off fragments of ice for cooling drinks.

a is placed on a stand, *b* is of similar construction but not mounted.

Ice-plow. A tool for cutting grooves in pond ice, to facilitate its fracture or cleavage into square blocks for landing, transportation, and stowage.

Fig. 2648.

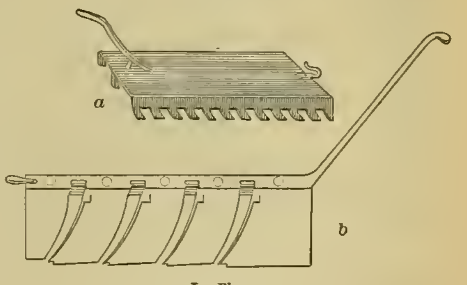


Ice-Planes.

The upper figure *a* is a frame which cuts three parallel grooves in moderately thick ice.

The lower figure *b* has five consecutive shares, which make and follow in the same groove in cutting deep ice. See also *a b*, Fig. 2658.

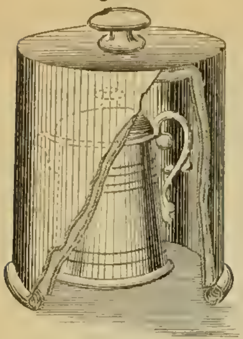
Fig. 2649.



Ice-Plows.

Ice-pre-serv'er. A cover for an ice-pitcher to economize the ice by keeping the warm air from contact with the outside of the pitcher. It is made of straw, woolen, or cotton felt, and lined within and covered without with flannel. The top is made of wood, to give form to the cylinder, and has a

Fig. 2650.



Ice-Preserver.

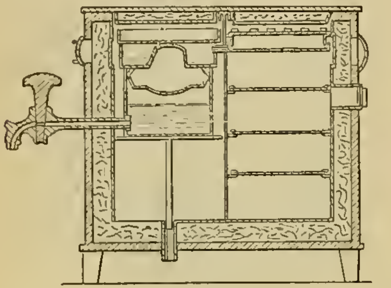
handle for convenience in raising it.

Ice-safe. A chest in which provisions are kept cool by the presence of ice.

The box and the cupboard forms are the more usual, and the safe sometimes is made quite ornamental for a dining-room.

In the example (Fig. 2651), the space between the inner metallic case and outer wooden one is filled with pulverized charcoal, and a wooden rack supports the ice. Air-passages connect the ice-chamber to the cooling chamber below. A tube carries the water from the ice-chamber to the filter.

Fig. 2651.

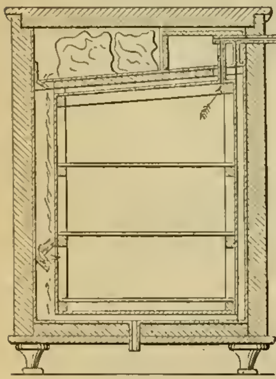


Ice-Safe.

The chambers are ventilated by pipes from the outside.

In the ice-safe Fig. 2652 the ice is on the slanting top of the food-chamber, and the water drips down the back, inducing a current of air which is cooled by contact and caused to circulate through the chamber in the direction of the arrows.

Fig. 2652.



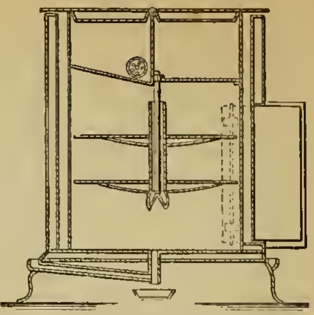
Ice-Chest.

Fig. 2653 has revolving shelves. A removable tube, with a perforated cap at one end and a diaphragm at the other, is fitted in the ice-chamber, which, with the refrigerator chamber, has a removable top of two lids hinged together. Two dead spaces, one inside of the other, surround the sides of the cylinder and the refrigerating space, and a trough with discharge-pipes runs around the outside wall at the bottom.

Ice-san'dal. A clog or shoe to be worn over the boot, and having spurs on the sole to prevent slipping on ice. (Fig. 2654.)

Ice-saw. A long saw with a weight at the lower end (beneath the ice), for cutting long kerfs in pond ice, to make a track for vessels, or to form long slices which are broken in blocks for storage.

Fig. 2653.

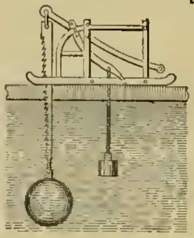


Refrigerator.

Ice-saws in the Arctic regions are made of $\frac{2}{8}$ to $\frac{3}{8}$ inch steel blades, 10 to 24 feet long. See *h*, Fig. 2658, ICE-TOOLS.

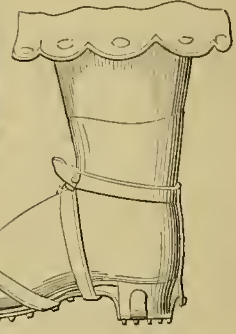
Hood's ice-saw (English) is mounted on a sled, which is advanced a given distance during each cut, by means of a lever-dog. The saw is suspended from the end of a brake-lever, the weight suspended at the lower end giving the effective stroke, while the men at the brakes raise it between cuts.

Fig. 2655.



Hood's Ice-Saw.

Fig. 2654.



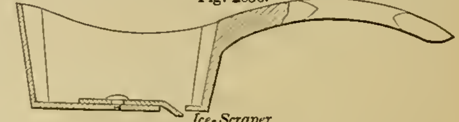
Ice-Sandal.

At each end of the saw is a link or clevis, by which it is attached to the brake-lever and the weight, respectively. The weight is of the shape of a double convex lens, so as to offer as little impediment as may be to its vertical motion in the water below the ice. The propeller is an iron bar having two claws at its lower end, by which it catches a foot-hold on the ice, and at top is a fork which embraces the lever and is suspended therefrom by a transverse pin. A weight is hung to the propeller to keep the toe-calks in contact with the ice. A transverse bar limits the upward throw of the brake-lever.

The saws are used in cutting ice for storage, but their principal use has been in northern latitudes, in cutting passages out of the ice floes and fields, in which vessels have become entangled and frozen up.

Ice-scrap'er. An implement to clean and remove snow from the surface of ice which is to be cut and stored for use.

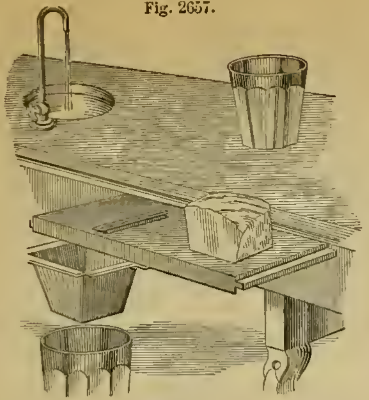
Fig. 2656.



Ice-Scraper

Ice-shav'er. A device for planing ice to cool a beverage in a tumbler.

Fig. 2657.



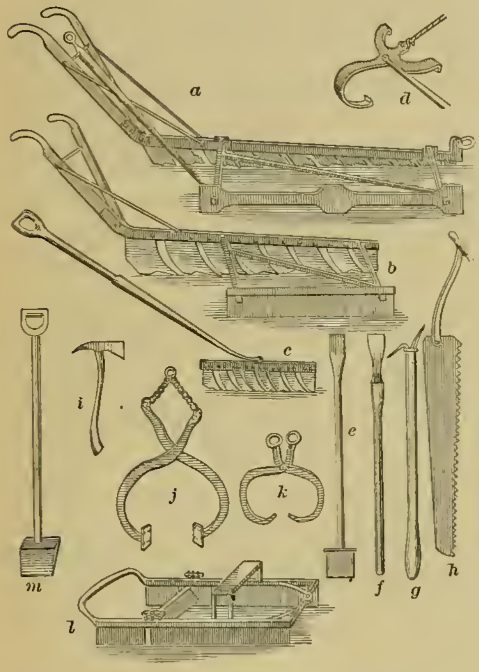
Ice-Shaver.

Ice-spade. A tool for cutting ice. See *m*, Fig. 2658, Ice-Tools.

Ice-tongs. Grasping implements for carrying blocks of ice; or, on a small scale, for handling pieces of ice at table. See *j k*, Fig. 2658.

Ice-tools. Fig. 2658 shows an assortment of cast-steel ice-tools made by Stafford, Holden & Co., of Barre, Vermont: —

Fig. 2658.



Ice-Tools.

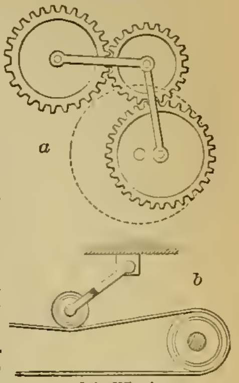
a is a marker.
b, cutter with guide.
c, a hand-cutter.
d, grapple.
e, striking-off bar.
f, chisel-bar.
g, hook and pick.
h, saw.
i, hatchet.
j, hoisting-tongs.
k, landing-tongs.
l, snow-planer.
m, ice-spade.

Ich'no-graph. (*Drawing.*) A ground-plan; an *orthograph* is a front elevation, a *scenograph* a general view.

I'dler. A cog-wheel (as at *a*) placed between two others to communicate the motion of one to the other. By its interposition they are caused to rotate in the same direction, which would be otherwise if they geared directly into each other.

Another description of idle-wheel (as at *b*) is caused to rest upon a belt to tighten it, to perfect its adhesion to the band-wheels over which it runs.

Fig. 2659.



Idle-Wheel.

I'dle-wheel. See Idler.

Id'wall-stone. A Welsh oil-stone from Snowdon.

Il-lu'mi-na-ted Clock. This practice appears to have commenced in Glasgow, Scotland, where a clock with two faces supported at the extremity of a projecting bracket was lighted by jets placed above it, the light of which was reflected upon the dials from mirrors placed beneath a carved phœnix which surmounted the clock. The jet was lit by a *flash-pipe*, which consists of a supplementary pipe pierced with a row of small holes throughout its length. Gas issuing from each of these is lit, and forms a communication between the match of the lighter and the issuing gas of the burner.

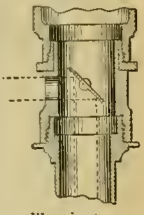
The more usual plan of illuminating clocks is to make a transparent dial-face, having figures thereon which show dark on a light ground. The dial-chamber is illuminated in the ordinary manner. The church-clock of St. Giles, in the Fields, London, was lighted April 23, 1827.

For modes of lighting the gas without climbing to the tower or spire, see Gas-lighting by Electricity.

Il-lu'mi-na-tor. A device to throw light upon an object in an optical instrument; such as a lens which condenses light upon an object under observation, or a lamp which throws a pencil of rays upon the micrometer wires in a telescope.

Beck's *opaque illuminator* for high powers consists of a circular disk of thin glass placed at an angle of 45° in the axis of a microscope, receiving rays from a lateral aperture, and directing them downward upon the object. The *objective* is made its own condenser.

Fig. 2660.



Illuminator.

The *white-cloud* illuminator is to transmit a subdued white light, and is sometimes a surface of pounded glass or of plaster of paris.

The *oblique illuminator* is for directing oblique rays upon an object. This is attained by the concave mirror, Amici's prism, etc.

The *black-ground illuminator* places an opaque surface behind the object and illuminates the surface. See Spot-lens; Parabolic Illuminator.

To these may be added the various illuminators for opaque objects, and known as Condensers, Side-reflectors, Parabolic Reflectors, Lieberkuhns, etc. (which see).

Il-me'ni-um. Symbol, *Il.* One of the rare metals but little known beyond the laboratory of the chemist.

Im-bow'ment. (*Architecture.*) A vault or arch.

Im'bri-cat-ed. (*Architecture.*) Overlapping; as tiles or shingles on a roof.

Im-i-ta'tion-met'als. See MOCK-GOLD; MOCK-SILVER, etc.

Im-mer'sion-lens. (*Optics.*) An achromatic objective for the microscope, which is used with a drop of water between the front lens and the glass cover of the object examined, to prevent the extreme refraction of the luminous pencils if air is present, as in ordinary microscopical examinations, and which thus secures better definition and longer working distance for the same power.

Im-pa'ges. The horizontal parts of the framework of doors, commonly termed rails.

Im-pe'ri-al. 1. A baggage-case on the top of a traveling-carriage.

2. A roof with a pointed or tent shape.

3. A size of paper, variously quoted as to sizes; paper-makers differ.

Printing-paper, 22 × 32.
Flat writing-paper, 22 × 30.
Blank-book paper, 22 × 30 to 23 × 31.

Im-plu'vi-um. The cistern in the central part of the court or atrium of a Roman house, to receive the rain-water.

Im-pos'ing. The arrangement of pages in a form.

When wedging up the *form* in the *chase* the form lies upon the *imposing-stone*, and the various pages are arranged so as to match their fellows on the other side of the sheet, so that when folded the pages shall come in consecutive order.

The *number of pages on one side of the sheet* determines its name, as follows: —

Folio, 2 pages.
Quarto, 4 pages.
Octavo (8vo), 8 pages.
Duodecimo (12mo), 12 pages.
16mo, 18mo, 24mo, etc.

When perfected, that is, printed on the other side, the sheet has double the number, so that there are 8 pages to a quarto signature, 16 to an octavo, etc.

They are imposed as follows, the illustration showing how the pages appear in the form.

O. F., outer form; I. F., inner form.

18, 24, 32, and 48mo may be imposed in a similar manner, or may be so imposed as to be cut before folding. See Ringwalt's "Dictionary of Printing."

Im-pos'ing-stone. (*Printing.*) A slab on which the type is made up into forms. The *chase* lies on the *stone*, and the *matter* is arranged inside, being keyed up by the *quoins*.

Im'-post. The upper member of a pillar, column, or entablature, upon which an arch or superstructure rests. A *plat-band*.

The upper stone of a pier or abutment, upon which the *springing* or bottom stone of an arch is imposed.

Imp-pole. (*Building.*) A pole serving to support the scaffolding. A scaffolding *imp*.

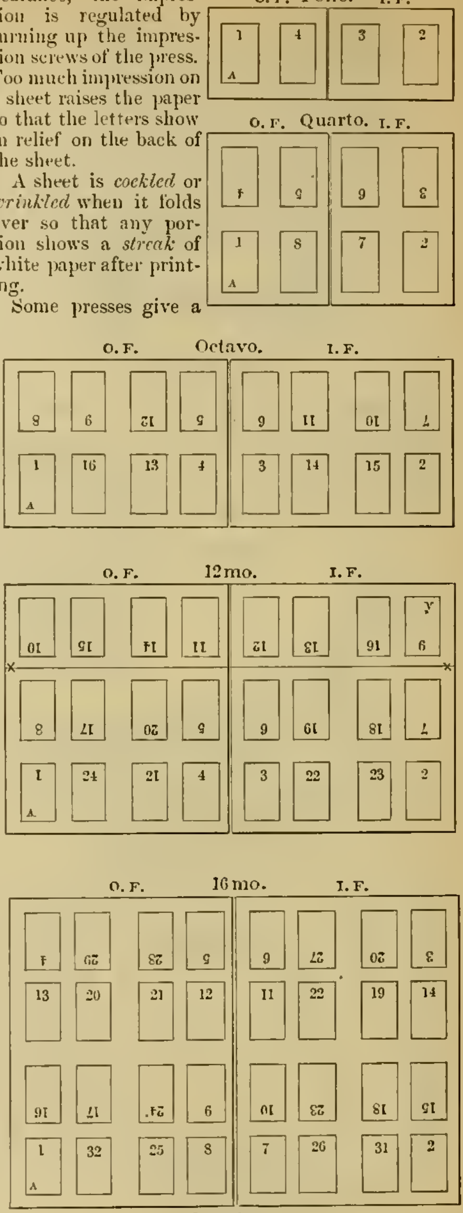
Im-pres'sion. (*Printing.*) The pressure applied to a sheet in the press. Also the appearance of the sheet, front or back, when it is taken from the press.

Making ready is to prepare press and form for printing. When some lines or letters in a form have been worn longer than the other type, a piece of paper is pasted on the bottom of these lines to raise them to the proper height. This is called an *underlay*.

When type or stereotype plates give a *faint impression* in spots, a piece of tissue paper of the size and shape of the spot is pasted upon the *tympan*. This is called an *overlay*. When the whole sheet has a gray or light appearance, the impression is regulated by turning up the impression screws of the press. Too much impression on a sheet raises the paper so that the letters show in relief on the back of the sheet.

A sheet is *cockled* or *wrinkled* when it folds over so that any portion shows a *streak* of white paper after printing.

Fig. 2661.



Imposing.

Some presses give a *dwelling* impression by holding the type and paper in contact for some instants. Lithographic presses give a *drawing* impression.

A sheet is *slurred* when it is allowed to slip upon the face of the type after inking. It is *smeared* after printing by handling or folding while *green*, or before the ink is *set*. Dry pressing printed sheets flattens down the impression and fixes the ink, though if pressed while too wet the ink may *offset*. *Monks* and *friars* are black or white blotches which may appear on a sheet from imperfect distribution of ink on the *rollers* or *form*.

Im-pres′sion-cup. (*Dentistry.*) A cup to hold material for taking an impression of the mouth for the purpose of making an artificial denture.

In-and-out-bolt. A *through* bolt. One passing through a ship's planking, the frame, and the knees of the beams.

In-boards. (*Bookbinding.*) The sides covered with paper.

Cut-in-boards: leaves cut after the cover is on.

Out-of-boards signifies that the edges are trimmed before covering.

In-cen′di-a-ry Com′pounds. Greek-fire, said to be the invention of Callinicus of Heliopolis, in Syria, in the seventh century. It was first used upon the Saracens' ships. It was blown out of long tubes of copper, shot out of cross-bows, and projected in other ways. It burned on water, and diffused itself on all sides.

The composition of Greek-fire was kept as a state secret in Constantinople. It is believed that it contained sulphur and nitrate of potash mixed with naphtha. See GREEK-FIRE.

The Arabs had an incendiary composition formed of sulphur, saltpeter, and sulphide of antimony, mixed into a paste with juice of black sycamore, liquid asphaltum, and quicklime.

The French engineer Chevallier, about 1797, invented a compound which would burn under water.

Shells, charged with this or a similar substance, are said to have been found on some of the ships of the French fleet which carried Napoleon and his army to Egypt, and were afterwards taken or destroyed by Nelson at the battle of the Nile.

Rock-fire is one of the best known modern incendiary compositions; it burns slowly, is difficult to extinguish, and is used for setting fire to ships, buildings, etc. For putting in shells it is cast in cylindrical paper cases, having a priming in their axes.

Rock-fire is composed of rosin, 3 parts; sulphur, 4; niter, 10; regulus of antimony, 1; mutton-tallow, 1; turpentine, 1. These are combined by pulverizing the sulphur, niter, and antimony separately, mixing them by hand, and passing them through a sieve; the tallow is melted over a fire, the rosin is then added, next the turpentine, and afterward the other materials; the whole being thoroughly incorporated by stirring with spatulas, and great care being taken to prevent its taking fire. When the composition becomes of a brown color the fire is permitted to go down, and when sufficiently fluid is poured into the paper cases.

Niepce experimented upon the effects of potassium and benzole, and ascertained that $\frac{1}{2}$ gramme of potassium in 300 grammes of benzole would spontaneously ignite on the surface of the water, burning and spreading over a considerable surface. Petroleum may be substituted for benzole. A solution of phosphorus or chloride of sulphur, in sulphuret of carbon, also spontaneously ignites on exposure to the air.

In-cen′di-a-ry-shell. A hollow projectile charged with incendiary composition, and designed for setting fire to buildings, ships, and other objects. Hollow balls, filled with fire, appear to have been among the earliest projectiles used in warfare after the introduction of the Greek-fire, though these were not fired from cannon; but descriptions are given of balls of fire used by the Saracens in Spain, which seem to correspond closely with modern incendiary-shells. The use of incendiary compounds appears to have gradually become obsolete, as we hear little or nothing of their employment until toward the close of the eighteenth century, hot shot being used as a substitute.

About 1797, Chevallier, in France, invented an incendiary compound, which seems to have been tried to a limited extent by the French government, for filling shells. Since then, many inventors have exercised their ingenuity upon this subject, the principal object being to obtain an inextinguishable composition for charging shells, to be ignited either by time-fuse or by percussion.

The only shells of the incendiary kind generally recognized in modern warfare are CARCASSES (which see).

In-cer′tum. A form of masonry made of a facing of square stones of irregular sizes and a filling of rubble. *Rubble-work.* See MASONRY.

Inch. The $\frac{1}{36}$ of a yard; the $\frac{1}{12}$ of a foot. The yard is the standard in England and in North America. See UNIT.

In′cli-na-tion. (*Compass.*) One of the three elements of magnetic force which are registered at the observatories. The other elements are the *declination* and *absolute intensity.*

The *inclination* or *dip* is the vertical angle of a freely suspended needle which it makes with the horizon. It has a general dependence upon the latitude, but varies from local causes. See DIPPING-NEEDLE.

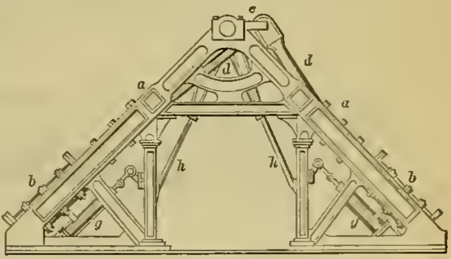
In′clin-a-to′ri-um. The dipping-needle invented by Norman, of London. See DIPPING-NEEDLE, also MAGNETOMETER.

In-clined′-cyl′in-der Steam-en′gine. A form of *direct-action steam-engine,* in which two cylinders are placed in a frame so as to work at an angle to each other, the connecting rods giving motion to the same crank.

It was invented by Brunel, and patented by him in 1822.

a a is a strong triangular frame of cast-iron, within which are fixed the two cylinders *b b.* Mr. Brunel preferred that the angle formed by the axes of the cylinders should be 102°. *d d* are the connecting rods attached to the crank *e,* which gives motion to the paddle-shaft.

Fig. 2662.



Brunel's Inclined-Cylinder Steam-Engine.

The piston-rods are supported upon rollers, which traverse on guide-plates to preserve their parallel motion during the stroke. In the small cylinders *g g* are piston-valves by which the steam from the boiler is admitted to the alternate ends of the cylinder and allowed to escape from the other end. The action of the piston-valve is regulated by the eccentrics on the paddle-shaft. These eccentrics give motion to the rods *h h,* which, by intermediate levers, operate upon the pistons in the small cylinder.

This is one of the numerous devices intended to obviate the use of the beam in marine engines.

In-clined′ Plane. An artificial slope forming an ascent for vehicles ; the climbing passes for pedestrians perhaps hardly deserve the name.

Stevinus, in his work on the principles of equilibrium, 1586, established the fundamental property of the inclined plane, and solved the value of forces acting obliquely. Galileo's treatise on Mechanics appeared a few years later.

In various parts of the old countries of Europe and Asia are the remains of vast engineering works on the main routes of travel and conquest.

It is supposed that the grade on the great canal of Sesostris (1500 B. C.), which united the Red Sea and the Nile, was overcome by a sluice ; probably an inclined plane down which the water ran. The difference in level is but slight, and perhaps on account of the fear of the contamination of the fresh water of the river by the salt water of the sea, it may really have been an inclined plane like that which crossed the Isthmus of Corinth some centuries afterward. The sluice preceded the lock in Europe (see CANAL), and was probably used also in the grand canal of China, built in the ninth century A. D. The canal lock was invented in Italy in the fourteenth century.

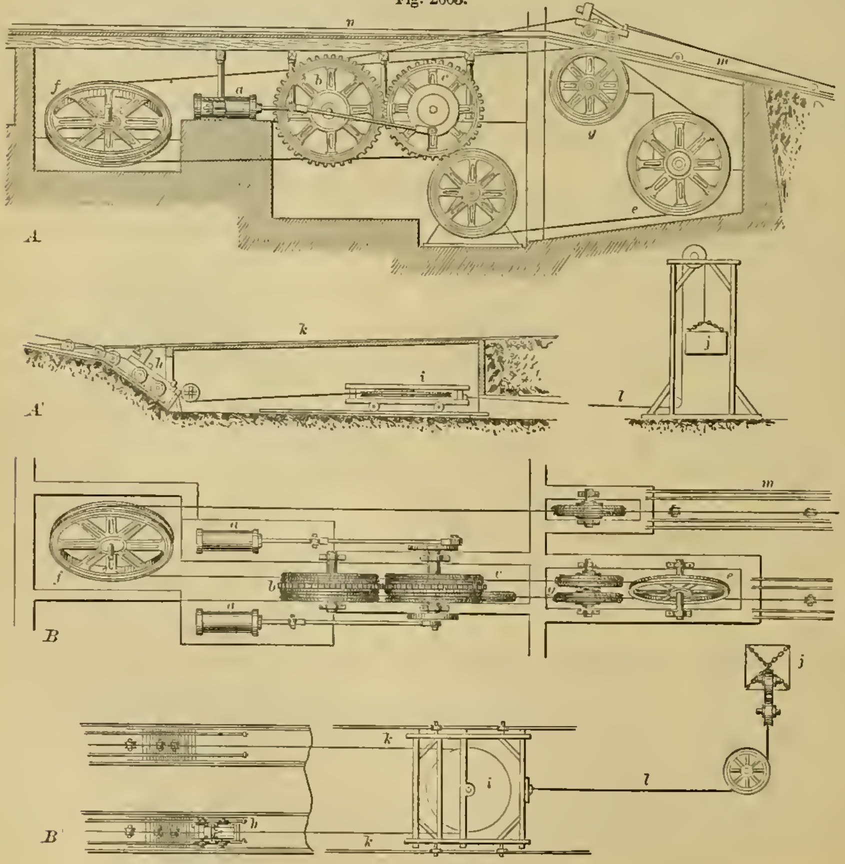
On the Mount Cenis Railroad, which crossed between Savoy and Italy previous to the completion of the tunnel, the elevation is overcome by a series of inclined planes, with mechanical devices to cause a positive grip upon the rails, instead of depending upon frictional contact for the tractile effect of the motor. The railway tunnel has superseded the mountain road.

On the old line of the Pennsylvania Railroad by Hollidaysburg, the reader may have noticed and admired the inclined planes by which the summit and several other gradients were ascended ; stationary engines at the summit of each grade hoisting or lowering the cars by means of ropes. The London and Blackwall Railway was operated in a similar manner, though the road was about level.

The Portage Railway formerly occupied a nearly central position on the main line of the Pennsylvania Canal, between Columbia and Pittsburg, and extended from Hollidaysburg, on the eastern base, to Johnstown on the western base of the Alleghany Mountains, a distance of thirty-six miles ; the total rise and fall on the whole length of the line being 2,571.19 feet. Of this hight, 2,007.02 feet were overcome by means of ten inclined planes, and 564.17 feet by the slight inclinations given to the parts of the railway which extend between these planes. The distance from Hollidaysburg to the summit-level is about ten miles, and the hight is 1,398.31 feet. The distance from Johnstown to the same point is about twenty-six miles, and the hight 1,172.88 feet. The hight of the summit-level of the railway above the mean level of the Atlantic is 2,326 feet.

The machinery by which the inclined planes were

Fig. 2663.



Inclined Plane of Mahonoy, Pennsylvania (Elevation and Plan).

worked consists of an endless rope passing round horizontal grooved wheels placed at the head and foot of the planes, which are furnished with a powerful brake for retarding the descent of the trains. The ropes were originally made $7\frac{1}{2}$ inches in circumference, but were afterwards increased to 8 inches to give them a better bite in the grooves of the wheels over which they passed. Two engines of 25-horse power each were placed at the head of the inclined planes, and were used alternately, week about, the duplication being for the purpose of security in case any accident happened to one of them. The traction rope passed around a horizontal grooved wheel driven by the engine.

The planes were laid with a double track of rails, an ascending and a descending car being attached to the respective ends of the rope at the same time. A safety-brake was attached to each car, which was attached by two ropes of smaller size to the endless rope by a hitch or knot.

Locomotives were used on the intervening levels and slight grades.

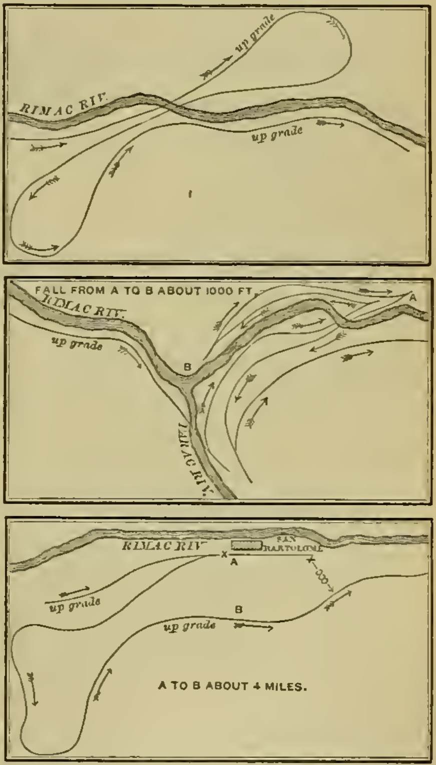
Fig. 2663 shows a side elevation and plan of the inclined plane of Mahonoy, Pennsylvania, up which the cars loaded with coal and other products from the mines of the valley of the Mahonoy are elevated by stationary engines and wire ropes. The length of the incline is about 2,400 feet, and the total elevation about 360 feet. It has two tracks of the usual gage, upon which the wagons ascend and descend alternately. Between each of the tracks are two narrower tracks, with rails about 40 inches apart, and which are traversed by trucks *h*, to which the hoisting rope is attached, and whose duty is to push the wagons traversing the wider track up hill, and also let them down gradually. The wire rope which moves the trucks passes over large pulley-wheels, with grooved faces, one *f* at the top, and the other *i* at the bottom of the plane. The pulley *f* at the top is on a fixed axis, but that at the bottom *i* is on a truck traversing a short track, and held at a certain tension by a rope *l* extending over a pulley on a frame, and with a suspended weight *j* of 3,960 pounds. By this means a regular tension is kept upon the draft-rope, notwithstanding changes of temperature of the wire rope. The same ties support both tracks and the frames of the pulley midway of the tracks which support the wire rope. These pulleys are 50 feet apart, and are from 9 to 14 inches in diameter. The cable is a little over 2 inches in diameter, the lower cable about $1\frac{1}{2}$ inches. The core of the cable is formed of 7 strands, each of which is formed of 7 wires; the exterior surface is 6 strands of 19 wires each. The cable has a spring attachment to the truck. The usual lift is 12 wagons at once. At the foot of the incline the truck runs into a pit below the track, and ascends in the rear of the last car of a train of 10 made up for ascent. In the descent of the empty cars, when the truck runs into the pit, the wagons continue to run by their acquired impetus upon the track *k*, the truck descending on the diving narrow track, as shown at the portion of the figure marked *A′*.

The hoisting apparatus is placed in an underground chamber at the top of the incline, beneath one of the two tracks. It is driven by two horizontal steam-engines *a a*, which turn the large drum *c*, and this is geared to the drums *b*. The drawing cable coming from one of the roads (say the lower one, shown in figures *B B′*), is bent by pulley *g*, and passes over one side of drum *b*, underneath it, and thence between it and drum *c*, then over the latter, encircling one half its periphery, and nearly describing a figure ∞; it then dives, goes under the drum below *e*, under *e*, recurves upwardly over *e*, then again over *g*, following another groove to its former course, the pulley *e* being set obliquely so as to give the rope the lateral deviation. To resume: the rope, passing back over *g*, goes over pulleys *b* and *c*, repeating its figure ∞ course, coming out under *c* and going around *f*, and thence to the car on the upper of the two tracks, as shown in the plan *B*. The pulley *F* is set obliquely so as to change the rope over to the other track. *n* is the level railway at the head of the slope *m*.

The parts have been disjointed for convenience of disposition on the page; the part *A′* belongs at the right hand of *A*, a long intervening stretch of 2,400 feet of wire being understood. The same may be said of the proper position of *B′* at the right of the portion *B*, which is a plan of the machinery at the head of the incline. The steam cylinders are 32 inches in diameter, and 7 feet stroke. The drums make 32 revolutions in a minute, the velocity of the rope being 1,400 feet per minute.

Some magnificent engineering works are to be found among the mountain regions of the world, where the grades are ascended by inclined planes. Among these may be cited some on the Callao, Lima, and Oroya Railway in Peru. The annexed engraving shows portions at Surco, the Parac, and San Bartolome, respectively. They are not "air lines" by any means. The grades are from $2\frac{1}{2}$ to 4 per cent (211 feet to the mile); curves are limited to 400 feet radius.

Fig. 2664.



Plan of Inclined Planes on the Callao, Lima, and Oroya Railway, Peru.

Mr. Meiggs is doing a great work. The western slope of the Andes at this point has no timber, nor for fifty miles on the east side. Oroya is thirty miles east of the summit tunnel, which is 15,200 feet above the level of the sea. At this hight you cannot cook beans in an open vessel, as the boiling-point is not hot enough. The railroad buildings and bridges are of iron, and come from England, as do the rails; the ties are from Oregon, the locomotives and cars from the United States.

The plate opposite is a view of the Furka pass and the Rhone glacier, Canton Valais, Switzerland. The winding road is shown in the view, climbing up a spur of the mountain, which is immediately west of Mt. St. Gothard. See also views in "Lippincott's Magazine," Vol. VIII. p. 324; and London "Engineer," Vol. XXXII., 1871, p. 233.

The longest inclined plane on an artificial road is said to be that from Lima to Callao, which is about 6 miles, and has a descent of 511 feet, or about 1 in 60.

The ascent from the Konkan, or flat country of Bombay, by the Western Ghauts to the table-land of the Deccan, is known as the Bhore Ghaut incline, in which the railway rises from the plain 2,000 feet in a series of steps 16 miles in length.

The Righi Railway in Switzerland rises by a locomotive of peculiar form 1,170 feet in traversing 4,700. The boiler, furnace, and carriage are inclined so as to present a level floor on the slope.

The inclined plane or railway of Mt. Washington is familiar to many tourists.

In this connection the following data may be useful: —

The pressure on a level pike against the collar is, say, $\frac{1}{30}$ of the load. An ascent of 1 in 35 would double the draft, and may be a suitable maximum ascent. The French maximum is 1 in 20. Telford's maximum was 1 in 30. Simplon, Italian side, average 1 in 22; Swiss, 1 in 17.

Angles. Degrees.	Inclination.	Feet per Mile.	Angles. Degrees.	Inclination.	Feet per Mile.
½	1 in 115	46	0° 28′	1 in 125	42
¾	1 in 76	69	0° 35′	1 in 100	53
1	1 in 57	92	1° 9′	1 in 50	106
1½	1 in 38	138	1° 16′	1 in 45	117
2	1 in 29	184	1° 26′	1 in 40	132
2½	1 in 23	231	1° 38′	1 in 35	151
3	1 in 19	277	1° 55′	1 in 30	176
4	1 in 14	369	2° 18′	1 in 25	211
5	1 in 11	462	2° 52′	1 in 20	264
			3° 49′	1 in 15	352
			4° 24′	1 in 13	406
			5° 43′	1 in 10	528

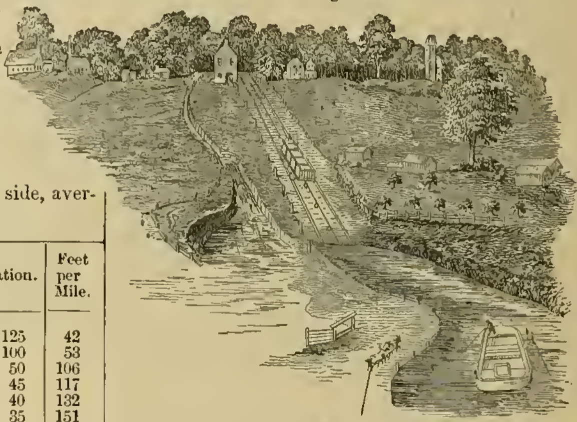
Inclined planes were used for raising the galleys and triremes of the Greeks from the waters of the Corinthian or the Cenchreæn Sea, for transportation across the Isthmus of Corinth. This was the *Diolcos* or drawing-place, 40 stadia or 5 miles in length, the narrowest passage between the two gulfs. A canal was attempted at this point by Julius Cæsar, Caligula, Nero; the ridge of native rock defeated all the attempts; it is very hard, and can hardly be worked without blasting. The incline was again used in the wars of the Genoese and Turks.

Inclined planes and *lifts* for raising and lowering canal-boats from one level to another, as a substitute for locks, are mentioned by Smeaton in 1774. Both systems are used on the English canals, in the neighborhood of Taunton; 80 feet of rise are overcome in this way.

The *inclined plane* has a steam-engine on the summit, which, by means of a drum and chain, hauls up the cradle containing the boat.

The *lifts* are worked by one attendant, who can raise or lower a boat from one level to another. There are two lock-chambers, over which is a lofty frame, having large wheels and chains, by which are suspended the cradles, into which the boats are floated when they are to be raised or lowered. See LIFT.

Fig. 2665.



Inclined Plane, Morris and Essex Canal.

On the Morris and Essex Canal, which crosses the State of New Jersey, connecting the Hudson and Delaware Rivers, there are, or were, 13 inclined planes, up which the canal-boats are hauled, the grades being thus ascended and descended without locking. The summit level at Stanhope is 900 feet above tide-water, and the changes of grade are sudden and frequent. A track of heavy rails is laid on the inclined plane, which has a grade of about 15°, and on this the cradle containing the boat ascends at the rate of five or six miles an hour. At the summit is the motor, consisting of a water-wheel, driven by the water on the upper level. The wheel is connected to a shaft carrying a drum, on which is wound a wire rope about two inches in diameter, and connected at either end to the cradle which contains the boat, and which forms a car for its conveyance. This car is a heavy frame running on flanged wheels, and descends a sufficient distance into the water to enable a boat to float into it, where, being secured, the car and boat ascend or descend the inclined plane together. From the forward end of the car the wire rope passes over anti-friction rollers between the rails of the track to and around a large submerged wheel some 100 feet distant from the summit, thence over the drum and other friction-rollers by the side of the track to another submerged wheel at the foot of the plane, around which it passes, and is attached to the rear end of the car. The boat is made in sections, to enable it to accommodate itself to the inequalities of the track when passing over the summit.

Arriving at a plane, the boat is drawn into the car in the order of its arrival, the team is unhitched, the tow-rope coiled on deck, the boat secured to the car by hawsers, and its two sections disconnected by a lever which pulls out the bolt uniting the hinge. The blade of the rudder is then raised out of harm's way, and the signal is given for the engine to start. After passing the summit the brakes are put on, and the car descends into the water where the boat floats out of it, and the tow-rope is again attached. In one place the canal has a fall of 200 feet, 80 of which are overcome by a single plane of 800 feet length, and the remainder by means of locks.

INCLINED PLANE.

THE RHONE GLACIER, FURKA PASS

See page 1176.

A mode by which canal-boats are enabled to ascend inclined planes while preserving their usual horizontal position was invented in England, but it is not known to the writer whether it was ever successfully put in practice. The carriage which received the boat had a forward pair of wheels which ran upon one double track, while the rear end (to the ascending boat) was supported by other wheels, which ran on another track set at such a distance outside of and higher than the former as to give the required level position to the carriage. The inclined boat-carriage is also shown in Day's United States patents for inclined planes and cradles for canal-boats.

In-cli-nom′e-ter. 1. An instrument to detect the inclination or dip, the vertical element of the magnetic force. Many delicate instruments have been constructed for this purpose, but the best known is the DIPPING-NEEDLE (which see).

2. An instrument to measure the slope of an embankment, slope, or incline. It may have an alidade with a level; an arc, and a base-piece which lies on the slope. A *batter-level.*

In-crease′-twist. (*Rifling.*) A rifle-groove which has an increased angle of twist as it approaches the muzzle, allowing the projectile to be easily started and giving it an increased velocity of rotation as it proceeds.

Rifling was known in the seventeenth century; its inventor and date being unknown. Mere grooved barrels, without spirality, were used two centuries earlier.

The increase twist is credited to Tamisier, and dates but a few years back.

In-crus-ta′tion. 1. (*Masonry.*) A facing or covering to a wall of a different material from that of which it is mainly built, such as marble or stone.

2. A thin sheet of wood applied upon a wooden surface. See VENEERING.

3. (*Steam-engine.*) The deposit from the water adhering to the inside of a boiler.

As nothing but pure water enters into the composition of steam, it has long been a problem in steam-engineering to get rid of impurities in water which it is found necessary to use in steam-boilers. Among these impurities may be mentioned the salt in sea-water, lime in the water of limestone regions, and minerals in many forms, which are often found in water supposed to be pure until thus tested.

The accumulation of salt in a marine boiler would soon fill it, if there were no way for its removal. In practice it is generally "blown off," when the *salinometer* indicates a certain point of saturation.

Lime in some forms incrusts a boiler very rapidly, having been known to form a *scale* several inches in thickness in a few days. This scale is a poor conductor of heat, and a large proportion of the products of combustion are lost by its interposition. It also weakens the boiler, and has been the cause of many explosions.

Condensers are used to supply pure water to boilers. See CONDENSER.

Feed-water heaters have a purpose, besides utilizing waste heat, to compel the deposition of impurities before the feed-water reaches the boiler.

Mechanical agitators, beaters, scrapers, etc., are often employed to remove crust from a boiler.

Chemical treatment of feed-water, or of water in the boiler, is a matter which has received much attention from engineers and scientists. Sawdust acts both chemically and mechanically to prevent incrustation, the tannic acid it contains uniting with the lime to form tannate of lime, which deposits itself as a slimy body. Clay has sometimes given good results, but sand is almost always present in some quantity, though small, and, if it passes over in priming, is very detrimental to the valve-faces, the cylinder, and the piston. Starch and sugary substances have the effect to clarify some waters, the viscid character of the glucose preventing agglomeration of the foreign matters, and forming scum instead of crust. Fatty bodies, tar, and graphite tend to prevent adhesion. The nature of the water to be treated determines the substance which shall be used.

Scott's English patent, 1828, describes a mode of catching the deposit which forms the incrustation by placing pans or trays in the boiler; these intercept the falling deposit.

Taylor's English patent, 1830, has a sediment-trough the length of the boiler, and forming a narrow chamber below the same, out of contact with the fire. The contents of this chamber are occasionally blown out, carrying the sediment.

To avoid the expenditure of space in stating at length the various materials which have been placed in steam-boilers to retain the mineral particles in suspension, or to prevent their adherence to the boiler, it may be stated that they consist of —

Acids, —
  Acetic.
  Hydrochloric.
  Muriatic.
  Nitric.
  Oxalic.
Alkalies.
Ammoniacal salts.
Animal fats, —
  Marrow, etc.
Arsenical salts.
Ashes.
Barks in great variety Ground
Baryta.
Black-lead.
Bones. Ground
Borax.
Bran.
Broom-corn.
Burgundy-pitch.
Camphor.
Carbonates in variety.
Caustic alkalies.
Charcoal.
Chlorides in variety.
Clay.
Coal-tar.
Copper. Salts of
Copper scraps.
Cream of tartar.
Creosote.
Cutch.
Decoctions of bark.
Dextrine.
Electric devices.
Fatty oils.
Felt.
Fibrous materials.
Flaxseed.
Galvanizing devices
Gambier.
Gas-tar.
Glass. Broken
Glue.
Graphite.
Gravel.
Gums in variety.
Hay
Horns. Internal portions of
Hydrocarbons.
Iron. Salts of
Iron scraps.
Isinglass.
Kerosene.
Lampblack.
Lead. Salts of
Leather scraps.
Leaves in variety.
Lime.
Lime-paint.
Linseed-cake.
Linseed-oil.
Logwood.
Malt.
Meal.
Metal in strips or scraps.
Molasses.
Moss.
Mucilage.
Muriates in variety.
Nutgalls.
Oak-bark and sawdust.
Ochre.
Oils in variety.
Oxalates in variety.
Oxides in variety.
Paints in variety.
Peat.
Petroleum.
Phosphates in variety.
Pitch.
Plants of various kinds.
Plumbago.
Potash.
Potatoes.
Resins.
Sal-ammoniac.
Sand.
Saponaria.
Sawdust of various woods.
Shells. Ground
Soap.
Soda.
Soda-ash.
Soot.
Sponge.
Starch.
Stones.
Sugar.
Sulphates in variety.
Sulphur.
Sumac.
Tallow.
Tan-bark.
Tannin.
Tar.
Terra-japonica.
Tin. Salts of
Tobacco.
Turf.
Turmeric.
Urine.
Valonia.
Vegetable dyes.
Voltaic devices.
White-lead.
Wood-fiber.

In′cu-ba-tor. A device for hatching eggs by artificial means.

The hatching of poultry by artificial heat is not mentioned by Herodotus, but is described by Diodorus Siculus as an ancient practice. The ancients obtained the heat by the fermentation of manure; the modern Egyptians by the regulated heat of ovens.

The ordinary domestic fowl is a native of India, and is neither mentioned in the Old Testament nor depicted on the paintings of Egypt. It was known in Palestine at the Christian era, and is supposed to have been introduced by the Romans into the countries they subjugated; perhaps earlier by the Persians, but this does not clearly appear. They were common in Greece.

The references to eggs in the Old Testament refer to those of wild birds, such as ostriches and partridges. That in Luke no doubt was the ordinary hen's egg. The word, in the singular or plural, occurs but twice in the Old Testament, five times in the New.

The business of egg-hatching is conducted by the Copts, who carry it on in Upper and Lower Egypt and pay a license to the government. A building containing from 12 to 24 ovens is called a *maamal*, and its charge is 150,000 eggs. An official report for 1831 gives for Lower Egypt 105 of these establishments, using 19,000,000 eggs, of which 13,000,000 produce chickens. This saves the valuable time of 1,500,000 hens for three weeks of inactivity and several succeeding weeks of care and scratching, enabling them to devote their undivided attention to the other duties of maternity, egg-laying and cackling.

The proprietors of an oven collect the eggs from the peasants in the vicinity. The eggs are placed on mats strewed with bran, and are changed to positions nearer to or farther from the heat of the fire-chamber till the expiration of six days, when they are tested by a strong sunlight for signs of the formation of the chicken; four more days in the warmest position, five days in a closed chamber, and they are then spread separately over the surface of the mats, being frequently turned and changed from one part of the mats to another during 6 or 7 days, outside air being carefully excluded. They are frequently tested for signs of life, the test being greater coldness than the eyelid of the attendant. The chickens appear within 21 days, but some with thin shells hatch earlier. The usual number that succeed is two thirds, of which half belong to the peasants and half to the proprietors of the oven.

The size of the building depends on the means of the proprietors; but the general plan is usually the same, being a series of eight or ten ovens and upper rooms, on either side of a passage about 100 feet by 15, and 12 in hight. The thermometer in any part is not less than 24° Reaumer (86° Fah.); but the average heat in the ovens does not reach the temperature of fowls, which is 32° Reaumer. Excessive heat or cold are equally prejudicial to this process, and the only season of the year at which they succeed is from the 15th of Imsheer (23d of February) to the 15th of Baramoodeh (24th of April), beyond which time they cannot reckon upon a sufficient percentage to make it a paying business.

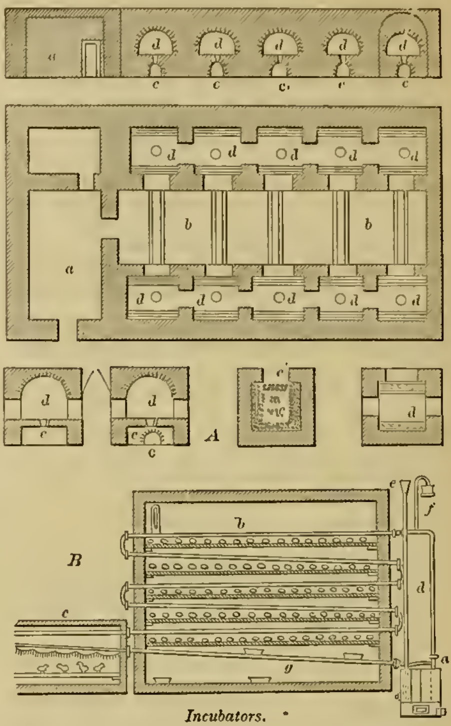
The illustration *A* (Fig. 2666) shows the modern Egyptian oven for hatching eggs.

a is the entrance room, and *b* the passage between the rows of ovens on each side. The chamber *c* for the eggs is below the one *d* in which the fires are made in troughs alongside the walls, the heated air passing to the chamber below by a hole in the floor dividing the two apartments. The illustration gives several horizontal and vertical sections, the entrances to the egg-chambers showing in the upper view at *c*. The upper chambers are connected.

The ancient Egyptian incubators are referred to by Aristotle, Diodorus Siculus, and Flavius Vopiscus.

Bonnemain's incubator *B* (A. D. 1777) is heated by hot water. *a* is the boiler; *b*, a building for holding the eggs on shelves; *c*, a coop for holding the chickens; *d*, tube for circulating the hot water; *e*, a supply funnel; *f*, a safety tube. The hot water rises from the boiler into tube *d*, thence follows the sinuous course of the tube above and below each shelf, and into the chicken-coop, eventually discharging into the boiler again by the pipe *g*.

Fig. 2666



Incubators.

There is some difference in temperature in the interior of the box as the convoluted pipe parts with its heat sufficiently to establish a circulation in the pipe.

The force of the circulation is in the ratio of the difference between the temperature of the water, passing out of the calorifère and re-entering it; any unusual degree of coldness in the lower part of the box will thus react, and increase the speed of the circulation, the normal tendency of the scheme being towards equalization.

The point to be regulated is the heat of the furnace, and this is accomplished by a thermostat, founded upon the unequal dilatation by heat of different metals. A compound metallic bar exposed to the heat of the chamber warps when the heat exceeds the medium, and draws upon a wire connected to the door of the ash-pit, and thus regulates the draft.

Pans of water secured the proper humidity of the air.

Periods of incubation; temperature, 140° Fah.

Swan	42 days.	Peafowl	28 days.
Goose	35 "	Duck	28 "
Hen	21 "	Pigeon	14 "
Turkey	28 "	Canary	14 "

In-dent′. 1. (*Carpentry.*) A notch, as in scarfing timbers together.

2. (*Printing.*) The blank space or *set-in* at the commencement of a paragraph.

In-den-ta'tion. (*Architecture.*) A zigzag molding. The shark's tooth molding. *Denticulation.*

In-dent'ed Chis'el. A boring-chisel whose face is in steps.

In-dent'ed Line. (*Fortification.*) One consisting of alternate salient and receding angles, each face forming a flank to its neighbor.

In-dent'ed Par'a-pet. (*Fortification.*) One whose interior slope has vertical recesses in which men may stand and fire along the front of the work.

In'de-pen'dent Piece. (*Shipbuilding.*) The main piece of the *head* or beak-shaped projection from the stem of a vessel. See STEM.

In'de-pen'dent Sec'onds-watch. A watch in which the action of the center seconds-hand is independent of the regular going works of the watch. It has two separate trains of wheels and separate springs, so that the regular time may be maintained when the center seconds-hand is stopped by pressing the stop-pin on the outside of the case.

The center seconds is set in conformity with the other works by a *square* at the back of the case.

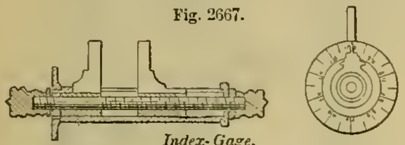
For great nicety in timing, quarter and fifth second watches are now made, and are capable of being stopped at the said fractional parts of a second.

In'dex. 1. A pointer, as the hand of a watch or clock, a finger or arm of a balance or measuring apparatus which moves along a graduated scale, or in relation to a line or central mark.

2. A brass rule accompanying the plane-table, furnished with perpendicular sight-vanes at each extremity. An *alidade.*

In'dex-gage. An instrument having jaws whose distance apart is indicated by a pointer and dial, or other means. In the example, the body to be measured is placed between the jaws, which are brought in contact with the opposite sides. The thirty-seconds of an inch are indicated by the jaw on the scale on the cylinder, and the hundredths of a thirty-second are indicated by the hand on the dial.

Fig. 2667.



Index-Gage.

In'dex-glass. A mirror at the center of motion of the index-arm of a quadrant or sextant, which moves with the index, and from which a ray of light from one of two given objects (one of which is, say, the sun) is reflected to another mirror, called the *horizon-glass*, fixed to one of the arms, and thence to a sight-hole in the other arm. See QUADRANT; SEXTANT.

In'dia-ink. A composition of lampblack and size. Said to have been formerly made from the pigment of the cuttle-fish. The ink of the Chinese scribe, used with a brush.

In'di-an Steel. A fine kind of steel, made in Southern Asia direct from the ore, and known as *wootz.* The *natural* steel of India.

In'dia-pa'per. The name given to a paper made with one exceedingly fine surface, and used for taking the finest impressions of steel, steel-plate, and wood engravings. It is made by the Chinese from the inner bark of the bamboo. It is imported in sheets 25 x 26 inches. The Chinese also make paper of the barks of the elm and mulberry, of the cotton-tree, hemp, wheat-straw, rice, and rice-straw. See WOOD-PAPER.

In'dia-rub'ber. India-rubber in the crude state is prepared for manufacture by grinding the sheets in water, for the purpose of cleansing it. After this it is dried and subjected to the tearing action of toothed rollers, one of which revolves faster than the other. At this stage the vulcanizing material, consisting of ½ ounce of sulphur or more to the pound of rubber, according to the required hardness, is added and thoroughly incorporated. Various other ingredients, as sulphate of zinc, whiting, plaster of paris, lampblack, pitch, etc., in addition to the sulphur, are also employed for the purpose of hardening. The selection of these depends on the peculiar ideas of the manufacturer and the destined application of the material.

In making boots and shoes the rubber is passed, in contact with cotton cloth, between heated rolls which rotate at different speeds, and is forced between the interstices of the cloth, to which it becomes firmly united. In some cases the rubber is drawn, either with or without the cloth, through rolls of equal speed, to a thickness suitable for the soles or uppers of shoes. The sheets thus formed are cut up, by suitable dies, into the proper forms for the soles and uppers, which are afterward cemented on a last by a solution of rubber dissolved in benzine. At this stage a coating of linseed-oil varnish is applied with a brush, and the shoe subjected to a heat of about 280° Fah., when the operation is complete.

In making hose or tubing, the rubber or rubber cloth is wrapped around a tube until the desired thickness is attained, and placed in a steam-heater at a temperature of about 280° Fah., which partially fuses the compound, causing the layers to unite. It is then removed from the heater and the tube withdrawn.

Belting is formed by laying together a sufficient number of layers of the vulcanized gum or gum-cloth and subjecting them to the action of a flat press at a heat of 280° Fah. Additional hardness is attained by the use of a larger proportion of sulphur and the application of greater heat.

The operation of uniting several layers of the material is, however, performed with much more expedition by the use of a steam cylinder-press.

Previous to 1821, it is said that india-rubber had only been brought to this country as an article of curiosity, molded into various fancy forms, as alligators and other reptiles. In that year a pair of what appeared to be solid models of shoes were brought home by a sea-captain, who presented them to an ingenious boy. Curiosity led him to cut into them at the instep, when he found a clay mold inside, this he removed, and finally, by dint of heating and stretching, adapted them for wear. This becoming known, led to the importation of the native shoes made upon clay lasts. See CAOUTCHOUC.

No process has yet been devised for restoring old rubber to the condition in which it was previous to vulcanization. It is, however, extensively used for mixing with new raw material in the manufacture of all kinds of rubber goods. By steaming and rolling it is reduced to a semi-plastic state, and in this condition it is applied to coarse fabrics and used for heel stiffening, a purpose for which it is well adapted. Pure rubber is but little used except for artists' purposes.

In'dia-rub'ber, Ar-ti-fi'cial. A compound of chloride of sulphur, oil, and collodion. In its plastic state, it is easily molded, and hard and durable when well set. It can be made of any color, and is susceptible of a high polish. An English compound consists of linseed-oil oxydized on glass plates by repeatedly dipping the plates in the oil, and allowing it to dry each time. The film thus obtained is removed from the glass, crushed, and worked by the mixing rolls, a small quantity of gum-shellac being added to give it the proper cohesion. The substance thus obtained is very much like rubber, and can also be vulcanized.

In′dia-rub′ber Bind′ing. A mode of binding books patented in England by Hancock, in which the usual operations of stitching, sawing, and hammering the back are dispensed with. The sheets are placed in a former to give the proper curvature to the back, and are then secured by packthread. They are next placed in a press, with their backs slightly projecting, and several coats of a solution of india-rubber applied, after which the bands are attached by means of the india-rubber solution, and the cover put on in the usual way.

In′dia-rub′ber Cloth. (*Fabric.*) Fabric covered with india-rubber. The latter is cleaned, triturated with sulphur, dissolved in benzine, or other solvent, and spread upon fabric by rolls.

In′dia-rub′ber Rolls. Rolls whereby rubber-cement, mixed with sulphur, and dissolved in benzine or other solvent, is spread upon fabric.

Some of these rolls spread the cement by a frictional action, the heated spreading-roll traveling faster than the cloth-carrying roll, and so grinding the gum into the cloth.

Gum mixed with paint is spread in a layer of the required thickness upon fabric, by rolls of even motion; and the rubber fabric is then cut into pieces according to pattern, for boot or shoe soles, etc.

In′dia-rub′ber Spring. The first known use of india-rubber for springs is in Lacy's English patent of 1825. He employed blocks of rubber with interposed plates of iron. Melville, 1844, obtained a patent for hollow spheres of rubber, enclosing air and separated by disks of wood or metal, the whole enclosed in iron cases. In 1845, Walker and Mills patented rubber bags filled with air and enclosed in a case for use as springs. Fuller, 1845, cylindrical rings of rubber having perforated disks between them, and a guide-rod passing through the whole. These had a tendency to swell out at the center under pressure, breaking or injuring the material. To remedy this defect, Spencer, 1852, 1853, formed the rubber rings of the shape which they would assume under pressure, and surrounded them with an annulus of iron. These have been used as buffer, bearing, and draw springs for railway-carriages with satisfactory results. (See also CAR-SPRING.) Eaton, 1856, employs alternate thin plates of rubber and metal, adapted for springs of great resistance and little flexibility. Hodge, 1852, patented a compound spring composed of a block of rubber inclosed in a two-part casing, the upper part surrounding the lower, and rising or falling according to the amount of compression of the rubber placed on each end of a steel spring. Scott, 1852, blocks of rubber placed over the center of a steel spring. Bridges, 1857, employs wooden instead of iron surrounding rings to confine the rubber blocks, and dispenses with the central rod. Fuller, above referred to, employs for suspension springs round cords, wound at a considerable tension around two metallic rollers or reels. During the Russian war, a number of mortar-boats were built by the British government, each carrying a 13-inch mortar. In order to diminish the shock occasioned by the recoil of such heavy ordnance on these small vessels, twenty very strong rubber rings were placed under each mortar-platform. These were tested by actual service at Sveaborg, in the Black Sea, and afterward in China, with very satisfactory results.

In′dia-rub′ber Thread. This is prepared by cutting a sheet into filaments, which are then stretched in a hot atmosphere or hot water; the process being several times repeated with alternate coolings. It is glazed by agitating with French chalk-powder.

In′di-ca′tor. A marking or recording instrument, or one which makes a visible sign by which the condition of the object or apparatus to which it is attached may be observed. The various uses to which indicators are applied may be suggested by the following: —

Door-indicator.
Leak-indicator.
Leeway-indicator.
Shoal-indicator.
Speed-indicator.
Station-indicator.
Steam-indicator.
Street-indicator.
Tourists'-indicator.
Weather-indicator.

Besides these compound forms, the term has also many other applications; as, —

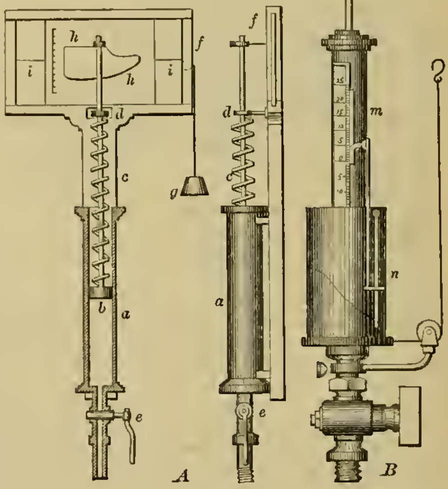
The gradient post of a railway.

A gage in a blast furnace to indicate the proper hight of a charge.

The principal meaning of the word, however, concerns the instrument by which working steam records its pressure.

1. (*Steam-engine.*) An instrument which registers the relative amounts of steam pressure exerted on the piston at each portion of its stroke. It was invented by Watt.

Fig. 2668.

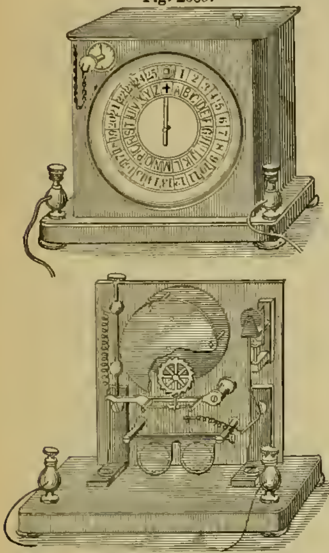


Steam-Indicator.

Watt's indicator *A* consists of a cylinder *a* in which works a piston *b*, that is (when the cylinder is not in communication with the steam-cylinder) maintained near the midlength of the indicator cylinder by the spiral spring *c*. The piston-rod works through a collar *d*, and has at its upper end a device for holding a pencil. Communication with the steam-cylinder is effected by the cock *e*, and when steam is admitted through this it causes the piston to rise, compressing the spring with a force equal to the excess of the steam pressure above that of the atmosphere. When a vacuum is produced by the condensation of the steam in the cylinder, a corresponding vacuum is formed in the indicator, causing the piston of the indicator to be forced down by a pressure equal to the excess of the atmospheric pressure over that of the uncondensed vapor in the cylinder. In order to register this, a small square movable frame *f* is placed at the upper end of the indicator, in which a card is inserted. One end of the frame is attached by a cord to some movable part of the engine, and the other has attached a string and weight. When the piston rises, the card is drawn to the left, raising the weight *g*, which, when the piston descends, draws back the card to its first position. An alternate reciprocating motion of the card is thus kept up. Thus as the piston of the indicator rises and falls, its pencil traces on the card a line whose vertical ordinates represent the actual pressure, and whose length corresponds to the length of stroke of the piston. The *diagram* thus formed is shown at *h h*. All above the median line *i i* indicates the pressures on the piston, and all below it the vacuum, or the difference between the pressure of the uncondensed vapor and that of the atmosphere.

B (Fig. 2668) shows a modification of the above, which is provided with an upright graduated cylinder *m* surrounded by a larger cylinder *n*, upon which the registering paper is placed. This has a partial rotation back and forth by means of a cord connected to some part of the engine which has a reciprocating motion and a spring which restores it to its first position.

Fig. 2669.



Telegraphic Indicator.

2. (*Telegraphy.*) The dial and mechanism of a dial telegraph. Fig. 2669 shows Breguet's.

The face has the letters and figures arranged in two concentric circles. The motion of the hand is continuous in one direction, advancing one letter at each closing of the circuit. This movement is effected by clock-work driving a scape-wheel, the teeth of which are alternately engaged and released upon opening and closing the circuit, by means of a pawl operated intermediately from the armature of the electro-magnets.

3. (*Optics.*) A finger working in the field of a microscope to point out a special object within the field of view.

4. A dynamometer or power measurer.

In'di-ca tor-card. A card containing a diagram drawn by the working steam by means of an INDICATOR (which see).

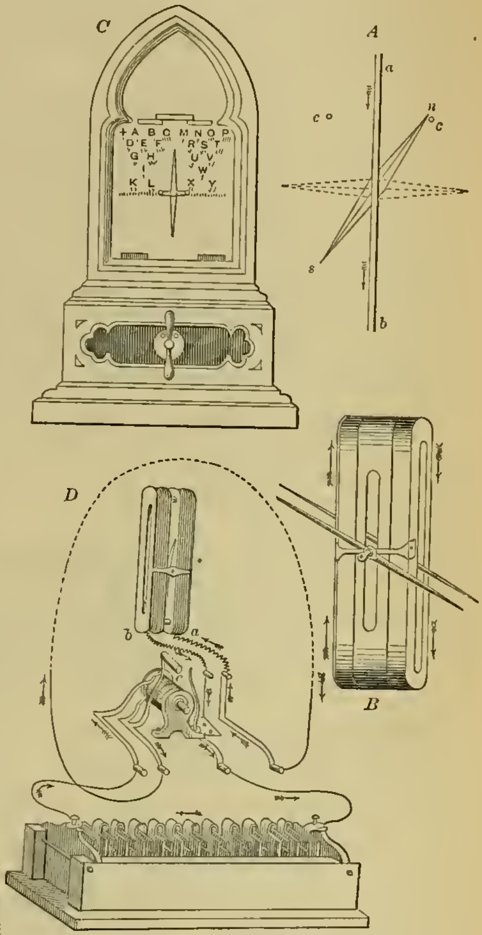
In'di-ca'tor-tel'e-graph. An electric telegraph in which the signals are given by the deflections of a magnetic needle.

It was about 1819 that Œrsted of Denmark made the discovery that if a magnetic needle, free to turn about its center, were placed near to and parallel with a wire, then, on causing an electric current to pass through this wire, the needle would be deflected to an angle proportioned to the force of the current.

In Fig. 2670, *A*, *a b* being the wire and *n s* the needle, the passage of a current in the direction of the arrow deflects the needle to the position indicated, the stops *c c* limiting its motions. When the direction of the current is changed, the *n* (north) pole of the needle is deflected in the other direction. By a preconcerted system, a given number of movements to right, left, or a certain number in alternate directions, a system of indications representing letters and numerals is obtained, as will be explained presently.

In practice, a pair of needles, rendered astatic (see ASTATIC NEEDLE), are used and placed in conjunction with a coil of wire, which multiplies the transmitted current so as to cause a much greater deflection than that due to the line current itself, as shown at *B*, which consists of a frame around which are wound several hundred feet of fine copper wire. The needles are mounted on the same axis, one within and one without the coil, and the outer one is exterior to the dial-plate of the telegraph.

Fig. 2670.



Indicator-Telegraphs.

Following the discovery of Œrsted, Ampère in 1820 suggested that the needle moved by the galvanic current should be used for conveying signals, and the idea was elaborated in lectures by Ritchie in 1830.

Baron Schilling, in Russia, in 1832, contrived a complicated instrument on this principle, in which a separate circuit and needle was employed for each letter and numeral, 36 needles being employed, each being excited by a current of electricity as the occasion required.

Cooke and Wheatstone's indicator-telegraph, patented June 12, 1837, is the most prominent and best example of this class of instruments, and is generally used in England.

America and the continent of Europe employ the much superior system of Professor Morse, introduced about the same time.

C is a front and *D* a rear view of Wheatstone's instrument. In this the right and left hand terminals *a b* of the multiplier are each connected to the line-wire, which is, when a message is not being transmitted, thrown out of connection with the local battery.

The circuit is opened and closed by means of a drum *c*, at each end of which is a stout steel wire forming respectively the positive and negative poles of the battery; these wires, on turning the drum, are brought in contact with springs connected with the line-wire, by which either a positive or negative current is transmitted, causing the needle at the receiving station to be deflected to the right or left accordingly.

The letters of the alphabet and other signals are indicated by the number of beats made by the needle, some to the right and others to the left; thus "D" is represented by a beat to the right and one to the left. "L" requires four beats, in the following order, right, left, right, left, and so on for other letters.

The double-needle telegraph on the same principle is much more expeditious, and has been extensively employed in England, but requires two line-wires. See ELECTRO-MAGNETIC TELEGRAPH.

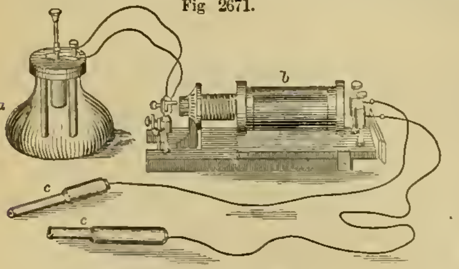
In-di-gom'e-ter. An instrument for ascertaining the strength of indigo.

In'di-go-mill. A four-sided iron cistern, cylindrical or rounded at bottom, resting upon gudgeons in a wooden frame. It has an iron lid with two leaves, between which works a rock-shaft receiving a vibratory motion from a crank, and imparting a swinging motion to a frame carrying six rollers, three on each side, which triturate the indigo to a fine paste; when sufficiently ground, the paste is drawn off by a stop-cock.

In-duc'tion. (*Electricity.*) That effect of an insulated electrified body which tends to produce an opposite electrical state in surrounding bodies.

In-duc'tion-coil. A compound coil by which voltaic or dynamic electricity is converted into static electricity or electricity of high tension. The discoveries of Faraday, Henry, Bequerel, and others led the way to the invention of the induction-coil, and it is believed that the first practically useful device of the kind was contrived by the late Dr. Charles G. Page of Washington.

Fig 2671.



Induction-Apparatus.

Ruhmkorff, of Paris, having made many instruments of the kind and contrived various improvements, the instrument is now very generally called by his name.

It consists essentially of an inner coil of coarse wire surrounding a core of soft iron rods, and connected with the poles of a voltaic battery. It is itself surrounded by, though insulated from, a coil of copper wire composed of a great number of convolutions, and connected with the discharging conductor. By opening and closing the circuit with great rapidity, which is effected by means of the AUTOMATIC CIRCUIT-BREAKER (which see), a nearly continuous current is produced. To intensify this, the return current from the primary coil produced by the disruption of the current is passed through a CONDENSER (which see); the effect may be increased by breaking the current under crude petroleum or other non-conducting medium.

The induction-coil is practically applied to many purposes in the arts, and in the treatment of diseases by electricity. Fig. 2671 is an instrument of this kind. The battery *a* consists of a single Grenetts cell, supplied with dilute sulphuric acid and bichromate of potash. One zinc and two carbon plates compose the elements, the former of which is lifted clear of the fluid when not in use. A vibrating spring opens and closes the circuit. *b* is the coil, and *c c* two dischargers, by means of which the current is directed to any part of the person.

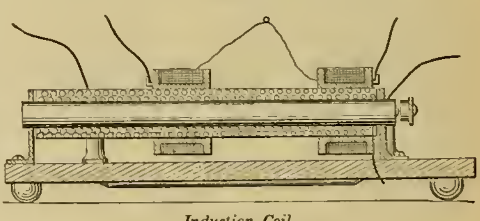
In the largest class of induction instruments, electricity of very high tension is produced.

One belonging to the Stevens Institute of Technology weighs 160 pounds; the primary wire is 200 feet and the secondary about 44½ miles in length. This projects a spark 21 inches in length and capable of penetrating glass three inches thick.

Another, at the Polytechnic Institute of London, has its primary wire 3,777 yards long, and weighing 145 pounds. The induction-wire is 150 miles long. This projects a spark 29 inches long, penetrating 5 inches of plate-glass. Its calorific effects are very intense, the most refractory substances, as platinum, being fused with ease.

In Kidder's induction-coil, the secondary helix or helixes are adjustable, so that they may be either concentrated at the central or neutral portion of the primary coil or placed toward the poles, so as to vary the power of the induced currents. See Noad's "Inductorium."

Fig. 2672.



Induction-Coil.

Electrical machines of great power are now constructed on the induction principle.

In-duc'tion-pipe. (*Steam-engine.*) The pipe which leads the live steam to the cylinder.

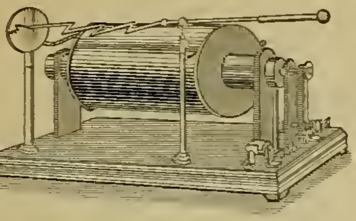
In-duc'tion-valve. The valve which controls the entry-port for live steam to the cylinder of an engine.

In-duc-tom'e-ter. An instrument for ascertaining the force of electrical induction.

In-duc-to'ri-um. (*Electricity.*) Another name for the induction-coil as adapted for the display of the electric spark. The instrument shown was constructed for the Royal Polytechnic Institution of London, and gave a spark 18 inches in length.

In Ritchie's instrument, the *secondary* consists of coils wound up into flat disks the thickness of the wire, and these are piled up against each other upon the primary coil, the separate coils being separated by thin disks of gutta-percha. The current is made to reverse from the center to the circumference and conversely, to and fro, as many times as there are coils upon the core.

Fig. 2673.



App's Inductorium.

In-fe'ri-or Let'ter. Letters cast with their faces low down on the shank ; as 4_b.

In-flect'ed Arch. 1. A reversed or inverted arch.

2. An arch, the curve of whose flanks is reversed near the crown, so as to terminate in an acute angle. (*c*, Fig. 305.)

In'gate. The aperture in a mold at which the metal enters. It then passes by *runners* to the spaces made vacant by the withdrawal of the pattern. The *ingate* is technically called the *tedge*, *gate*, *geat*, or *git*. The latter two are corruptions of *gate*.

In'got. A cast mass of steel from the crucible.

A cast mass of gold or silver, more or less pure, for *assaying*.

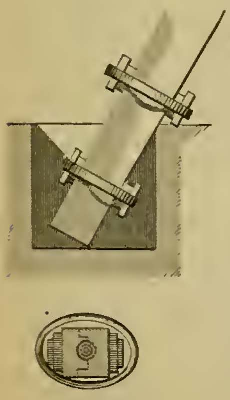
A cast block of gold, silver, or a properly proportioned alloy of either, for *coinage*, or for working into other forms, as watch-cases, etc.

The crude ingot of gold or silver, after being assayed and brought to the standard fineness (varying according to its purpose), is cast into *bars* ready for rolling, if for coin.

Gold and silver are run into *ingots* or *bars*.

A transposition of *ingot* made *nigot*, which passed into *nugget*.

Fig. 2674.



Ingot-Mold.

Iron is cast into *pigs*.

Steel is cast into *ingots*.

Copper at one stage into *bricks*, at another into *pigs*.

Tin is run into *blocks*.

Silver from the subliming furnace is in porous blocks, called *bricks*.

The cast, flat lump of gold for the gold-beater weighs two ounces, and is ¾ of an inch broad.

In'got-mold. A flask in which metal is cast into blocks.

The *ingot-mold* for cast-steel is made of cast-iron, and of a shape and size to suit the form and volume of the steel bar or plate required. The mold is in two parts, separating longitudinally, and united for use by collar-clamps and wedges. The interior of the mold is smoked by the fumes of burning pitch, so as to give it a carbonaceous coating, the purpose of which is to prevent the adherence of the cast-steel thereto.

The operation of pouring the metal is called *teaming* ; the ingot is turned out while yet red-hot, and is rolled into the shape required.

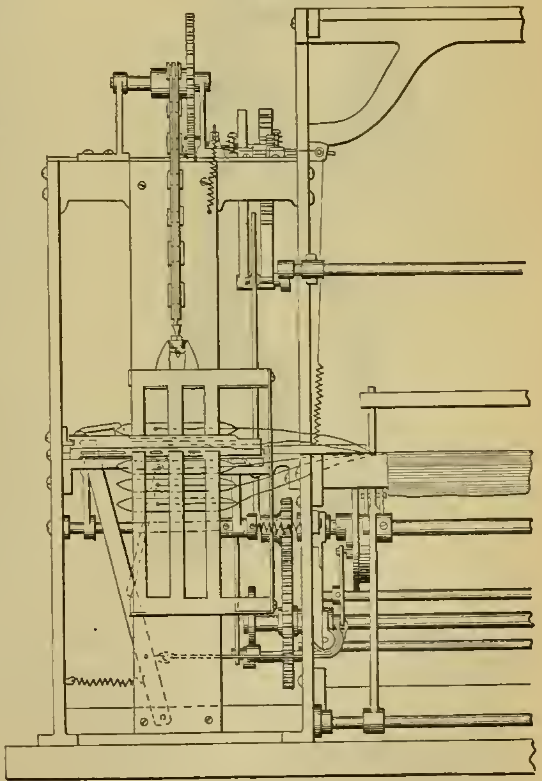
In'grain. A yarn or fabric dyed with fast colors before manufacture.

In'grain Car'pet. A carpet manufactured from wool or woolen dyed *in the grain* (before manufacture). These carpets are known as *Scotch* or *Kidderminster*, from the country and town where they are so extensively manufactured ; also as *two-ply* or *three-ply*, according to the number of webs of which the fabric is composed. See Two-ply Carpet.

In'grain-car'pet Loom. A loom in which two or more shuttles, one for the ground and the other for the figure, are employed.

In Bigelow's (Fig. 2675) the two, after being thrown, are received in horizontal boxes on each side of the frame, and a third series, containing the different colored yarns producing the pattern, are placed in a set of vertically arranged boxes ; all the shuttles are actuated by the same picker-staves ; and the figure shuttles are raised and lowered as required by pinions having a reciprocating rotary motion on a shaft, their presentation being determined by a pattern-wheel, having movable cam-surfaces on the

Fig. 2675.



Ingrain-Carpet Loom.

shaft; one vibrating cam moves the lay forward to beat up the cloth, and another moves it backward, while a shuttle is thrown.

In-hal′er. 1. An apparatus to filter and warm the air respired by persons with delicate lungs, or by those subjected to a deleterious atmosphere.

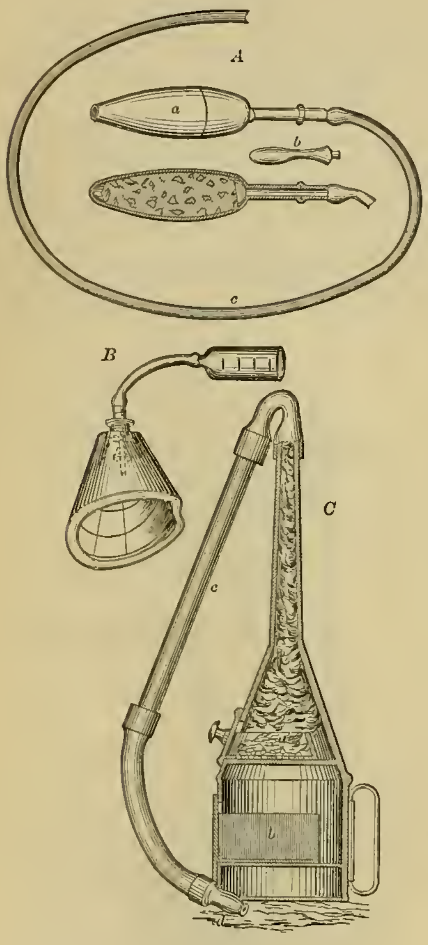
In apparatus for consumptives, it consists of a replicated wire-gauze tissue. A *respirator*.

2. For cutlers and others subjected to an atmosphere of iron dust, it is a magnetic tissue which arrests the dust.

3. An instrument for inhaling or inwardly applying medicated vapors or anæsthetic agents.

4. An apparatus to enable a fireman, miner, or diver to work in a poisonous or heated atmosphere, or in water, carrying with him a supply of vital air. See Diving.

Fig. 2676.



Inhalers.

Dr. Priestley's letter, speaking of "Gaseous oxyd of Septon" (*dephlogisticated nitrous air*), was addressed to one of the editors of the "New York Medical Repository," and was republished in the "London Monthly Magazine," June 1, 1800.

Chloroform was discovered by Guthrie, Souberain, or Liebig, about 1831, but its valuable properties as an anæsthetic were not appreciated until 1847. Dr. Morton of Boston, and Professor Simpson of Edinborough, discovered its applicability to this purpose almost simultaneously in 1847. See Anæsthetic Apparatus.

Morton's inhalation apparatus, November 13, 1847, has a chamber to hold the sponge, and two lateral openings through which respectively enter the atmospheric air and pass out the air impregnated with the vapor of the anæsthetic agent. These openings are valved to prevent reflux of air, and a chamber above contains a reserve of liquid, which is admitted to the sponge-chamber by moving a valve, at such times as may become necessary.

Roper's cup, October 10, 1848, is a vessel to hold sulphuric ether, and the rim fits closely over the mouth and nose. The body of the instrument then inclines downward, and an opening in front admits air, which passes into the ether-chamber, and then to the mouth and lungs of the patient.

Dr. Buttles's inhaler (*A*, Fig. 2676) consists of a bulb *a* of hard rubber in two sections, and containing a sponge which is charged with the required medicament. It has an opening at one end, which is closed by a stopple *b*, and to the other end is attached a flexible tube *c*. For use, the bulb is introduced into the mouth, the open end nearly touching the veil of the palate, and the air inhaled through the flexible tube becoming charged with the medicament in its passage through the sponge. It is also adapted for nasal inhalation, one nostril being closed by the finger while inspiration is performed through the other.

This inhaler may be conveniently carried in the pocket.

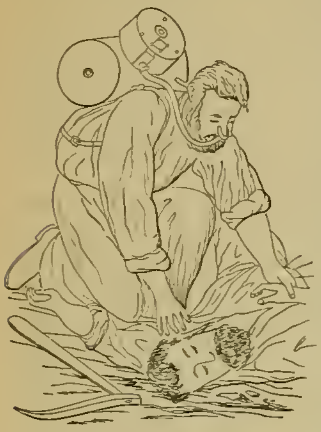
The inhaler *B* (Fig. 2676) consists of a light conical frame-work of wire, having a soft cushion at the base and adapted to fit over the nose and chin, but not covering the eyes. A double cone of flannel is slipped upon this, over which is screwed a short tube having three branches equidistant from each other. This is covered by a cone of tin or other material impervious to ether, maintained in place by a nut screwing over the tube. For use, an india-rubber tube is drawn over the tube above mentioned, the other end of the rubber tube being attached to the neck of a bottle containing ether.

Tichenor's inhaler (*C*, Fig. 2676) is made of sheet metal in the form of a cylinder, surmounted by an inverted funnel. It contains an upper drawer *a* and a lower drawer *b*, in the former of which is placed the medicinal substance to be vaporized, and in the latter live coals or a piece of hot iron to effect this result. The top is connected with a tube *c*, the ends of which are of vulcanized rubber, and is provided with a mouth-piece *d*. The drawer *b* is left partially open during the generation of the vapor, admitting air which, passing through the perforated bottom of the drawer *a*, causes a draft through the funnel and serves to dilute the medicated vapor. This apparatus is also designed for anal and vaginal applications, the drawer *b* being closed and a hand-bellows attached to the tube employed to cause a draft.

The nitrous-oxide inhaler has two valves. One opens during the inspiration to admit gas from the reservoir to the lungs, and closes during expiration. The other valve opens during expiration to allow the effete air to pass off, and prevent its mixing with the contents of the reservoir. Thus a pure article is breathed at each expansion of the lungs.

Pilatre des Roziers invented an inhaler for enabling persons to enter places filled with deleterious gases; it consisted of a bag or case of leather or metal charged with air under pressure ; it was carried on the back, and provided with a flexible tube reaching around to the mouth of the bearer, and provided with an inwardly and an outwardly opening valve for inspiration and expiration. The nostrils were closed by a spring clamping the nose.

Fig. 2677.



Rouquayrol's Apparatus.

Galibert's apparatus is very similar to the above. Rouquayrol's apparatus, Fig. 2677, consists of a sheet-iron reservoir capable of bearing a pressure of 25 to 40 atmospheres ; air is forced into it by a pump, the piston of which is fixed and the cylinder movable. Above is a bellows-like arrangement, which transmits the air to the tube leading to the nostrils of the operator, under merely the ordinary atmospheric pressure. A small two-leaved valve of india-rubber, kept closed by the external pressure of the air, opens to allow the escape of the air respired. This apparatus is carried on the back, like a soldier's knapsack. It is also used in submarine explorations.

In'haul. (*Nautical.*) A rope or purchase for rigging-in the jib-boom, studding-sail, or other spar.

In-jec'tion-cock. (*Steam-engine.*) The cock which closes the injection-pipe by which cold water is admitted to the cistern of the condenser.

In-jec'tion-con-dens'er. A cast-iron vessel of any convenient shape, and strong enough to bear the atmospheric pressure from without, in which the exhaust steam from the cylinder is condensed by a shower of cold water. The capacity of the condenser in Watt's original engines was ⅛ that of the cylinder ; but, according to present practice, it ranges from ¼ to ½ of that of the cylinder, and sometimes even more. See CONDENSER ; AIR-PUMP, etc.

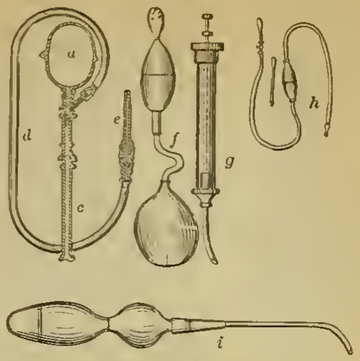
See Burgh, "On Condensation of Steam" (London, 1871).

In-jec'tion-en'gine. (*Steam-engine.*) One in which the steam is condensed by cold water injected into the condenser. See CORNISH ENGINE ; ATMOSPHERIC ENGINE.

In-jec'tion-pipe. (*Steam-engine.*) The pipe through which the injection water passes to the cistern of the condenser. In marine engines, the injection-pipe is open to the sea by a pipe which passes through the bottom of the vessel. See AIR-PUMP ; CORNISH ENGINE.

In-jec'tion-syr'inge. (*Surgical.*) A syringe for administering douches or medicines.

Fig. 2678.



Injection-Syringes.

c is the stand-pipe which rests in the bowl ; *a* is the elastic air-bulb ; *d*, the pipe ; *e*, the nozzle.

f is Roosa's instrument for treating diseases of the middle ear. See Fig. 1814, p. 769.

g is a self-injecting elastic syringe.

h is Tiemann's transfusion syringe.

i is an insufflator for blowing powder into the larynx or otherwhere. See INSUFFLATOR.

In-jec'tion-valve. (*Steam-engine.*) The one which governs the entrance of water into the condenser from the sea, river, or well.

The area of the injection-valve of a marine steam-engine is stated at one square inch for every 10-horse power. This is said to be ample allowance in all cases, and is more than necessary when the injection water has a temperature of 52° Fah. The average temperature of the Mediterranean is about 65° ; the Atlantic Ocean, at 20° of latitude, about 75° ; and at the equator, about 82° Fah.

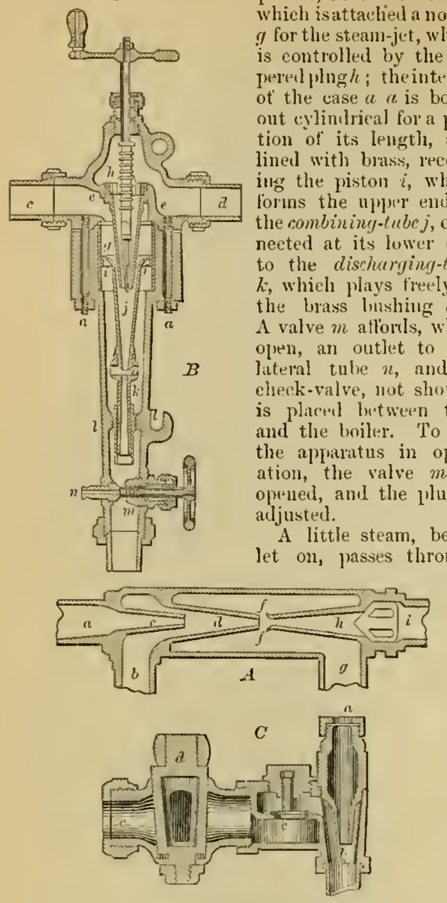
In-ject'or. A device for injecting a supply of feed-water into the body of a steam-boiler.

In Giffard's injector this is effected by the pressure and condensation of steam from the boiler itself. Fig. 2679, *A*, illustrates the operation of this apparatus. Steam escaping from the boiler through the pipe *a* is compelled to pass through the contracted nozzle *c*, by which its velocity is greatly increased. The feed-water from the pipe *b* is drawn into an annular space surrounding the nozzle *c*, and, mingling with the condensed steam, is driven through the pipe *h* and valve *i* into the boiler. Excess of steam or water, from want of proper adjustment, escapes through the outlet *f f g*.

The principle is as follows : Under a given pressure the velocity of escaping steam is much greater than that of the water which would be ejected were a hole opened in the boiler below the water-line. At a pressure of 90 pounds to the square inch, the excess of velocity of the steam is about in the proportion of 9 to 1. As the escaping steam, in being condensed, loses none of its velocity, except that due to the friction of the pipes through which it passes, it consequently, after condensation, has a penetrating force about nine times greater than the resisting force of the water in the boiler. At the moment of condensation it imparts its momentum to the water by which it is condensed, and with which it mingles. For instance, 1,700 cubic inches of steam on being condensed into one cubic inch of water imparts sufficient momentum to eight cubic inches of the water by which it is condensed to exactly balance the pressure of water in the boiler. In this case the opposing forces are in equilibrium ; but combined with any less quantity of water, say seven inches, the momentum will more than suffice to overcome the resistance of the water in the boiler, and the mingled condensed steam and feed-water will force its way into the boiler, if a properly constructed entrance be provided for it.

Fig. 2679, *B*, shows Sellers' improved injector on the Giffard principle. *a a* is the outer casing in two parts united by bolts. It has two inlets, one *c* for water, and the other *d* for steam, separated by a

Fig. 2679



Giffard's Injector.

plate *c*, in the center of which is attached a nozzle *g* for the steam-jet, which is controlled by the tapered plug *h*; the interior of the case *a a* is bored out cylindrical for a portion of its length, and lined with brass, receiving the piston *i*, which forms the upper end of the *combining-tube j*, connected at its lower end to the *discharging-tube k*, which plays freely in the brass bushing *l l*. A valve *m* affords, when open, an outlet to the lateral tube *n*, and a check-valve, not shown, is placed between this and the boiler. To put the apparatus in operation, the valve *m* is opened, and the plug *h* adjusted.

A little steam, being let on, passes through the small aperture in the steam-plug, creating a vacuum and causing the water to rise, when it is driven through the tubes *j k*, escaping at *n*. The plug *h* is then raised, increasing the flow of steam, and the valve *m* closed.

The action is as follows: The steam passing into *j* is condensed by the water from the water-supply tube, and the combined jet is driven through the discharge-tube *k*, and thence into the boiler.

If the water supply is in excess, a portion escapes by the opening *o* between the combining and delivery tubes, elevating the piston *i*, and contracting the annular space through which the water enters the combining-tube and limiting the supply. If the water supply is deficient, the velocity of the steam-jet is increased, a partial vacuum is formed in the chamber, and the piston *i* descends, enlarging the area of the water-supply space and permitting an increased flow. The apparatus is thus rendered self-regulating.

The injector *C* is used in the Westinghouse air-brake as an air-pump; the steam entering at *a*, and passing out as a jet at *b*, induces a current of air through the pipe *c* which leads from the cylinder beneath the car. (See BRAKE.) In this cylinder is the piston, which is mechanically connected to and works the brake-bars. *d* is a faucet which shuts off connection between the injector and brake-cylinder. *e* is an automatic valve which prevents reflux air through the pipe.

The injector has many other uses in the arts and manufactures: —

As an air and vapor pump it is applied to vacuum-pans, condensers of steam-engines, aspirators (by Bunsen), pneumatic dispatch-tubes (Siemen), etc. The well-known locomotive blast-pipe was an early application of the principle of the injector. (See LOCOMOTIVE; NOZZLE.) The action of these pipes was afterwards explained by Zeuner, and further results are due to Prüsman.

Gurney's steam-ventilator acted by means of steam passing through one pipe and sucking air through another connected with it. This simple apparatus was afterwards employed by Nagel and Kaemp in centrifugal pumps. Besides these may be mentioned Thompson's pump, the water-bellows, and Danchell's steam-manometer.

Ink. 1. A colored liquid or viscous material used in writing or printing.

The ancient ink was thick, and so is the modern Chinese. Demosthenes reproached Æschines with laboring in the grinding of ink as painters do in preparing colors. There is a difference between a *paint* and a *dye*, though the distinction is very imperfectly made out in customary language. A paint is smeared over an object, a dye colors or stains it. Some inks are of one kind and some of the other. The essential characteristics of the best ink are: limpidity, permanence, distinctness. The first enables it to flow easily and avoids clogging the pen. The second prevents its fading and becoming indistinct. The third makes it readily legible, both to the eye in following the motions of the pen, and to the eyes of readers subsequently.

An ink was found in an inkstand at Herculaneum. Some ancient manuscripts show the ink in relief when held to the light, and some have evidently been corroded by the ink.

Black ink is a solution of tanno-gallate of iron suspended in gum-arabic water. Logwood adds to the color. Take bruised galls, 6 ounces; gum-arabic, 4 ounces; green vitriol, 4 ounces; soft water, 6 pints. Boil the galls in the water, add the other ingredients; keep in a bottle, shake occasionally, and in two months' time decant into bottles and cork.

A drop or two of creosote or essential oil of cloves will prevent molding, or, as Dr. Gale remarked to an astounded Indianian, "will prevent the deposition of the ova of infusoria animalculæ."

He might have added, "and the sporadic growth of thallogenic cryptogams."

Such would probably be fatal to the fungi; the mere definition settled our brother from Indiana.

The addition of sugar to ink prevents sudden drying and makes *copying ink*.

Japan ink: Ribaucourt's recipe: aleppo galls, 8 ounces; logwood, 4 ounces; sulphate of iron, 4 ounces; gum-arabic, 3 ounces; sulphate of copper, 1 ounce; sugar candy, 1 ounce.

The galls and logwood to be boiled in twelve pounds of soft water until reduced to six pounds. Strain, and add the other ingredients. The ink dries with a gloss; hence its name.

Desormeaux recommends that the sulphate of iron be calcined to whiteness; coarse brown sugar instead of sugar candy; ¼ ounce of acetate of copper instead of 1 ounce of the sulphate; and agitation twice a day for two weeks before decanting and bottling.

Indelible ink. The addition of lampblack to ink will fortify it against the discharge of its colors by hydrochloric acid.

Close's recipe: copal, 50 grains; oil of lavender, 400 grains; lampblack, 5 grains; indigo, 1 grain. Dissolve the copal in the oil by heat, and then add the coloring matter. Thin with oil of turpentine.

Sheldrake's recipe is a varnish, and is used for tombstones and marble: asphaltum or pitch, oil of turpentine, amber varnish, lampblack.

Red ink is a solution of alum colored with Brazil-wood; or an ammoniacal solution of cochineal.

An indestructible red ink, or rather paint, consists of copal, 2 ounces; oil of lavender, 14 ounces; vermilion, 7 ounces.

Blue ink: sulphate of indigo dissolved in water to the desired tint.

Yellow ink: French berries, 8 ounces; water, 1 quart; alum, a small quantity.

Green ink: a mixture of blue and yellow.

Orange ink: a mixture of red and yellow.

Purple ink: a mixture of red and blue.

Brown ink: a mixture of black and yellow.

Sympathetic ink is an ink which is invisible till the writing is subjected to a subsequent operation, such as warming, exposing to sunlight or to a chemical reaction.

The ancients were acquainted with several modes. Ovid indiscreetly advises maidens to write with new milk. This, when dried, may be rendered visible by rubbing ashes upon it. Pliny suggests the milky juices of certain plants.

Modern chemistry has given us a number of recipes. Writing in the following solutions, subsequently dried, will be rendered visible by the means cited, developing certain colors.

Ink.	Treatment.	Color developed
Acetate of lead.	Liver of sulphur.	Brown.
Gold in aqua regia.	Tin in aqua regia.	Purple.
Infusion of galls.	Sulphate of iron.	Black.
Dilute sulphuric acid.	Heat.	Black.
Cobalt in dilute aqua regia.	Heat.	Green.
Precipitated oxide of cobalt in acetic acid and salt	Heat.	Blue.
Lemon juice.	Heat.	Brown.

Marking-ink is an aqueous solution of lunar caustic thickened with sap green and gum. It is written on a surface prepared by a weak solution of carbonate of soda and gum-arabic.

A *marking-ink* requiring no preparation of the surface is made of nitrate of silver, 1 ounce; bi-tartrate of potash, 1 ounce; solution of ammonia, 4 ounces; archil, ½ ounce; honey, 3 drachms; tragacanth powder, 1½ drachms. When written, pass a hot iron over it or hold to the fire.

Marking-inks formed of a silver compound may be discharged by a solution of cyanide of potassium or a solution of corrosive sublimate, 1; sal-ammonia, 1; water, 100.

Lithographic ink for writing on stones, or for transferring autographically from paper: dry soap, 100; white wax, 100; mutton suet, 30; shellac, 50; mastic, 50; lampblack, 30. Incorporate with heat; pour on an oiled plate; cut into sticks, and use like India-ink.

Lithographic printing-ink resembles that for letterpress, but is ground up with burned linseed-oil, known as *lithographic varnish.*

Copperplate printing-ink is similar to that for letterpress; but is made of ivory-black or other fine quality.

Printing-ink is a smooth, jet-black oil paint, made of boiled linseed-oil, rosin-oil, or nut-oil, and lampblack; soap and rosin are sometimes added.

Red and other colored printing-inks are made of linseed-oil boiled into a varnish, and with pigments of the required colors. Vermilion, Prussian blue, indigo, orpiment, chrome, red and orange lead, verdigris, etc. See Ringwalt's "Encyclopedia of Printing," page 226.

India-ink is a compound of lampblack and size; formerly prepared from the pigment of the cuttle-fish.

Ink for zinc plant-labels: chloride of platinum, 100 grains, in a pint of water; add mucilage and lampblack.

Or: sal ammonia, 1 drachm; verdigris, 1 drachm; lampblack, ½ drachm; water, 10 drachms. Mix.

Fire-proof ink for use in writing or printing on incombustible paper consists of: powdered graphite, 22 drachms; copal or other resinous gum, 12 grains; sulphate of iron, 2 drachms; tincture of nut-galls, 2 drachms; and sulphate of indigo, 8 drachms. These materials are mixed together and boiled in water. This ink, which, besides being fire-proof, is said to be insoluble in water, under ordinary circumstances is black; but when colored inks are desired, the graphite is replaced by an earthy or mineral pigment of the desired color.

2. (*Machinery.*) The socket of a mill spindle. See STEP.

Ink-bench. (*Printing.*) An inking-table.

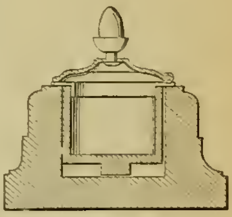
Ink-block. (*Printing.*) A block on which the ink is spread to be taken up by the balls or rollers.

Ink-cup. A dip-cup for ink. In the example, it is of rubber or glass in a wooden socket, and has a metallic flange and cup.

Ink-cyl'in-der. (*Printing.*) A cylinder rotating in the ink-fountain to bring the ink in contact with the *ductor* or fountain-roller.

Ink-foun'tain. (*Printing.*) The ink-reservoir of a printing-press from which the ink is taken by an ink-roller and passed to the *ductor*, or the distributing-roller.

Fig. 2680.

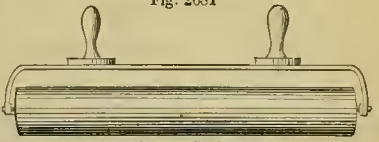


Ink-Cup.

Ink'ing-ap'pa-ra'tus. Different forms of apparatus have been adapted to different presses, and some of them are peculiar to the kinds. See list on page 226, Ringwalt's "Encyclopedia of Printing."

Ink'ing-roll'er. (*Printing.*) A roller which receives the ink from the inking-table and transfers it to the type in hand-press work. In power-presses, several rollers are employed, which are fed with ink from a trough, distributing it and transferring it to the inking-roller.

Fig. 2681



Inking-Roller.

The composition of glue and molasses was invented by Donkin and Bacon (English patent, 1813). It is stated to have been previously used by one Edward Dyas of Madeley, Shropshire, England, who was indebted to an accidental overturning of his glue-pot to the suggestion of using the lump of semi-hardened glue.

Francis and Letmate's patent composition, June 21, 1864, consists of glue, 14 pounds; glycerine, 28 pounds; castor-oil, 2¼ pounds; borax, 3 ounces; ammonia, 2 ounces; sugar, 7 pounds.

The endwise motion of the ink-distributing rollers is in the English patent of Professor Cowper, 1818.

The diagonal arrangement of the inking-roller, to give it a *relatively* endwise motion to the inking-table, is described in Applegath's English patent, 1823.

Ink'ing-ta'ble. (*Printing.*) A table upon which ink is spread to be taken up by the inking-roller.

The combination of inking-table, trough, and hand-roller was invented by Professor Cowper, and was described in his English patent, 1818.

In his printing-machine, the inking-table passed back and forth under rollers which received an end motion at the same time by means of an indentation along the edge of the table acting upon a frame in which the rollers were mounted.

In Applegath's English patent, 1823, the rollers are placed diagonally across the table and receive an end motion thereby.

Ink'ing-trough. The reservoir of ink from which the inking-roller is supplied.

In'kle. A broad linen tape. *Wrought* spinel. Spinel is bleached yarn for the manufacture of the tape, and is known as *unwrought inkle.*

Ink-print'ing Pro'cess. (*Photography.*) A process by which positive prints are obtained in common writing-ink. Immerse the paper in a solution of bichromate of potassa, in the dark. Expose under a negative. The picture will be brown on a yellow ground. Wash to remove the undecomposed chromium salt. Immerse in a weak solution of protosulphate of iron, wash; the iron salt will adhere to the image or mordant. Immerse in tannic acid; the picture blackens by the formation of tannate of iron. Wash and dry.

Ink-slice. A paddle for handling ink.

Ink'stand. A cup or bottle, from which ink is dipped with the pen.

Among the varieties may be cited: —

A, a fountain inkstand in which ink is raised in the dip-hole by depressing the piston in the reservoir. In a modified form a porcelain block is suspended in the ink and forces ink into the dip-cup by displacement.

B has an elastic caoutchouc ink-cup in a wooden case. The screwing down of the cover raises ink in the neck.

C. The raising of the lid elevates a little pan of ink to a convenient position for dipping.

D is a fountain inkstand with an overflow chamber closed by a plug.

E is a globular fountain inkstand, movable in a socket.

F is the ordinary fountain inkstand with metallic base, and pen-rack.

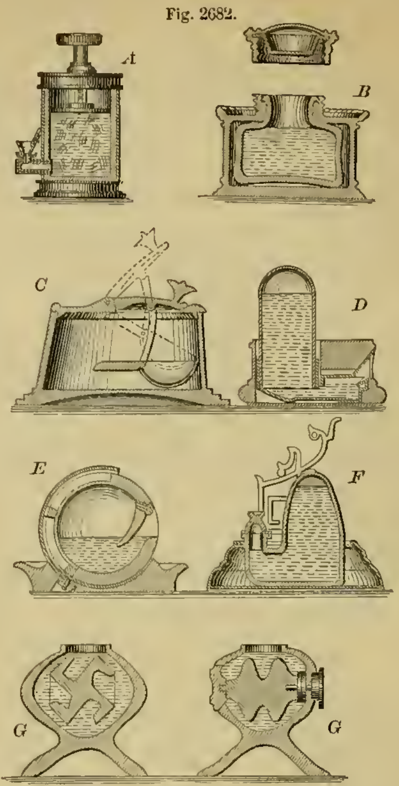
G G are two views of an inkstand having a glass disk containing four cups; rotation in one direction brings a cup of ink to be dipped from; in the other direction brings a solid portion of the disk to the aperture, and protects the ink from dust and evaporation.

The inkstands of the ancient Egyptians were of wood, porcelain, or other materials. Specimens are in Dr. Abbott's collection. They contain places for the red and black pigments, and also for the reed pens.

The inkstands of the Romans were round, square, or hexagonal; and single or double, the latter for red and black inks. A number were found at Pompeii.

The invertible inkstand is first shown in the English patent, No. 3407, November 25, 1869. It has a supplemental chamber and funnel above the usual center dip reservoir, to catch any ink which may pass out of the lower one in inverting. The present usual form is a center dip reservoir which latter has a lateral capacity sufficient to contain the contents of the dip-basin when tipped on its side or inverted.

Fig. 2682.



Inkstands.

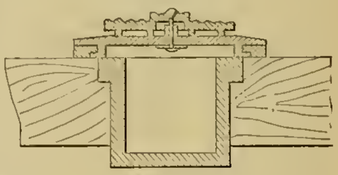
Ink-sur'face. (*Printing.*) The surface on which ink is distributed in a cylinder-press.

Ink-ta'ble. A flat-topped table on which ink is brayed or mulled ready for the inking-roller.

Ink-well. An ink-cup adapted to occupy a hole in a desk, its top letting down flush with the top of the desk, or nearly so.

In'laid-work. That in which one material is sunk into a hollowing in the surface of another, the two making an even face. See BUHL; REISNER-WORK; MARQUETRY; PARQUETRY; MOSAIC, etc.

Fig 2683.



Ink Well.

In-lay'ing. A species of ornamentation in which choice woods, metal, ivory, mother-of-pearl, etc., are inserted within portions of groundwork which are sunken to receive them, thus forming a sort of mosaic.

We find specimens of inlaying of metals in the articles recovered from ancient Babylon.

Overlaying was practiced by the same people.

Herodotus states that "Glaucus the Chian" was "the man who invented the art of inlaying steel." The salver made by Glaucus was offered by Alyattes the Lydian at the oracle of Delphi. It is described by Athenæus as "covered with representations of plants and animals." Alyattes was the father of Crœsus, who reigned till defeated by Cyrus, 556 B. C.

Under this head we may fairly refer to the Taj at Agra, the most beautiful building in the world. It is thus described by Sir Charles Dilke: —

"On the river bank [the Jumna], a mile from Akbar's palace, in the center of a vast garden entered through the noblest gateways in the world, stands the Taj Mahal, a terrace rising in dazzling whiteness from a black mass of cypresses, and bearing four lofty and delicate minars, and the central pile that gleams like an alp against the deep blue sky, — minars, temple, tomb, all of spotless marble and faultless shape. Its Persian builders named the Taj 'the palace floating in the air.'

"Out of the fierce heat and blazing sunlight you enter into chill and darkness, but soon begin to see the hollow dome growing into form above your head, and the tomb itself, that of Noor Mahal, the favorite queen of Shah Jehan, before you, and beside it her husband's humbler grave. Though within and without the Taj is white, still here you will find the walls profusely jeweled, and the purity retained. Flowers are pictured on every block in mosaic of cinnamon-stone, carnelian, turquoise, emerald, and amethyst; the corridors contain the whole Koran, inlaid in jet-black stone; yet the interior, as a whole, exceeds in chastity the spotlessness of the outer dome. Oriental, it is not barbaric. . . . . In a Persian manuscript there still remains a catalogue of the prices of the gems made use of in the building of the Taj, and of the places from which they came. Among those named are coral from Arabia, sapphires from Moldavia, amethysts from Persia, crystal from China, turquoises from Thibet, diamonds from Bundlecund, and lapis lazuli from Ceylon. The master masons were of Constantinople and Bagdad."

The varieties of inlaid work are numerous, and some of them very beautiful, bringing into use small fragments of valuable material that could hardly be applied to any other purpose. The principal varieties consist of *marquetrie*, in which woods of a variety of tints are inlaid in the form of flowers and other ornamental devices.

Buhl, wherein metals are inlaid upon a ground of ebony or tortoise-shell. The German cabinets made of ebony, and inlaid with precious stones or various woods and metals, constitute a species of this kind of work.

Mosaic inlaying, composed of extremely small pieces. The Hindoos make very beautiful boxes in this style. At the London exhibition in 1851 a table produced in Spain was shown, composed of three millions of pieces. Many Chinese and Japanese works of bijouterie are also of this class.

Parquetrie is a species of marquetrie on a bolder scale, applied chiefly to decorating floors, woods of different colors being cut to pattern and inlaid.

Pietra dura, consisting of certain kinds of hard stone, such as agate, jasper, chalcedony, carnelian, and lapis lazuli, inlaid in slabs of marble, generally black.

The marble is worked to a thickness not much exceeding one eighth of an inch, the design is drawn upon this, and is cut out with a fine saw and a file. The hard stones, worked into the required pattern by the usual modes of gem cutting, are accurately fitted into the spaces thus prepared, in a polished and finished state. After the whole is thus prepared, it is fixed as a veneer to a thicker slab.

Tarsia. This was formerly much practiced in Italy during the Middle Ages, and is now carried on in France and elsewhere. It is executed in woods of different shades, the figures comprising flowers, birds, and colored ornaments; the various parts being cut out to the required figure are then placed according to the design and fixed on paper; afterwards they are applied like veneers to a piece of furniture; being mounted, they are cleaned off and slightly polished, and the finer lines then engraved.

In-lay′ing-saw. A saw used in piercing stuff for buhl-work. See BUHL-SAW.

In′let. An opening into a drain or culvert.

In′ner-form. (*Printing.*) The form beginning with the second page of a sheet usually worked off first. In a quarto, it contains pages 2, 3, 6, 7.

In′ner-post. (*Shipbuilding.*) A piece brought in at the fore-side of the main-post, and generally continued as high as the wing-transom to seat the other transoms upon.

In′nings. (*Hydraulic Engineering.*) Lands recovered from the sea.

In-quar-ta′tion. (*Metallurgy.*) See QUARTATION.

In′sect-de-stroy′er. A device for killing noxious insects.

By *fumigation;* a bellows which drives poisonous fumes or vapors, such as those from sulphur, upon insects or plants.

By *dusting* sulphur upon them by means of a bellows and tube.

By *steam-jets.*

By *atomizers* which distribute coal-oil or turpentine in a fine spray.

By a *lamp*, which attracts nocturnal insects to singe their wings or allure them to a pan of water.

By *wire cages*, which imprison moths and worms which seek access to beehives. These are *traps.*

In′sect-trap. A device to catch insects upon or approaching an object.

Traps are set upon trees to catch the curculio. Such are frequently merely circular troughs around the stem. In some countries it is necessary to let the legs of tables, cupboards, and bedsteads stand in cups of water to prevent access of ants.

The moth-trap for beehives is a familiar instance, and consists of a wire cage which arrests them; or a lure to a box or pan, out of which they cannot get; or viscous smear which imprisons them; or a light which clips their wings.

In-sert′a-ble-tooth Saw. One with removable teeth. See SAW-TOOTH.

In-ser′tum-o′pus. A wall in which the stones are small and unhewn, similar to rubble-work. See MASONRY.

In′set. (*Bookbinding.*) Same as *offcut.* A certain portion of the printed sheet in 12mo, 24mo, etc., which is *cut off* before folding and set into the middle of the folded sheet, to complete the succession of paging.

In′shave. (*Coopering.*) A jointer having a convex-edged bit, on which the inner faces of staves are dressed.

In′side-cal′i-pers. A calipers for measuring bores and inside diameters of tubes. See CALIPERS.

In′side-cyl′in-der. (*Steam-engine.*) A cylinder placed in the smoke-box of a locomotive, to keep it warm; preventing the radiation of heat incident to the customary *outside* exposure.

In′side-fram′ing. (*Steam.*) *a.* The frame of one form of English locomotives, in which the wheels and driving-gear are inside of the main frame.

b. The stays of a locomotive-engine, that rest on the axles. The English practice is to have the framing *outside* of the cylinders, the connecting-rods of the engines, passing to cranks on the axles.

In'side-gear. (*Steam-engine.*) The English arrangement in locomotives of the pitmans and cranks inside the frame, in contradistinction to the American practice of connecting the cross-heads of the engines by pitmans to wrists on the outside of the driving-wheels.

In'side-screw. A hollow screw; one having its thread on the inside.

In'side Screw-tool. (*Lathe.*) A hook-shaped tool for threading interior surfaces while revolving in a lathe. A form of *chaser*. See Fig. 1256.

In'side-tin. (*Bookbinding.*) A plate laid inside the cover of a book when placed in the standing-press.

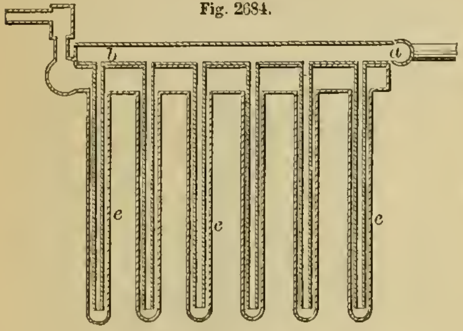
In'side-tool. (*Wood-turning.*) For hollowing out work and bottoming holes.

In'soles. A thickness of cork, felt, flannel, leather, paper, etc., placed inside a shoe to protect the sole of the foot, or to improve the fit of the shoe.

> "Suppose one's short, —
> They put cork soles within the heels of her shoes."
> ALEXIS; quoted by ATHENÆUS, A. D. 220.

In-stan-ta'ne-ous Gen'er-at-or. A form of steam-boiler or generator, in which a small body of water is injected at a time into a highly heated vessel, flashing into steam immediately. It differs from ordinary boilers in there being no unvaporized water in the boiler. In most cases there is no steam-chest, and the theory has been to inject at each time a quantity sufficient for one impulse of the piston. The term *flashers* has been applied to this form of generators, from the fact that the jet of water instantly *flashes* into steam. Trouble has been found in the rapid corrosion, and in the cracking of the material of the boiler.

Fig. 2684.



Instantaneous Generator.

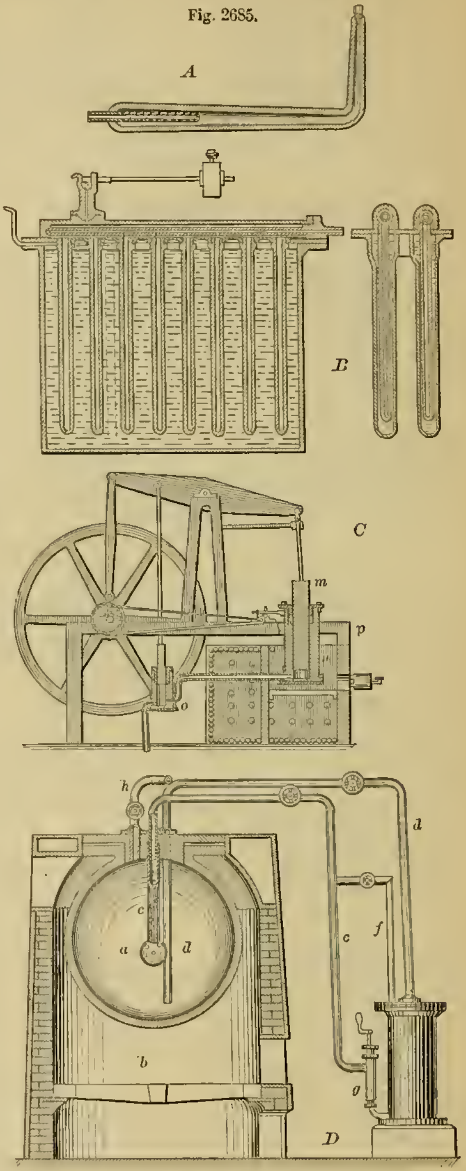
McCurdy's English patent (*A*, Fig. 2685), 1824, has a tube into which is introduced a smaller tube with perforations which deliver a fine shower into the outer tube, which is exposed to the heat of the furnace.

Dr. Alban, of Mecklenburg, patented, in 1825, a device (*B*, Fig. 2685) in which steam was generated in a series of strong vertical tubes, which are submerged for the greater portion of their length in a bath of molten lead. The row of vertical pipes was supplied by water trickling from a pipe above, somewhat as in Fig. 2684, in which, however, the water is conducted from the pipe *a b* by an inner tube down to the bottom of the pipe *c*, in which it is flashed into steam.

Jennings's steam-engine, 1828 (*C*, Fig. 2685), has a piston or plunger *m* which moves in a cylinder *n* when water is injected beneath it by means of the pump *o*. Means of escape for the expanded steam are afforded by a valve working on the frame *p* when the piston has completed its upward stroke.

In Danford's steam-generator (*D*, Fig. 2685) *a* is a spherical vessel, into which water is injected in a spray through pipe *c c* by the force pump *g*. *d* is a pipe through which superfluous water is blown off back to the reservoir. *f* is a branch pipe leading back from the injection-pipe *c* to the reservoir, and by means of a cock such part of the water as may be desired is returned. It forms a means of graduating the amount injected. *b* is the furnace, and *h* the steam-pipe to the engine.

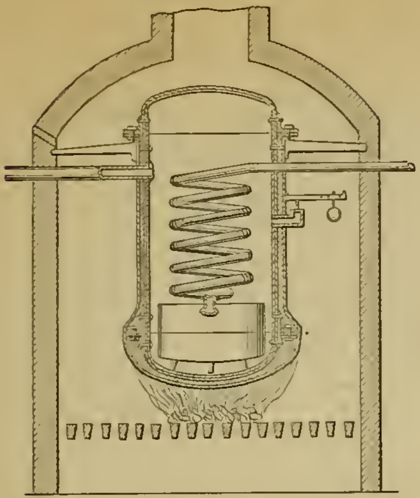
Fig. 2685.



Instantaneous Generators.

Fig. 2686 is a form in which a metallic cup extends upward from the lower and inner surface of the

Fig. 2686.

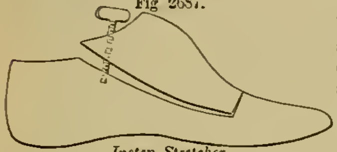


Case's Steam-Generator.

boiler to receive the water or steam thrown in by the feed-pump, and prevent sudden cooling of any part of the boiler.

In'step-stretch'er. A shoemaker's implement for distending the instep of a boot. The movable piece is elevated by a screw.

Fig 2687.



Instep-Stretcher.

In-suf-fla'-tor. An instrument for blowing burned alum or other powder into the larynx or other deep-seated part. See *i*, Fig. 2768.

In'su-lat-ed Col'umn. (*Architecture.*) One unconnected with any wall or building.

In'su-lat-ed Wire. 1. One suspended by insulators (which see) so as to prevent the electric current from going to *earth*.

2. One wrapped with silk or clothed with gutta-percha or caoutchouc to prevent the escape of the electric current.

Among the best insulators are dry air, shellac, sulphur, resins, gutta-percha, caoutchouc, silk, dry fur, glass. See INSULATOR; SUBMARINE CABLE; TELEGRAPH.

Among the materials prominently put forward for the insulation of wire, and forming by themselves or in various combinations the subjects of patents, are:

Animal substances.
Asbestus.
Ballata.
Bituminous substances.
Collodion.
Fiber.
Gums.
Kerite.
Paraffine.
Pyroxyline.
Spun glass.
Varnish.
Vitreous coating.
Wax.

In'su-lat-ing-stool. A stool with glass legs to insulate a person or an object placed thereon.

In'su-lat-or. (*Electricity.*) A (so-called) non-conducting material; that is, one of relatively very small conductivity, placed between an electrified body and other objects. A device for supporting a wire or other conductor without affording a way of escape to earth of the electricity. It is sometimes of glass or porcelain, with the wire wrapped around it, or tied by wire to it.

The accompanying cut shows several kinds. *a* has a two-hooked head, around which the wire is lapped or wound. The shank is firmly socketed in a glass or vulcanite socket, which screws into the telegraph-post.

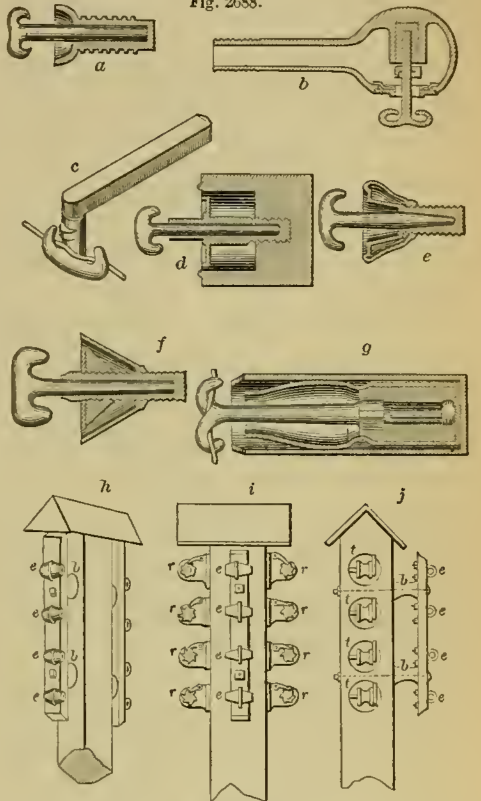
In *b* the inverted cup has a shank by which it is secured to the post, and a socket to hold the end of the pin; between the latter and the edge of the cup is an annular non-conducting disk.

c has a shank to enter the telegraph-post, and a two-pronged stem covered with vitreous enamel.

d has a flanged disk to prevent the accumulation of a film of moisture around the stem.

e, the metallic hook is socketed in a hard rubber-plug which enters the telegraph-post. A flaring cap is rooted to the insulator-plug, and its rim approaches the hook.

Fig. 2688.



Insulators.

f has a bell around the disk on the rubber socket of the hook-shank.

g is Varley's insulator, which obtained the prize at the Paris Exposition. It has a paraffine cup and a conducting shield which conducts off atmospheric electricity.

h i j are three views of Cooke's insulator (English). *e e* are earthenware thimbles for the wires. *b b* are insulating earthenware struts. *r r* are winding ratchets for the reels *t t* on which the wires are strained. Posts at intervals of 400 yards.

All bodies are conductors of electricity; but while in some the degree of conductivity is so great that they are used to convey the electric fluid, others resist the passage of the current to such an extent that they are said to insulate, or confine the fluid to a more favorable medium. The following bodies admit the passage of electricity about in the order written: —

Silver.
Copper.
Gold.
Mercury.
Cadmium.
Zinc.
Tin.
Iron.
Lead.
Platinum.
Carbon.
Graphite.
Acids.
Saline solutions.
Metallic ores.
Animal fluids.
Water.
Vegetables.
Animals.
Flame.
Smoke.
Vapor.
Earths.
Metallic oxides.
Oils.
Ashes.
Phosphorus.
Lime or chalk.
Caoutchouc.
Camphor.
Porcelain.
Dry wood.
Gases and air.
Leather.
Lycopodium.
Parchment.
Paper.
Feathers
Hair or wool.
Silk.
Glass.
Wax.
Sulphur.
Resin.
Amber.
Paraffine.
Shellac.
Gutta-percha.

In-tagl'io. Cut in; as of the lines in an engraved plate, the sunken letter in the matrix of a type, the design in a seal, punch, or die, which delivers a raised or *cameo* impression. The opposite of *cameo*.

In-tagl'io-type. A process allied to the graphotype and depending upon the production of a friable surface of oxide of zinc on a metallic plate under hydraulic pressure. Upon this lines are drawn with an oleaginous ink, the object of which is to repel a watery solution subsequently applied. A solution of chloride of zinc or analogous salt is washed over it and hardens the surface not protected by the oil. After drying, the surface is brushed over, and the bristles or velvet remove the oxide and ink, leaving an intaglio impression, from which castings may be made in the electro-bath or by stereotyping.

In-ten'si-fy. (*Photography.*) A term applied to various modes of giving strength or increased opacity to the deposit forming the photographic picture on an exposed and developed negative plate. It is frequently effected by continuing the development, using fresh quantities of "developer" and nitrate of silver; also by converting the deposit of metallic silver already formed into new compounds having greater opacity. Sulphuret of silver and mercury and other substances are used.

In-ten'si-ty. 1. A term applied to indicate the energy of the magnetic force, which varies at different places and different times. It is one of the three elements of the magnetic force which are registered by the magnetometrical instruments of the chain of observatories in Europe, Asia, Africa, and America. The other two elements are the *declination* and *inclination*. See MAGNETOMETER.

2. (*Electricity.*) A term which expresses the electro-motive force of a current. An *intensity battery* is one in which the elements are coupled up together, to give a current known as *high-tension*, that is, of great electro-motive force. The term, as applied to a battery, is used in contradistinction to *quantity*.

In-ter-co-lum-ni-a'tion. (*Architecture.*) The distances between the columns composing an architectural front. These are regulated by the diameter of the column, being in —

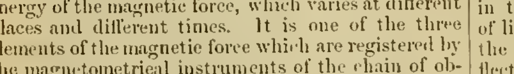
Aræostyle, from 4 to 5 diameters; diastyle, from 3 to 4 diam.; eustyle, 2¼ diam.; systyle, 2 diam.; pycnostyle, 1½ diameters.

In-ter-den'tal. (*Machinery.*) 1. The space between teeth or cogs.

2. (*Architecture.*) The space between two *dentils*.

In-ter-fer'ing, At-tach'ment for. A device fastened to the leg or foot of a horse, to prevent cutting by collision of the feet or shoes. In the example, the rubber guards are attached to the padded strap, which is buckled round the horse's leg. See LEG AND FOOT GUARD.

Fig. 2689.



Interfering-Strap.

In-te'ri-or Screw. One cut on an interior or hollow surface, as of a nut, burr, or tap-hole. A *hollow* or *socket* screw.

In-te'ri-or Slope. (*Fortification.*) The slope of the embankment from the crest inward toward the body of the place. See ABATTIS.

In-ter-leave'. (*Bookbinding.*) A book bound with alternating blank leaves, for notes, additions, translations of the text, etc.

In-ter-lig'ni-um. (*Architecture.*) The space between the ends of the tie-beams.

In-ter-me'di-ate Frame. (*Spinning.*) The second fly-frame; an intermediate, in order of time, between the *slubbing* and the *roving* frame.

In-ter-me'di-ate Shaft. The shaft crossing the frame of a marine-engine, to connect the two engines and two paddle-wheels.

In-ter-mit'tent Gear. 1. A wheel having a part of its cogs cut away. A *mutilated* gear.

2. A wheel moved at intervals by a cog, cam, ratchet, rack, or lever; as in counting-machines, meters, registers, escapements, etc.

In-ter-mit'tent Light. One of the characters of light exhibited from lighthouses under the catoptric system. The variations or different characteristics of lights enable a mariner coming within sight of them on a coast to determine his geographical position and bearings.

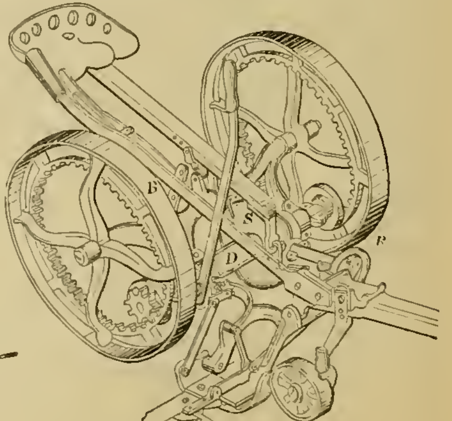
The *intermittent light* bursts suddenly into view, remains steady a short time, and is then eclipsed for half a minute. The effect is produced by the motion of shades in front of the reflectors, alternately displaying and hiding the light.

The other varieties of lights are: —

Fixed, *revolving*, *flashing*, *colored*, *double*, and these are variously combined. See LIGHT.

The *intermittent* and the *flashing* lights differ in respect of their modes of rising and fading, as also in their duration. The *flashing*-light gives a flash of light every five seconds, with intervals of dimness, the effect being produced by the revolution of a reflector frame with eight sides. The natural world affords several examples of light-carriers. The little fire-fly of the United States, whose common name is rather more than half sublime, *lightning*-bug, is an example of the *flashing*. The fire-flies of Italy and of South America, some species of nocturnal moths, and

Fig. 2690.



Internal Gear-Wheel

the female glow-worm, have luminous patches on the head, sides of the thorax, or the abdomen. The light is considered phosphorescent, but is urged into activity by a nervous action, probably derived from voltaic impulse (as we call it) from the battery, the brain.

In-ter-mit'tent Wheel. This includes all the *escape-wheels* ; counting wheels in meters, arithmometers, and registers ; stop-motions in clocks and watches ; ratchet movements, etc., etc. *See the above.* See also WHEEL ; GEARING.

In-ter-mo-dill'ion. (*Architecture.*) The space between two modillions.

In-ter'nal Gear. A wheel whose cogs are on the internal perimeter, as in the example where the pinions on the shaft *D* are driven by engagement with the internal gear of the driving-wheels *B*. Inside the box *S* is a bevel pinion on shaft *D*, which turns a shaft on which is a wrist-wheel *R*, from which proceeds the pitman, which reciprocates the cutter-bar of the harvester.

Many agricultural implements have internal gear-wheels.

In-ter'nal Safe'ty-valve. (*Steam-engine.*) A valve opening inwardly into the boiler to allow air to enter when a vacuum is formed inside by the condensation of steam.

In'ter-nal Wheel. An annular wheel whose cogs are presented internally. See INTERNAL GEAR.

In-ter-ro-ga'tion, Note of. (*Printing.*) A sign (?) indicating a query.

In'ter-tie. (*Carpentry.*) *a.* A horizontal timber framed between two posts.

b. A binding joist.

In'ter-val. A space or distance, as a space between cogs, an *interdental* space.

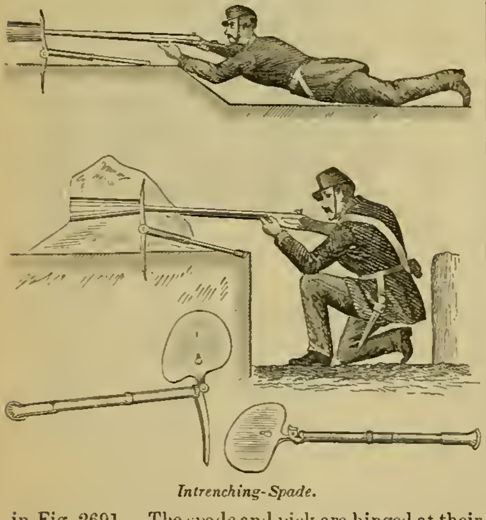
Between the frames in a military mine. A *bay*.

In-tra'dos. (*Architecture.*) The lower surface or *soffit* of an arch.

In-trench'ing Tools. Implements carried by the pioneers of regiments.

A combined spade and pick, invented by Captain Harrison of the London Military Engineers is shown in Fig. 2691. The spade and pick are hinged at their junction, to fit the tool for the respective uses. The embrasure is made by a roll of sheet-metal or bark, or a bundle of sticks tied up into a cylindrical shape. The spade has a hole for the barrel and sight.

Fig. 2691.

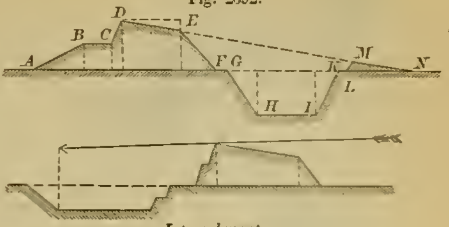


Intrenching-Spade.

In-trench'ment. (*Fortification.*) A defensive work consisting of a ditch, and a parapet made from the excavated earth.

The upper figure shows a profile of an intrenchment, in soils of which the natural slope is one perpendicular to one base.

Fig. 2692.



Intrenchment.

A B C D E F is the profile of the parapet.
G H I K the profile of the ditch.
L M N the profile of the glacis.
A B is the banquette slope.
B C tread of the banquette.
C D the interior slope.
D E the superior slope.
E F the exterior slope.
F G the berme.
G H the scarp.
H I the bottom of the ditch.
I K the counterscarp.
A the foot of the banquette slope.
B the crest of the banquette.
C the foot of the interior slope.
D the interior crest.
E the exterior crest.
F the foot of the exterior slope.
G the crest of the scarp.
H the foot of the scarp.
I the foot of the counterscarp.
K the crest of the counterscarp.
M the crest of the glacis.
N the foot of the glacis.

The lower figure shows a cover for troops, having an inner trench of sufficient depth, when aided by the hight of the parapet, to give shelter to troops when standing in the trench. The natural ground serves as the banquette.

In-vag'i-na-to'ri-um. (*Surgical.*) A douche for the vagina.

In'va-lid-bed. One having conveniences for the sick or the wounded, having elevating head and shoulder portion, to give the patient a change of position ; a portion which conforms to the shape of the bended knees ; conveniences for lifting the patient, introduction of a bed-pan beneath a removable section of the mattress, etc., etc.

In'va-lid-chair. A chair capable of assuming and retaining any required position from the erect to the prone. The figures illustrate the positions, the sustaining devices of the back, seat, leg-piece, and foot-stool being racks and screws. The one illustrated has a capacity for thirty changes.

The invalid-chair which has traveling arrangements is known as a *perambulator* or *locomotive-chair*.

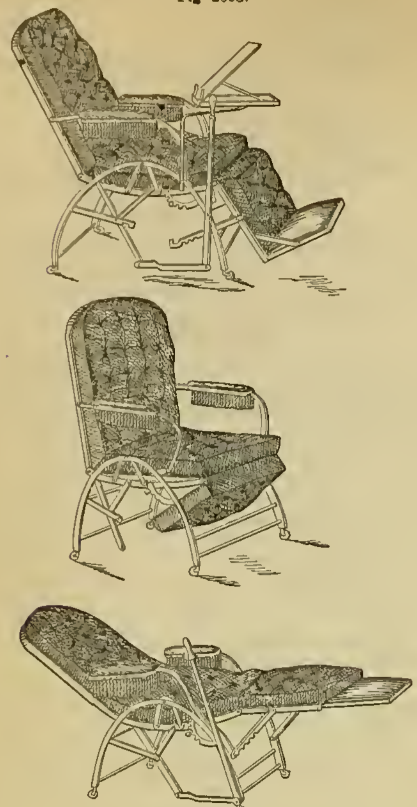
In-vers'or. An instrument invented by Dr. Bird to reverse quickly a voltaic current.

In-vert'. 1. An inverted arch.

2. The floor of a canal lock-chamber. It is usually an inverted arch (convexity downward). See CANAL-LOCK.

In-vert'ed Arch. An arch whose crown is

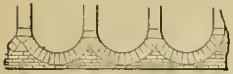
Fig. 2693.



Invalid-Chairs

downward. The *key-stone* being the lowest of the *voussoirs*, and the *springings* the highest. It is used in foundations, the floors of tunnels, etc.

Fig. 2694.



Inverted Arch.

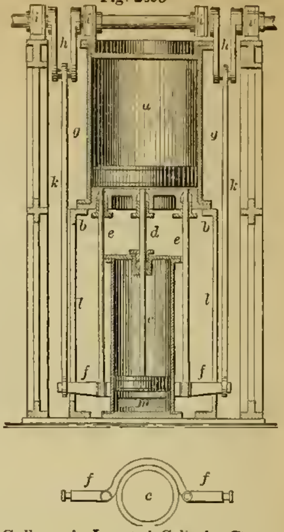
In-vert'ed Com'mas. A sign of the beginning of a quotation (" ").

> "Age cannot wither her, nor custom stale
> Her infinite variety."

In-vert'ed-cyl'in-der Steam-en'gine. Galloway's inverted-cylinder steam-engine is a form of direct-action engine, intended to obviate the use of the beam in marine engines.

a is the cylinder supported upon the frame or platform *b b*; *c* is the air-pump placed beneath the cylinder and concentric with it. The piston-rod *d* of the air-pump passes through a stuffing-box in the cover of the latter, and through another stuffing-box in the cover of the cylinder, and is attached to the steam-piston. Two piston-rods *e e* pass down through stuffing-boxes in the cylinder cover and are keyed to the cross-head *f*, which is curved so as to encompass one half of the air-pump. *g g* are two connecting-rods proceeding from the bearings of the arms of the cross-head to the crank *h h*. *i i* are the plummer blocks which carry the paddle-shaft; two of these are supported by the top of the cylinder, and the other two by the side frames *k k*. *m* is the neck in which is placed the foot-valve connecting the pump with the condensers. *l l* are the guides in which the cross-head *f* works.

Fig. 2695



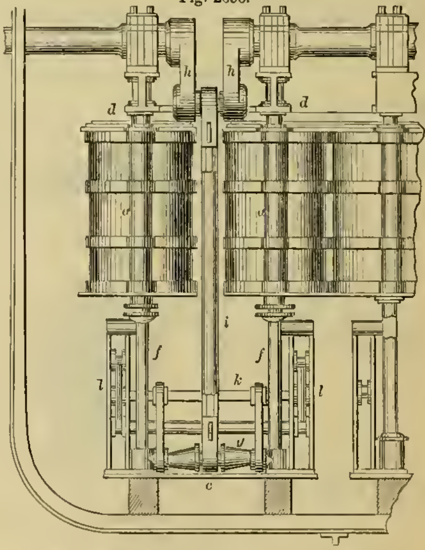
Galloway's Inverted-Cylinder Steam-Engine.

In-vert'ed Dou'ble-cyl'in-der Steam-en'gine. A form of steam-engine having two parallel cylinders, each of half the area necessary for the intended power, and combined to form one engine. The cylinders are inverted, being above the crank to which their piston-rods are directed. The four cylinders composing the pair of engines are ranged in a line across the vessel.

a a are the cylinders which stand upon strong iron columns (not shown) which rest on the foundation plate *c*, and, passing through suitable bosses on the sides of the cylinders, support the entablature plate *d* and the crank pedestals above. The cylinders are placed at a sufficient hight from the bottom of the vessel to allow the piston-rods to work downward. The two piston-rods *f f* are connected together by a cross-head *g*; the stuffing-boxes have self-acting oil-cups.

The power is transmitted directly from the main cross-head *g* below, to the cranks *h h* above the cylinders, by the connecting-rod *i*. The two piston-rods *f f* and the cross-head *g* are made to work uniformly together by a strong vibrating cast-iron frame *k*, which forms part of the parallel motion, and with the side levers *l* serves also to work the air, feed, bilge, and brine pumps.

Fig. 2696.



Hick's Inverted Double-Cylinder Steam-Engine.

Each cylinder has its separate slide-valve in order that it may be nearer to the cylinder than it would be were one used for both. The condenser is not shown, but is beneath the slide-valve case, and the air-pump, foot-valve, and discharge-valve are similar in construction to those used in ordinary engines. The air-pump and condenser are connected by a passage beneath the foundation plate. The waste water is discharged from the hot-well by an overflow pipe through the side of the vessel.

The feature of the double cylinder is copied from *Maudslay's double-cylinder steam-engine*, but in the *Hick's engine* the cylinders are inverted, and the details of the connections are very different. This, like Maudslay's, is a *direct-action engine*, intended to obviate the use of a beam in *marine engines*.

In′ward-dis-charge′ Wa′ter-wheel. A form of reaction water-wheel or turbine in which the water reaches the wheel from an outer encircling scroll and passes inward, discharging at the hollow center of the wheel.

I-rail. A double-headed rail with flanges on each side above and below; on the *foot* and *tread*. See IRON, ANGLE.

I′ri-an-kis′tri-um. A hook-shaped instrument used in the operation for artificial pupil by separation.

Ir-i-dec′tome. (*Surgical.*) A knife for operations on the eye.

A journal of February 1, 1801, gives an account of an operation performed by Citizen Demours of Paris upon a left eye, five-sixths of whose cornea was perfectly opaque. "The only portion of the latter which remained pervious to light was on the upper part, and so high as to prevent any rays from passing thence through the pupil to the retina. To remedy this, the operation was conceived of cutting an opening through the pupil opposite to the luminous part of the cornea, which was accordingly performed by making a small orifice near the latter, large enough to introduce a very fine pair of scissors, with which a small slit was made in the iris. This opening being above the crystalline lens, and out of the sphere of its action, the patient is obliged to use very convex glasses in order to read, as those persons do from whom the crystalline humour has been extracted in the usual manner."

The Rev. W. H. Milburn gives the following account of the treatment of his eye by the famous oculist Professor Von Graefe of Berlin. The ophthalmoscope had been invented by Helmholtz five years, when, in 1856, Von Graefe, as Mr. Milburn says, "banished to the night of the past the blindness fatally attached to the glaucomatous eye." He relates that the Professor advised him to do without the chloroform, saying: —

"'There is only a slight transparent spot in the cornea into which I can cut; the merest muscular twitch, the deviation of the knife by the tenth part of a hair's-breadth, will ruin the operation; chloroform cannot hold you as steady as your will. What say you? I have confidence in your self-control.'

"I answered, 'Go on without the chloroform.'

"The eyelids were fastened back by springs, and the cutting proceeded.

"First, a linear incision was made through the cornea or colorless part of the eye, and a cut in the iris or colored part behind. Delicate forceps were then introduced to draw the iris out so as to line the new-made opening, and the edges of the iris, clipped with scissors, were skillfully fastened to the surface of the eye. Thus the operation for artificial pupil, called iridectomy, required in this case about four minutes and a half, — longer than usual, — and it can be well imagined that the time seemed much longer to me."

I-rid′i-o-scope. An optical instrument which shows the inside of the eye. Used to detect foreign substances and diseases.

I-rid′i-um. Equivalent, 99; symbol, *Ir.*; specific gravity, 22; nearly infusible.

It is a white, hard, brittle metal, more difficult to fuse than platinum, and the heaviest of all known substances.

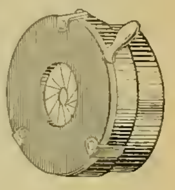
It has been used for forming the tips of gold pens.

The alloy of iridium and osmium, called iridosmine, is the hardest of all alloys. It forms the point of the "everlasting pen," made by Hawkins of England, and is ground by diamond-dust.

Ir-i-dos′mine. An alloy of iridium and osmium. The hardest of all known alloys.

I′ris-cope. An instrument contrived by Dr. Reade for exhibiting the prismatic colors. Sir David Brewster describes it in the "Phil. Trans." for 1841 as a plate of polished black glass, having its surface smeared with a solution of soap and dried by wash-leather. On breathing through a tube upon the glass, the vapor is deposited in brilliant colored rings.

Fig. 2697.



Iris-Diaphragm.

I′ris-di′a-phragm. (*Optics.*) A contractile diaphragm, simulating the action of the natural iris, to regulate the size of the aperture in a microscope through which light passes.

I′ron. 1. The most useful and abundant of the metals.

Equivalent, 28; symbol, *Fe.*; specific gravity, cast-iron, 7.2, wrought-iron, 7; fusing-point, 2,786° Fah. The ores principally worked are the oxides and carbonates, the metal in combination with oxygen, or with oxygen and carbonic acid.

The protoxide is an antidote for arsenic.

The peroxide is an ore, and is used as a pigment (ocher).

The loadstone is a magnetic oxide.

The bi-sulphuret (pyrites) is the bane of the gold and silver miner. Pyrites is now roasted for the production of sulphuric acid.

The protosulphate (green copperas) is used in dyes and inks; and calcined forms *crocus, rouge, cocothar*, for polishing.

The useful forms of iron are cast-iron, steel, and wrought-iron. The former two are compounds of iron and carbon, being carburets or carbides of iron. Cast-iron has the larger proportion of carbon in its composition. Wrought-iron is nearly pure iron, but it has generally some traces of carbon, sulphur, and phosphorus. The less the better, but the two last are hard to eliminate.

Iron was found, so says the chronicle, on Mount Ida, by the Dactyles, after the burning of the forest by lightning, at a period answering to our 1432 B. C. The Greeks claim the first discovery of it, of course. How many centuries it had been used in China, India, and Egypt can hardly be determined. Moses, who died 20 years before the era assigned, credits one with the invention who had been dead 2,000 years when he, the great lawgiver, wrote.

Chariots, axes, bedsteads, harrows, weapons of iron, are mentioned in Hebrew history between 1490 B. C. and 1040 B. C. Jeremiah and Ezekiel speak of iron, and mention two qualities, one of which the latter calls "bright iron," probably steel. The same distinction is made by Hesiod (850 B. C.).

Some doubts have been expressed as to the rendering of the Hebrew passage which speaks of Tubal Cain as an artificer in *iron*, and the passage which speaks of the *iron* bedstead of Og, King of Bashan, about 1450 B. C. The Arundelian marbles place the use of iron in 1370 B. C., and other authorities go back to 1537 B. C. These corroborate the iron bedstead of Og. Extremes meet, and we have lately revived the use of the material first recorded as used for that purpose. Moses mentions an iron furnace 1490 B. C., and Job speaks of iron as "taken out of the earth."

Gold, silver, and copper, and alloys of the last, were, no doubt, used before iron, and it would be reasonable to expect that such would be the case, as they are so readily obtained by simple metallurgic operations, while iron is more refractory.

The existence and uses of iron among the ancient Egyptians are pretty well proved by the paintings, in which the iron or steel knives and sickles are distinguished from the bronze by the color; one being blue, the other a reddish-brown.

In Dr. Abbott's collection, now in the possession of the New York Historical Society, are the following articles of iron, stated by the doctor to be of undoubted authenticity. They were found at Thebes: —

Iron helmet, neck-guard, and breast-plate of scale armor, with the name of Shishak, who invaded Judea 971 B. C.

An iron spatula, iron arrow-head, warrior's flail with iron studs, and some emblematic articles of iron.

The ancient iron mines of the Egyptians have been lately discovered by English explorers. The process was wasteful, and the slag contains 53 per cent of iron. The sites are in the vicinity of Mt. Sinai, and it is proposed to work over the *débris* of the former workings.

Of the first use of iron in Egypt, Wilkinson says, we have no certain record. His surprise at the execution of the sculptures is very natural, but he does not appear to have estimated the character of the alloys of copper and tin, some of which are very hard. (See ALLOY; BRONZE.) Belzoni discovered an iron sickle-blade beneath a granite sphinx at Karnak. Colonel Vyce found an iron blade imbedded in the great pyramid. Layard found a steel cross-cut saw, and other articles of iron, at Nimroud; the saw is now in the British Museum. The butchers of Thebes and Memphis had steels slung from their belts. At Babylon the stones of the bridge across the Euphrates, built by Nitocris, were cramped by bands of iron set in lead. Thucydides says the blocks of the walls of the Pireus were fastened in the same way. Theseus, who ascended the throne of Athens 1235 B. C., was buried with a bronze sword and spear. Some have dated the use of iron in Greece at 1406 B. C., but Hesiod makes it later. Homer generally speaks of bronze arms, but mentions iron.

We learn from the "Iliad" that at the time of the siege of Troy (1184 B. C.) iron was used in making axes, shipwrights' tools, axles for chariots, plow-points, sheep-hooks, and some other agricultural implements. "As the smith plunges the loud-hissing axe into cold water to temper it, for hence is the strength of iron," etc., shows clearly that the writer or compiler of the "Odyssey," whom we are content to call Homer, lived in a time when iron and steel were forged and tempered.

About 500 B. C., and thereafter, steel was imported into Greece from the Chalybes, a people inhabiting the shore on the southeast of the Black Sea, and the use of bronze for weapons terminated soon after. Marathon was fought 460 B. C. The steel was called Chalybian, and we retain the name in connection with waters, as Chalybeate springs.

In Asia the Chalybes were noted for their works in iron, from which they obtained great profits. — XENOPHON, *Anab.*

Aristotle mentions that their arenaceous ores were washed, and he also partially describes the operation of making wootz in India; Diodorus Siculus says that in the island of Ethalia the ores were roasted and broken fine before melting. It was *wrought*-iron that was produced and employed, and not *cast*-iron, which is a comparatively recent production, and it is probable it was all obtained, by a primitive direct process, from rich and easily reducible ores.

The early means for the reduction of iron from the ore were small furnaces with cold blast, in which rich ore was heated in contact with incandescent charcoal, the viscid mass being hammered to remove earthy impurities. This plan is yet practiced in India, Africa, Malaya, Madagascar, and forms the

> "Mass of iron, shapeless from the forge,"

offered by Achilles as a prize at the funeral games of Patroclus, recorded in Homer's twenty-third book of the "Iliad."

Dr. Livingston refers to the iron-smelting furnaces of the tribes encountered in his "Expedition to the Zambesi." The articles produced by these peoples are hammers, tongs, hoes, adzes, fish-hooks, needles, and spear-heads.

King Porus presented to Alexander the Great a wrought bar of laminated steel, for which Damascus was subsequently so famous that it is known as Damascene. One of the most remarkable forgings in the world, if it be one, is the wrought-iron pillar within the precincts of a mosque near Delhi. It is a shaft with a capital 22 feet high above ground, and a greater length below. Its probable weight is over 38,000 pounds. It has an inscription in Sanscrit, which records that it was erected by King Dhava of the Hindoo faith.

The character of the Sanscrit inscription, according to the English linguists of Hindostan, indicates a period at about A. D. 400. See FORGING.

The examples cited from the writings of Moses, Hesiod, and Homer, the attestation of the recovered implements from Egypt and Nineveh, and the Egyptian paintings, render it useless to cite the facts within the notice of the gossiping and credulous Pliny, who professes to give the early history of the metal. Palestine, Asia Minor, Scythia, Elba, and Spain were each celebrated in their time for the production of iron. From Iberia the art spread to Gaul, and from the latter, probably, to Germany.

An army of Gauls was defeated by the Romans, 222 B. C., chiefly because the swords of the former bent after a blow or two, and required straightening by the foot, while the superior metal of the Romans stood the brunt.

Strabo mentions that one of the exports of Britain was iron; the bold islanders met their invaders with scythes, hooks, broadswords, and spears of iron.

The arrival of the Romans and the introduction of artificial blast, which the Romans had derived from their Eastern neighbors, gave a great impulse to the iron works of England.

Under Adrian, A. D. 120, a fabrica or military forge was established at Bath, in the vicinity of iron and wood.

During the Roman occupation of England, some of the richest beds of iron ore were worked, and the *débris* and cinders yet exist in immense beds to testify to two facts: one, that the amount of material worked was very great; the other, that the plans adopted were wasteful, as it has since been found profitable to work the cinder over again.

During the Saxon occupation the furnaces were still in blast, especially in Gloucestershire.

The early Norman sovereigns were so intent upon skinning the Jews and the Saxons, that it became dangerous to succeed in any business, success being an invitation to the barons to plunder. Accordingly, we find in the time of King John that iron and steel were imported from Germany.

The business lumbered along for some centuries, the government tinkering at it now and again, the exportation being prohibited in the fourteenth century, and the importation of iron in the fifteenth century.

The direct method of obtaining wrought-iron from the ore prevailed until the commencement of the fifteenth century, but then gradually gave way to a less direct process, but one more convenient when handling large quantities. Blast-furnaces, operating by the aid of strong blast, to *melt* the iron and obtain *cast-iron*, which is carbureted in the process, were in use in the neighborhood of the Rhine about A. D. 1500. A second process in a *forge-hearth* was used to eliminate the carbon and other impurities, and the result is *wrought-iron*. The *puddling-furnace* was invented more than 250 years afterward.

In the sixteenth century (1590), we find a notice of a mill for slitting iron into bars for smiths' use by Godfrey Bochs.

The change from the use of wood coal to that of mineral coal was only accomplished in England after a great many futile attempts.

In the reign of Elizabeth, blast-furnaces were of sufficient size to produce from two to three tons of pig-iron per day by the use of charcoal. In the small works, the iron was made malleable before being withdrawn from the blast-furnace, and in larger works was treated by the refinery-furnace.

Wood becoming scarce, and a number of furnaces having gone out of blast, in 1612, Simon Sturtevant was granted a patent for thirty-one years for the use of pit-coal in smelting iron. Failing in his proposed plans, he rendered up his patent the following year.

The patent was granted in 1613 to John Ravenson, who also failed, and resigned his patent, which was again and again granted to succeeding inventors and adventurers who believed themselves possessed of the means and knowledge for accomplishing the object.

In 1619 the patent came into the hands of Dudley, who at the age of twenty left Oxford University to take charge of his father's furnaces at Pensnet, in Worcestershire, and who succeeded in producing three tons of iron per week in a small blast-furnace by the use of coke from pit-coal. The parties who yet possessed plenty of wood, and with whom the production of iron was fast becoming a monopoly, urged the charcoal-burners to destroy the works of Dudley, which was done. Dudley's patent was granted for thirty-one years, which would bring it to 1650, the time of the Protectorate, when England had a ruler fit to succeed Queen Bess. The celebrated statute of King James, limiting the duration of patents to fourteen years, was passed in 1624.

From the circumstance that Dudley petitioned Oliver Cromwell and Council for a renewal of the term, two things are evident: one, that he had pursued the scheme and anticipated or had achieved success; the other, that the limitation of his patent from thirty-one to fourteen years had not been enforced or had been revoked. Dudley charges that the extension of his term was refused by the influence of favorites of the Protector, who wished to share in his profits, and on his refusal defeated his application for extension.

It is likely that Dudley only received a moderate remuneration for his pains, as no one seems to have taken any interest in the business after it was thrown upon the public by the expiration of his patent. Iron of poor quality continued to be made in districts where wood was scarce, and of good quality from charcoal in places where the forests yet remained. The demand for iron continuing to grow, — a natural effect of advancing civilization, — iron was exported from Sweden and Russia in large quantities and of excellent quality. The forests of these countries gave them a natural advantage over England, whose woods had by this time become thinned out, so that the use of wood for iron smelting had been forbidden by act of Parliament in 1581, within twenty-two miles of the metropolis, or fourteen miles of the Thames, and eventually was forbidden altogether.

The art of making iron with pit-coal, and of casting articles of iron, was revived by Abraham Darby, of Colebrookdale, about 1713, and was perseveringly followed, although it was but little noised abroad. In the Philosophical Transactions for 1747 it is referred to as a curiosity.

Certain parties had attempted to smelt iron in clay pots exposed in a furnace, resembling that used for glass, to the flame of a pit-coal fire, expecting to procure the iron by tapping the pots. The scheme, which might have answered with a more tractable material, failed in the case of the iron ore.

Tinning of iron was introduced from Bohemia in 1681.

The extension of the iron manufacture dates from the introduction of the steam-engine, which increased the power of the blast, and the blowing engines driven by manual, horse, or ox power were superseded by engines. The dimension of the blast apparatus was increased from time to time, and about 1760 coke was commonly used in blast-furnaces. In 1760 Smeaton erected at the Carron works the first large blowing cylinders, and shortly after Boulton and Watt supplied the steam-engines by which the blowers were driven. Peter Onions, in his patent of 1783, described the *rationale* of the puddling process; and Henry Cort, of Gosport, in 1784, made it practicable, and added grooved rolls, by which the puddled bar was drawn. Neilson, of Glasgow, introduced the hot blast in 1828. Aubulot, in France, in 1811, and Budd, in England, in 1845, heated the blast by the escaping hot gases of the blast-furnace. The Calder works, in 1831, demonstrated the needlessness of coking when hot blast is employed.

Experiments in smelting with anthracite coal were tried at Mauch Chunk in 1820, in France in 1827, and in Wales successfully by the aid of Neilson's hot-blast ovens in 1837. The experiment at Mauch Chunk was repeated, with the addition of the hot blast, in 1838, 1839, and succeeded in producing about two tons per day. The Pioneer furnace at Pottsville was blown July, 1839.

The first iron-works in America were established near Jamestown, Virginia, in 1619. In 1622, however, the works were destroyed, and the workmen, with their families, massacred by the Indians. The next attempt was at Lynn, Massachusetts, on the banks of the Saugus, in 1648. The ore used was the bog ore, still plentiful in that locality. At these works Joseph Jenks, a native of Hammersmith, England, in 1652, by order of the Province of Massachusetts Bay, coined silver shillings, sixpences, and threepences, known as the "pine-tree coinage," from the device of a pine-tree on one face.

Of the special processes for treating and purifying, a few may be cited: —

Smelting by blast with charcoal, pit-coal, and coke, and with the addition of limestone or shells as a flux, have been noted. See *supra*; also Blast-furnace.

Puddling and *boiling*, somewhat similar operations for burning the carbon of pig-iron and eliminating other impurities, are considered under those heads. See also Decarbonizing-furnace; Reducing-furnace; Malleable Iron; Bessemer Process; Forge, etc. See list under Metallurgy.

Steel processes are considered under Steel. See also Bessemer Process; Convertor; Cementation-furnace, etc.

A process for decarbonizing molten cast-iron by applying an air-blast in the hearth of a blast-furnace was invented by C. Shunk.

Kelly patented in the United States, in 1857, a mode of decarbonizing molten crude cast-iron by running it into a cupola or vessel, separate from that in which it was melted, and blowing through it from the bottom a blast of air, so as to burn out the excess of carbon, — the blast being strong enough to furnish rapid combustion of the carbon, and thereby retain the temperature and fluidity of the molten metal until sufficiently refined, without the use of other fuel.

Bessemer worked as an original inventor in the same line, and much improved the process in general and in detail. Holley gave it its American form. See Bessemer Process.

The process of decarbonizing the molten iron by addition of manganese is found in Reynolds's English patent, about 1800.

Mushet's patent consisted in the introduction of manganese or other highly oxidizable metals, during the process of melting the crude iron, for the purpose of detaching and removing oxidized substances.

Krupp uses spiegeleisen.

Schmit, of the Troy Bessemer works, recommends ferro-manganese in small quantities and in solid pieces, as a recarburizer.

Clay's process of making wrought-iron direct from the ore (English, 1843) consists in sifting rich ground ore, mixed with $\frac{1}{10}$ weight of coal, into the chamber of a furnace where it is puddled and balled; after this it is shingled and rolled in the ordinary manner.

Jameson's process consists in exposing the calcined and crushed ores in a series of deoxidizing chambers, where it is exposed to the heat of the burning gases which come from the furnace below. It is pushed from the floor of one chamber to another, and in the last chamber is exposed to hydrogen generated by the decomposition of a jet of steam injected upon it to aid in ridding it of sulphur and phosphorus. Thence to the charcoal bed and refining chamber, where the *loop* is formed, and whence it is taken to the hammer.

Henderson's process for the manufacture of iron-steel (patents, 1870) embraces the use of fluor-spar and titaniferous ores, and treating crude ores by fluorides and oxides.

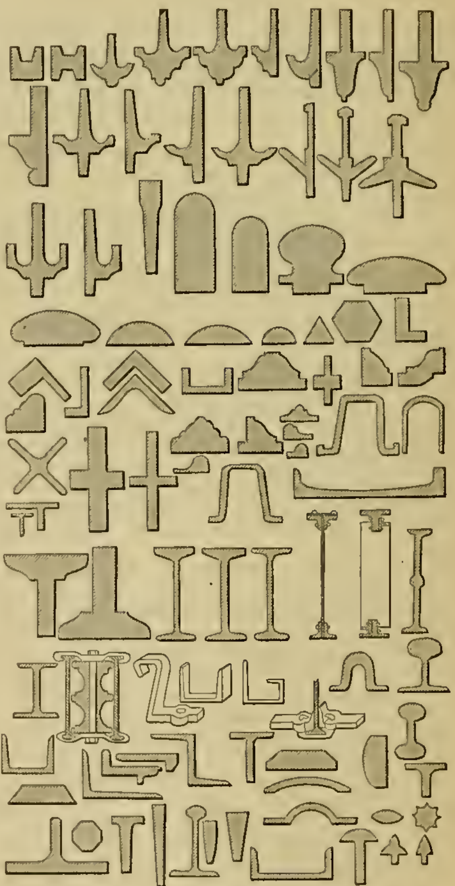
The Ellershausen process consists in the conversion of crude cast-iron into wrought-iron by the admixture of granulated iron ore, a layer of molten iron, and a sprinkling of powdered ore, alternating in molds. These blooms are put in a reverberatory, puddled, squeezed, and rolled.

Bessemer has patented in England a mode of applying to the decarbonization of iron, nitrates, chlorates, and other salts, which evolve oxygen when heated.

By Blair's process, patents Nos. 126, 923, 924, 925, of 1872, the oxides of iron are subjected, in contact with solid carbon for a certain time, to a uniform red heat, the access of other oxygen during the process being prevented. By this means the oxygen leaves the iron and unites with the carbon, passing off in a gaseous state, while the iron remains, being reduced to a metallic state as iron sponge. The metallic iron thus obtained is, however, in a very sensitive condition while hot, and in that state absorbs oxygen with great avidity; but, if cooled before being brought into contact with the atmosphere, it does not readily re-oxidize.

After reduction, the iron sponge retains the shape of the ore from which it is derived, but somewhat expanded in bulk, and with very marked loss of weight. It has a spongy texture; is readily sectile; is easily indented by the finger-nail; chews like lead between the teeth, and polishes quickly to a silvery luster. Its color, unless influenced by some coloring matter accidentally present in the ore, is grayish, varying from blackish to a clear lead-color. When powdered and burned in the open air it sparkles brilliantly, as does iron burned in an atmosphere of oxygen.

Fig. 2698.



Angle, Bar, Girder, and Rail Irons.

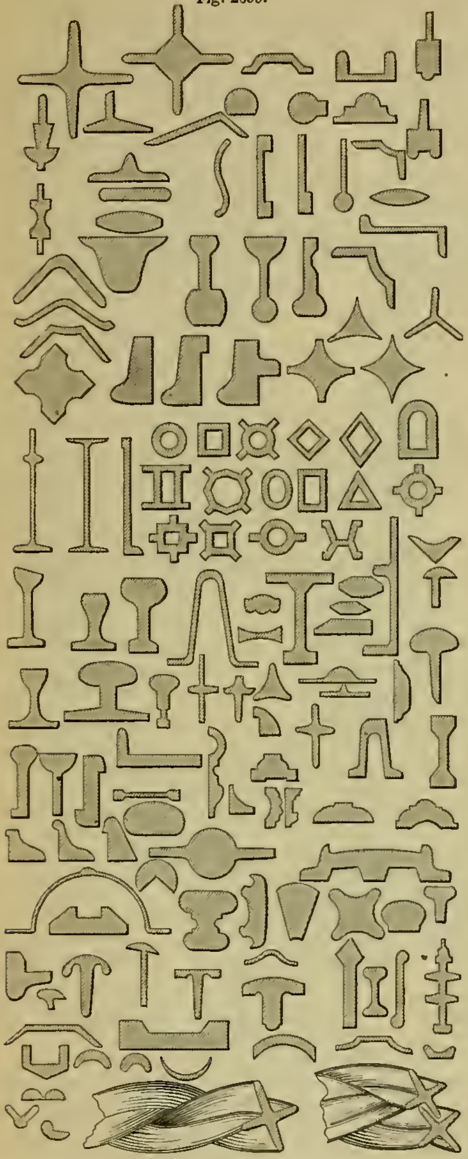
Taylor describes a method of making cast-iron from oxides of iron by reducing magnetic iron ores to powder and separating the iron oxides therefrom by magnets, and preparing and uniting the same for use in the furnace.

See STEEL. Also, and much better, see Percy's "Metallurgy, Iron and Steel," London, 1864.

2. An instrument or utensil of iron.

A *box-iron*, *flat-iron*, *smoothing-iron*, *sad-iron*, or

Fig. 2699.



Angle, Bar, Girder, and Rail Irons.

Italian-iron is a form of heated instrument for smoothing damped clothes, starched or otherwise.

The *iron-heater* is a piece of metal or wire heated in the fire and placed in an urn, *box-iron* or *Italian-iron*, to heat it.

The *iron-holder* is a pad upon the handle to protect the hand; or is a ring or tripod to stand the iron upon temporarily.

Tailors' and *hatters'* irons are forms of smoothing-irons adapted to the uses of the said operatives. A tailor's iron is known as a *goose*.

A *plane-iron* is the bit or cutting portion of a joiner's plane.

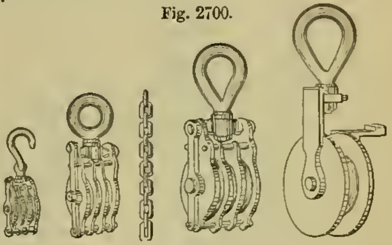
3. The iron portion of a thing, as a *boom*-iron, or *pump*-iron; a *clip* of a single-tree; the *plow*-irons, the iron portions of a plow, etc.

I'ron, An'gle, etc Figs. 2698 and 2699 show forms of rolled iron for bridges, girders, beams, rails, etc.

See Brandt's "Eisen-Konstructionen," Berlin, 1865; Heinzerling's "Die Brücken in Eisen"; Fairbairn's "On the Application of Cast and Wrought Iron," London, 1854; Zorè's "Recueil de Fers Spéciaux," Paris, 1853; and Maurer's "Die Formen der Walzkunst und das Façoneisen," Stuttgart, 1865. See also ANGLE-IRON.

I'ron-block. A tackle-block with an iron shell and strap. The illustration shows several kinds and sizes.

Fig. 2700.



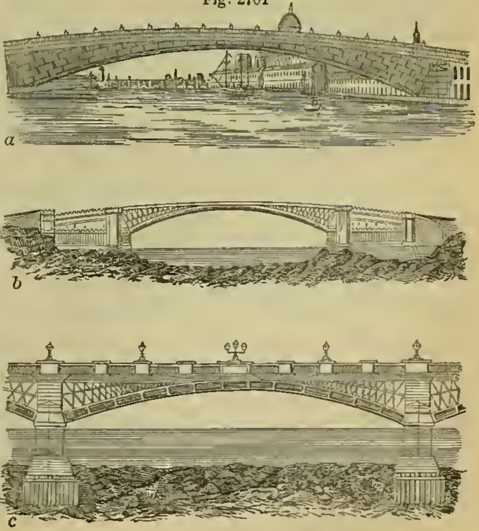
Iron-Blocks.

I'ron-boat. One made of iron-sheets, riveted together.

I'ron-bot'tle. An iron bottle with a screw-plug, for holding quicksilver. It is made by swaging and drawing from a disk of tough wrought-iron. After being brought by swaging to the form of an open-ended cylinder, it is put on a steel mandrel and driven through holes of decreasing dimensions till it becomes a long cylinder. The neck is pressed and twisted into shape and fitted with a screw-stopper.

I'ron-bridge. Iron-bridges were first used in China. — DU HALDE.

Fig. 2701



Cast-Iron Bridges.

Iron-bridges are of many forms: cast-iron arches, lattice, truss-girders, arched beam, or arch and truss, tubular girder, tubular arch, suspension. These are most of them considered under these separate heads.

The first built in England was an arch of cast-iron sections, erected in 1779 over the Severn, at Coalbrookdale, Shropshire, England, by Abraham Darby and John Wilkinson. It had five ribs, each cast in two pieces, secured where they join at the crown of the arch by a cast-iron key-plate, and connected together horizontally and vertically by cast-iron braces, formed with dovetails and forelocks. The ribs are covered with cast-iron plates, and the railing to the sides was of iron.

Dimensions of some of the principal Cast-Iron Bridges.

Date.	Place.	River.	No. of Spans.	Span. Feet.	Rise. Feet.	Weight. Tons.	Architect.
1779	Coalbrookdale	Severn	1	100.5	45	378 5*	Darby & Wilkinson.
1795	Buildwas	Severn	1	130	27	173.9*	Telford.
1796	Sunderland	Wear	1	240	30	260*	Wilson.
1818	Southwark †	Thames	3	240‡	24	5,308*	Rennie.
1836	"Carrousel"	Seine	3	187	15 5		Polonceau.
1859	Tarascon	Rhone		204 4	13 6		
1854	St Petersburg	Neva		150	13.8		
	New Blackfriars	Thames	5	185§	17		
	Georgetown Aqueduct ‖	Rock Creek	1	200	20		Meigs.

* English tons of 2,240 pounds.

† *c*, Fig 2701.

‡ And two side arches of 210 feet span each.

§ And four spans of 155, 175, 175, 155 feet; roadway and sidewalk, 75 feet wide.

‖ Two cast-iron pipes having a water-way of 42 inches, arched in form, carrying the roadway and forming conduits for the water supply of Washington.

In 1801 Telford proposed a cast-iron bridge (*a*, Fig. 2701) of 600 feet span across the Thames, and one of 500 feet span across the Menai Straits (*b*, Fig. 2701) in preference to the suspension-bridge of 570 feet span erected by him.

Other forms of iron-bridges involve the use of wrought-iron, as in the examples *a*, *b*, *c*, Fig. 2702, which are combinations of the arch and truss.

a is known as the rectangular tubular arch bridge.

b, iron-arch and lattice-girder bridge.

c, strut girder bridge.

d. The Kuilinburg bridge over the Leck, an arm of the Rhine, in Holland. It has nine spans; the principal truss shown in the cut is 515 feet in length, clear span 492 feet, depth in center 35.6 feet; at ends, 26.24 feet; weight of iron, 2,193.94 tons (English). Total length of bridge, 9 spans, 2,181 feet; total weight, 4,490.14 tons (English); clear roadway, 26.25 feet; double railway track.

e is a truss bridge over the Avon in England, the center resting on a cluster of screw-piles.

Dimensions of some of the principal Wrought-Iron Bridges.

Date.	Place	River.	No. of Spans.	Widest Arch Span. Ft In.	Widest Arch Rise. Ft In.	Character.	Architect.
1850	"Britannia"*	Menai Straits	4	458 3	29 3	Tubular	Stephenson.
1860	Plymouth	Hamoaze		433 6	30 6	Tubular	Brunel.
1855	Boyne	Foyle		250	32 6	Lattice	McNeil.
1858	Montreal *	St Lawrence		330	31 8	Tubular	Stephenson.
1857	Cologne	Rhine		313	31	Lattice	
1851	Dirschau	Vistula		398	40	Lattice	
1874	St. Louis †	Mississippi	3	515	51 5	Tubular arch	Eads.
1856	Kuilinburg	Leck	9	515‡	Level.	Lattice	Michaëlis.
	Louisville §	Ohio	29	400	Level.	Truss	

* See Tubular Bridge.

† Two side arches of 497 feet each. See Tubular-arch Bridge.

‡ Clear span of main truss, 492 feet; also one span of 262 feet; seven of 187 feet each. See *d*, Fig. 2702.

§ Whole length, 5,294 feet; weight of iron, 8,723,000 pounds.

The iron truss-girder bridge over the Tay in Scotland, about 1¾ miles west of Dundee, is to be 10,320 feet in length, and to have, commencing on the Fifeshire side, spans as follows: three spans of 60 feet, two of 70, twenty-two of 120, fourteen of 200, sixteen of 120, twenty-five of 66, one of 160, and six of 27 feet. The bridge will thus have eighty-nine spans, and has a hight of about 78 feet above mean high water.

The Girard Avenue Bridge, Philadelphia, is shown on the opposite page. It crosses the Schuylkill River at the entrance to the Fairmount Park, and was built by the Phœnixville Bridge Company. The bridge is 100 feet wide; the frame is entirely of iron, the flooring being iron joists covered with corrugated iron plates and asphate concrete, and granite blocks laid in cement.

I'ron-cham'ber. (*Puddling.*) That portion of the puddling-furnace in which the iron is worked. The *reverberatory-chamber*, *charge-chamber*.

I'ron-clad Ves'sel. One having the exposed portion of the hull protected, in whole or in part, by a covering of iron.

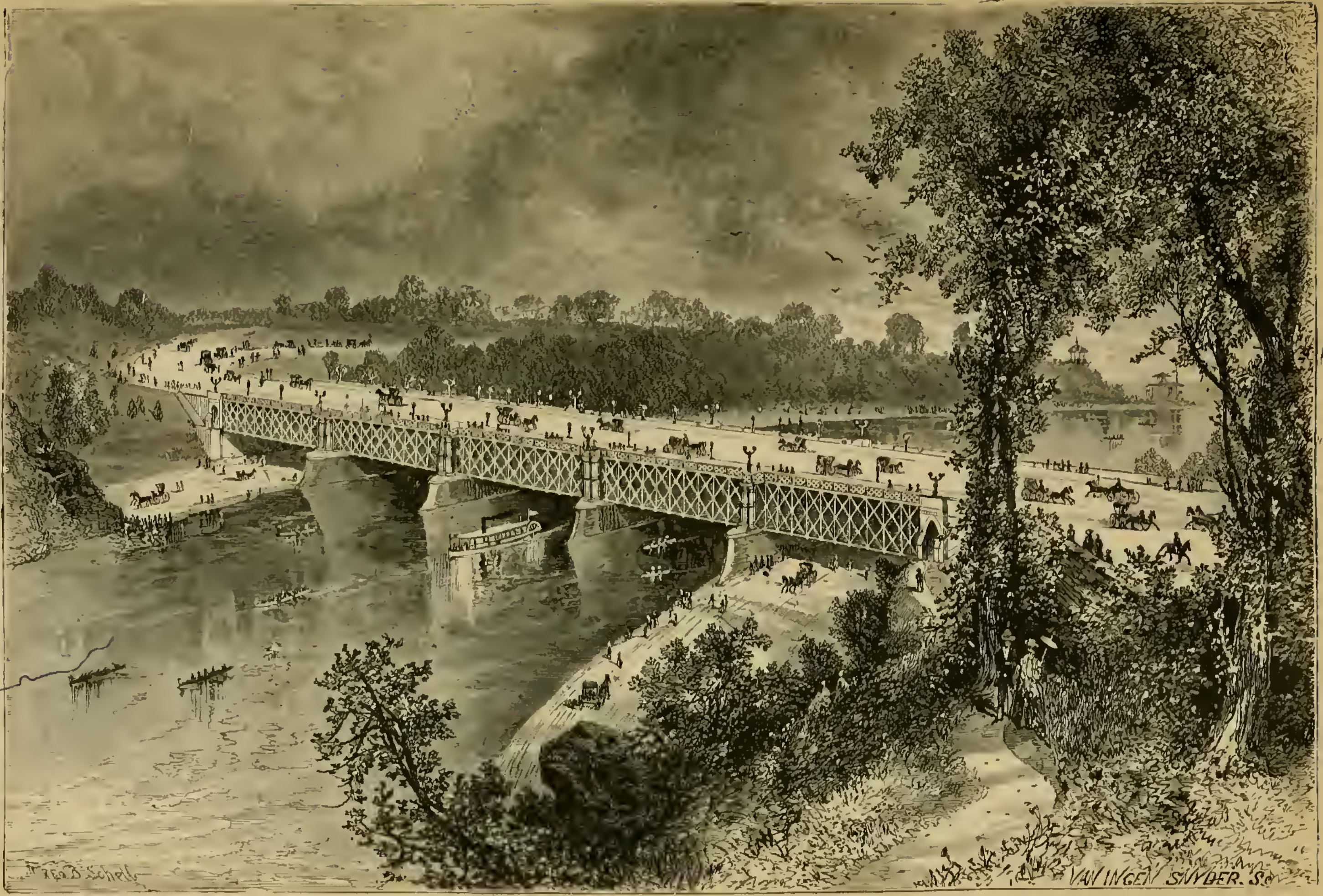
At the siege of Gibraltar in 1782, the French and Spaniards employed floating batteries, made by covering the sides of ships with junk, rawhides, and green timber to the thickness of seven feet, and bomb-proofing the decks. The largest of these vessels was 1,400 tons burden; their armament was 32-pounders, and they were manned by 500 men. They had furnaces for heating shot. These vessels were finally set on fire by red-hot shot. In 1813, Fulton constructed a steam floating-battery for the United States.

The first application of iron for this purpose was by the French, during the Crimean war in 1855, to gunboats. These had a displacement of about 2,000 tons, were 172 feet in length, 43 feet beam, and 17 feet deep, protected by 4½-inch plating, and mounted 16 guns, all of which could be fought on one side. They were frequently struck by shot, but received no severe injury. The English at the same time built gunboats very similar in size and construction. As far back, however, as 1842, Mr. Theodore R. Timby had invented an iron-plated turret, adapted either to ships or fortifications. See Monitor; Turret.

The civil war of 1861 gave a great impetus to improvements in iron-clad vessels; the success of the monitors inducing the governments of Europe to engage extensively in the construction of iron-clads, the tendency being constantly to increase the thickness of the armor.

Iron-clad vessels are of the monitor or turret class, carry guns merely in broadside, or have the two systems combined.

The iron-clads employed by the United States on the Western rivers during the late civil war were mainly river steamers, the sides above the water-line placed at an



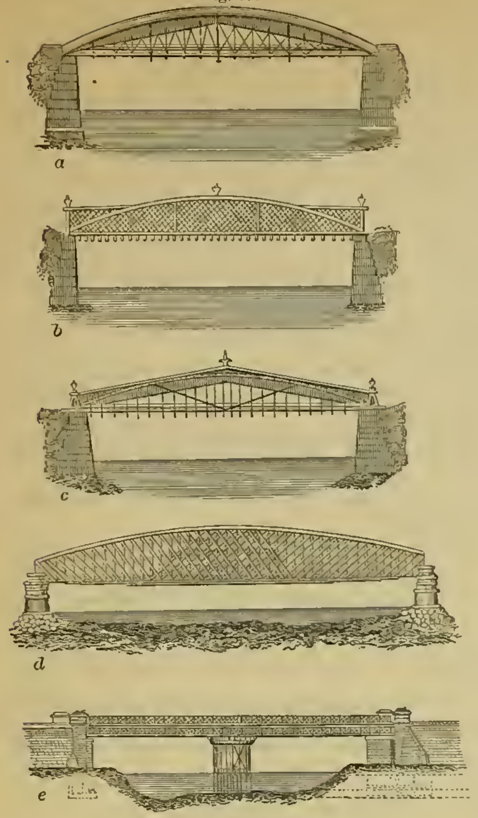
GIRARD AVENUE IRON BRIDGE.

PLATE XXVIII.

OVER THE RIVER SCHUYLKILL; PHILADELPHIA, PA

See page 1:0C.

Fig. 2702.



Wrought-Iron Bridges.

angle of about 30°, and plated with 2 to 4 inches of iron, backed with 3 feet of oak. They carried 4 to 16 guns, and some of them were made to float in 2½ feet of water. They were calculated to fight "bow on," and were practically invulnerable to 100-pound shot when in this position. The "Benton," "Exsex," "Carondelet," "Lexington," and a large number of others, were of this construction. Toward the latter part of the war a number of monitors were built for service on the Mississippi.

A class of vessels plated with ¾-inch iron were jocularly called tin-clads. Their armor was a protection against rifle-balls, but was easily penetrated by shells from the lightest field-pieces.

Improvised iron-clads, consisting of river steamers plated with railroad-iron, were used by both parties on the Mississippi. They were simply makeshifts, but in some cases were found to be quite formidable.

The "Galena" was one of the first three sea-going iron-clads built for the United States government, the "Monitor" and "New Ironsides" being the other two. The "Galena" was a two-masted vessel, 1,000 tons, 300 horse-power, and pierced for 18 guns. Her armor was of overlapping corrugated plates, from 2½ to 4½ inches in total thickness, backed by 18 inches of oak and walnut. In service she was found not to resist shot much heavier than 64 pounds at short range, and she lost many men in her first attack on Fort Darling.

The "Monitor," Ericsson's first iron-clad, was a vessel of about 1,000 tons, 172 feet long, 41 feet beam, 9 feet depth of hold, the deck about 2 feet above the water-line, and overhanging the hull some 6 feet on the sides and 20 feet astern. Under this "overhang" the screw worked. The deck, and the sides for 6 feet below the water-line, were plated with five inches of iron, in one-inch plates, breaking joints. The turret amidships was a round box of iron, built up of inch plates to 20 feet in diameter, 9 inches thick, and 9 feet high, with a grating or covering of railway bars. It contained two 11-inch guns. Her defeat of the "Merrimac" in Hampton Roads, March 9, 1862, rendered this little craft historic. She foundered in a storm, off Hatteras, December 31, 1862. See MONITOR. See also ARMOR-PLATING, p. 152.

The "Ironsides," completed at Philadelphia in 1862, was the only formidable side-gun iron-clad ever put in service in the United States. She was 240 feet long, 58½ feet beam, and rated 3,250 tons, 1,600 horse-power. She was plated with solid plates 4½ inches thick, and carried eighteen very heavy guns, sixteen 11-inch guns, and two 200-pounder rifles. She was found to resist all but the very heaviest shot at the closest range, thus proving the superiority of solid over laminated armor. She was struck more than 70 times in one day, and several hundred times in all, while serving in front of Charleston, but was never seriously injured. She was, unfortunately, burned at the wharf in Philadelphia, 1865.

The "Dunderberg" is an inclined armor broadside ship, of 7,000 tons displacement. Her armor consists of 3½ and 4½ forged iron plates, over a timber backing of from one to six feet. She was built in New York by W. H. Webb, Esq. The contract price was $1,400,000. She was sold by permission of Congress to the Emperor of the French for $3,000,000, having cost much more than was anticipated.

The "Roanoke" is an old United States wooden ship-of-the-line, cut down to near the water-line, plated with 4½ inches of iron, and has three turrets, 11 inches thick, each carrying two 15-inch guns. She was only used for harbor defence, being found to roll so much as to be almost unseaworthy.

The "Merrimac" was a United States wooden ship-of-the-line, and was set on fire at the Norfolk Navy Yard when that place was abandoned at the breaking out of the war. The hull was raised by the Confederates, and a false deck put on, above which an iron-clad fort was built, the sides sloping upward at an angle of about 30°. She carried ten heavy guns, some of them rifled 100-pounders. Her first engagement, March 8, 1862, showed her to be more than equal to a fleet of wooden vessels, she having sunk the "Cumberland" and crippled the "Congress" in a few hours. She was defeated next day by the "Monitor," and blown up two months later to escape capture.

The "Atlanta" was an iron vessel cut down, plated with two thicknesses of 2-inch iron plates over heavy wooden backing. She was captured by the monitor "Weehawken," June 17, 1863, having been disabled at the fourth shot from that vessel.

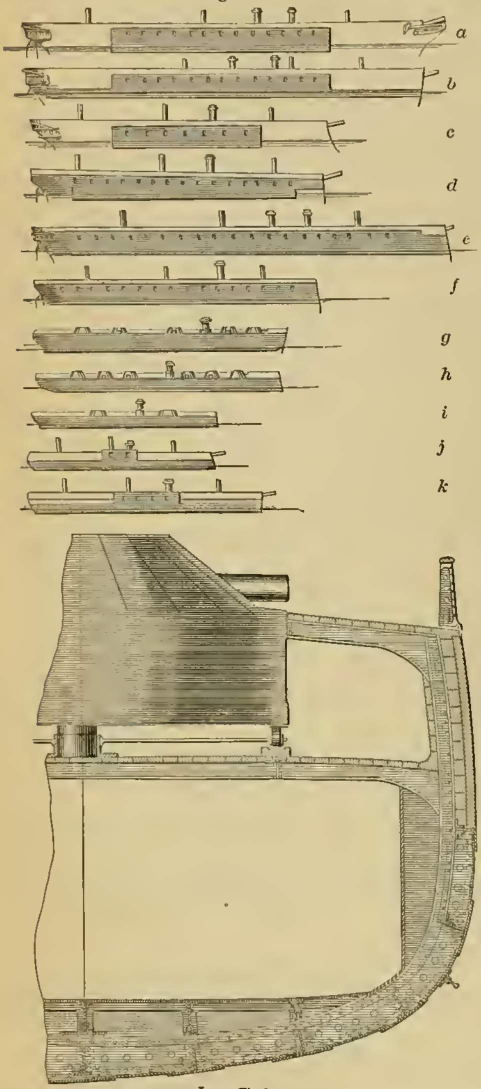
Most British iron-clads are built on the broadside principle, the "Captain," built something on the monitor plan, having foundered in a moderate sea, carrying down all on board.

The "Lord Clyde," said to be the fastest English iron-clad, is 280 feet long, 59 feet beam, 21 feet draft, 4,067 tons burden. The cylinders of her engines are 116 inches diameter, having 4 feet stroke. The boilers, nine in number, have brass tubes 2½ inches in diameter, with an aggregate heating surface of 19,000 square feet.

On her trial trip a speed of 13½ knots per hour was attained.

The "Hercules," launched in February, 1868, is 325 feet long, 59 feet beam; tonnage, 5,662; draft, 24½ feet when fully equipped. Her ram is a solid mass of iron, weighing 5 tons. She has 5 water-tight bulkheads. The iron plating is from 6 to 9 inches thick, the former thickness extending the entire length of the vessel to several feet below the water-line. This is backed by 10 inches of teak, 1½ inches of iron, 20 inches more of teak, and ¾ inch of iron. The engines, of 1,200 nominal horse-power, are capable of being worked up to 7,000 horse-power. The weight of iron used in construction of the vessel is stated at 9,520,000 pounds; of wood, 1,814,400 pounds.

Fig. 2703.



Iron-Clads.

The thickness of armor-plating has been greatly increased since its first introduction; thus the "Warrior," built in 1861, has plating 4½ inches thick, that of the "Bellerophon" is 6 inches, and that of the "Hercules," as already stated, 9 inches. The French have increased the thickness of their plating to 15 centimetres, about 6 inches; and the "Marengo" and "Ocean" have plating 20 centimetres, or nearly 9 inches, in thickness.

Plates for experimental purposes have been rolled 15 inches thick, and it is claimed that plates of sound and uniform quality can be rolled 10 inches thick.

To resist the attacks of iron-clads the British government is erecting at Spithead two forts, plated with 15-inch iron. Each fort is 700 feet in circumference, 230 feet in height, and is armed with two tiers of guns, one consisting of twenty-four 600-pounders, and the other of twenty-five 400-pounders. The two will command the only deep channel leading from the sea to Portsmouth Harbor. The estimated cost of each fort is about £1,000,000 sterling. See ARMOR-PLATING.

Fig. 2703 shows broadside views of a number of English iron-clads, and is introduced to illustrate the modes of arming and of protecting; the shaded portions indicating the partial protection only, afforded in some instances to the battery and engines, and at about the water-line.

a shows the "Warrior" and "Black Prince" class of 6,039 tons.

b, the "Achilles," of the same size.

c, the "Defence" and "Resistance," 3,668 tons.

d, the "Hector" and "Valiant," 4,063 tons.

e, the "Northumberland," "Minotaur," and "Agincourt," 6,621 tons.

f, the "Prince Consort," "Royal Oak," "Royal Alfred," "Ocean Triumph," and "Caledonia," 4,045 tons.

g, the "Royal Sovereign," 5-turreted vessel, 3,765 tons.

h, the "Prince Albert," 6-turreted vessel, 2,529 tons.

i, a two-shield ship of 1,385 tons.

j, the "Enterprise," 990 tons.

k, the "Favorite," 2,186 tons.

The lower portion of the figure is a midship section of a British iron-clad ship of 1,385 tons, carrying two of the shields as adapted by Captain Coles of the British service. He was unfortunately drowned in the "Captain," which capsized off Cape Finisterre. The turret is shown as rotating on a central axis, and a circular system of anti-friction rollers. The conical portion only of the shield is exposed above deck, and the bulwarks are made hinging, so as to be thrown down when in action. The ribs, floors, iron-plating, and backing are also clearly shown.

The "Glatton," a modified monitor on Captain Coles's plan, was subjected to experimental firing by the British government to determine whether, by the impact of a 600-pound shot propelled by a 12-inch rifled gun, this turret could be jammed or prevented from working. There was also to be ascertained the probable damage that might be caused to the guns and other interior fittings of the turret.

The armor-plating of the latter, against which the shot was to be thrown, consisted of, first, one rolled covering of iron fifteen inches in thickness, disposed in two tiers, and secured to the backing and inner skin by bolts. Behind this armor-plating there is fourteen inches of teak, then an inner skin formed of two ¾ inch iron plates.

The gun used was one of the 25-ton 12-inch muzzle-loading Fraser guns, made at the Woolwich Arsenal. The projectiles selected were the Palliser 600-pound shot, solid and chill-headed, and the powder charge was 85 pounds large pebble. The vessel carrying the gun, the "Hotspur," was moored at a distance of 200 yards from and on nearly a parallel line with the "Glatton." In the turret of the latter, a kid, a rabbit, and a fat hen were placed to try the effects of concussion.

The first shot which struck, took the turret armor in its weakest part, in the center of the turret-wall, upon a bolt-head and upon the lower edge of the upper 14-inch armor-plate. It lifted the upper plate until its lower edge was separated from the upper edge of the lower plate to a distance of 2½ inches, the upper edge of the lower plate, where the shot penetrated, being depressed nearly one inch by the sheer downward force of the shot.

The fracture extended upward from the plate's lower edge in a three-quarter-circle form, measuring 17 inches vertically and nearly 20 inches along the plate's edge. Inside the turret, the inner end of the bolt struck by the shot was found to have driven in and fractured the inner skin or iron lining, its nut breaking off and lodging upon one of the trunnions of the starboard gun.

The depth of penetration was 15 inches. Still, with all the immense striking force of the shot, estimated at a little over 6,100 tons, there was no through penetration, and the turret was found to revolve with the same facility as before the shot was fired. None of the gun fittings or gear were injured in any way. The kid, the rabbit, and the hen looked dazed, but they had sustained no other injury.

The German navy has the following iron-clads: "King William," 345 feet long, 58½ feet beam, covered with 8-inch iron-plates and 20 inches of elastic wood; it has 23 guns. "Prince Frederick Charles," 282¼ feet long, 52¾ feet beam, protected by 5 inches of iron and 15 inches of elastic wood cushioning; carries 16 guns. "Crownprince" is 277¾ feet long, 48½ feet beam, covered with 4½ to 5 inches of iron and 10 inches of elastic cushioning; bears 16 guns. "Arminius" is 194 feet long, 35 feet beam, covered with 4½ inches of iron and 9 inches of cushioning; bears 4 guns. "Prince Adalbert" is 154 feet long, has 4-inch iron-plates, 8 inches of cushion, and carries 3 guns. The last two ships are monitors. The guns are all of heavy caliber.

The Russian sea-going turret ship "Peter the Great" is 329 feet 8 inches length between perpendiculars. Her greatest outside breadth is 63 feet. The builders' measurement is 5,352 tons, and the displacement, with coal, stores, and water in boilers, will be 9,665 tons, at a mean draft of 23 feet 9 inches. The plates on the ship's sides and on the raised building amidships vary from 12 to 14 inches, and the armor-plate protects the ship to a depth of 6 feet below the water-line. The vessel has no spur, but the upright stem is heavily plated and of enormous strength. The ship has two large turrets, which are plated with 16 inches of iron in two thicknesses of 14 and 2 inches. She has no masts, but depends entirely on her compound engines, which were built at St. Petersburg. Each engine is of 700 horse-power, and connected with 2 four-bladed screws. There are 12 boilers, which will require at full speed 132 tons of coal in 24 hours; and at this rate of consumption the engines will work at 10,000 effective horse-power, and the ship will be driven at 14½ knots speed per hour. If the engines are worked at the second grade of expansion, she will have coal for 17 days, steaming 12½ to 13 knots per hour.

With the single exception of the teak-wood backing, all the materials of the ship, engines, and armament were produced in Russia, by Russian workmen.

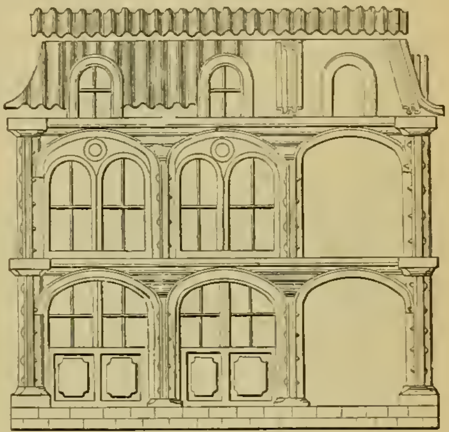
A round vessel invented by the Russian Admiral Popoff is 100 feet in diameter, plated with 9 inches of iron, and propelled by six screws on the part which may, by courtesy, be called the stern. A turret amidships carries two guns, which are fired *en barbette*. Below the water-line the vessel is divided into a large number of water-tight compartments.

I'ron, Cor'ru-ga-ted. Corrugated iron is used in many structures, — houses, sheds, cars, carriages, boats, tanks, etc.

As a covering for buildings it was first used as a roof for the Eastern Counties Railway Station at the London terminus, 1840. The plan is rectangular, with three aisles 230 feet long. The middle aisle 36½ feet wide, the side aisles 20½ feet. The iron is No. 16 wire gage, $\frac{1}{16}$th of an inch. The curve of the arch is at right angles to the corrugation. The sheets are riveted together in the direction of their length. The water follows the curves of corrugation to the gutters, which lead it to the posts; these are hollow, and conduct it to drains beneath the pavement.

Corrugated iron is in extensive use for buildings in countries deficient in wood, especially in some of the English colonies in the southern hemisphere; for railroad stations, exhibition and temporary buildings, warehouses, railroad freight cars, fire-proof floors, partitions and roofs, gutters, window-shutters.

Fig. 2704.



Corrugated-Iron House.

Fig. 2704 is an elevation of a house made of corrugated sheet-metal upon an iron frame.

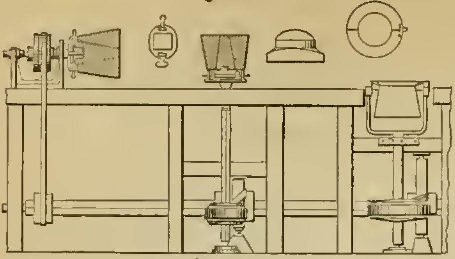
I'ron-fur'nace. (*Metallurgy.*) A furnace in which iron ore or the metal is exposed to heat. The purposes and construction are various. The subject is treated under the different heads: BLAST, REDUCING, DESULPHURIZING, DECARBONIZING, PUDDLING, FURNACES. See list under METALLURGY.

I'ron-ing-board. (*Domestic.*) A laundry implement on which clothes are ironed; sometimes having a special shape, as for bosoms, pantaloons, etc.

I'ron-ing-lathe. (*Hat-making.*) A machine having mandrels carrying blocks on which hats are mounted for ironing. The different blocks and positions shown are for holding the hat while the side, crown, and outside and inside of the brim respectively are ironed.

I'ron-ing-ma-chine'. One for ironing clothes, etc. Specific forms are make for hat-ironing, for hosiery, and for tailors. The example shows one

Fig 2705.



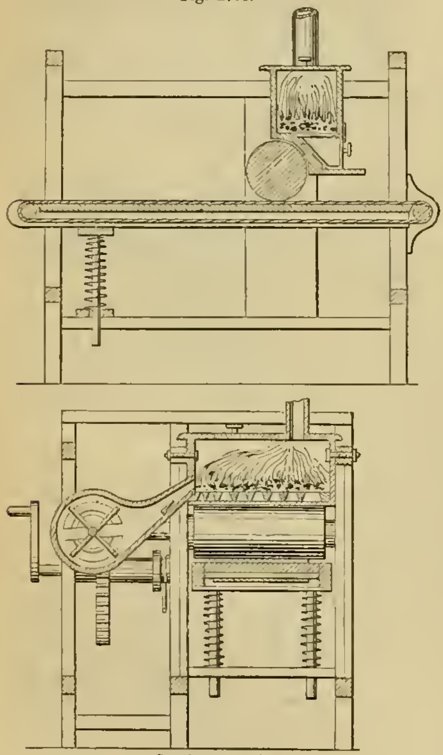
Hat-Lathe.

in which the clothes are carried on the endless belt under the heated roller. The table is depressible to allow the passage of heavy articles. The roller cover is the bottom of the fire-chamber, and the fire is urged by air from a blower driven by the crank which carries the endless apron.

I'ron-liq'uor. (*Dyeing.*) A solution of acetate of iron, used as a mordant by calico-printers.

I'ron-man. (*Cotton-manufacture.*) A name applied to the self-acting mule invented in 1825 by Roberts, of Manchester, England. The working of the ordinary mule was confided to the most skillful operatives. The machine by which their services were dispensed with was regarded as a triumph of ingenuity, and was thus named. See MULE.

Fig. 2706.



Ironing-Machine.

I'ron-pa'per. A name given to extremely thin sheet-iron, which has been rolled thinner than the finest tissue-paper. In the American Department of the British Exhibition of 1851 very thin specimens were shown, and from this period a lively competition ensued as to who would show the finest and thinnest specimens. The results are mentioned under SHEET-IRON (which see).

I'ron-pipe. Welded iron tubes are made of skelps bent to a circular form, heated to a welding heat in an appropriate furnace, and then drawn on a draw-bench through a pair of jaws with bell mouths. The mouths are opened to receive the end of the skelp, and then closed. The tube is drawn without a mandrel. The sizes are from —

6 inches internal diameter, $\frac{1}{4}$ to $\frac{3}{8}$ inch thick.

$\frac{1}{4}$ inch internal diameter, $\frac{1}{16}$ inch bore.

For *cast-iron water-pipes* the working tension may be $\frac{1}{6}$ of the bursting tension, say, —

Bursting tension . . .	16,500 pounds.
Proof tension . . .	5,500 "
Working tension . . .	2,750 "

The working tension of *cast-iron steam-pipes* should be $\frac{1}{6}$ only of the ultimate tension.

I'ron-rust Ce-ment'. A cement for stopping joints or cracks in iron-work. It consists of iron borings or filings, 112; sal-ammoniac, 1; sulphur, 1; whitening, 4. Mix with water and use. It forms a dense rust. See CEMENT, page 508.

I'ron-sand. 1. (*Pyrotechnics.*) Steel filings, used in pyrotechny for brilliant fire, etc.

2. A variety of octohedral iron ore in grains.

I'ron, Sheet. See SHEET-IRON.

I'ron-stone Chi'na. One of the contributions of Wedgwood to the ceramic art.

The materials of the Staffordshire ware are calcined flints and clay. The flints are burned in kilns, and then, while hot, quenched in water, by which they are cracked through their whole substance. After being quenched they are ground, with water, in mills resembling the arrastra. The mill is a hollow cylinder of wooden staves bound with hoops, and having a bottom of blocks of chert; the mill-shaft is perpendicular and has two horizontal arms, between which are laid loose blocks of chert, which are moved round on the bed-stone as the arms revolve, and thus grind the flint with water to the consistence of cream.

The clay, from Dorsetshire and Devonshire, is mixed with water, and in this state, as well as the flint, is passed through fine sieves to separate the grosser particles. The flint and clay are now mixed by measure, and the mud or cream is passed again through a sieve, in order to render the mixture more complete.

In this state it is called *slip*, is then evaporated to a proper consistence in long brick troughs, and tempered in the pug-mill. Cups, pots, basins, and other round articles are turned rough on the horizontal potter's-wheel, and when half dried are again turned in a lathe. They are then fully dried in a stove, and the remaining roughnesses are afterwards removed by friction with coarse paper. Articles that are not round, and the round ones that have embossed designs on their surface, are made of thin sheets of clay rolled out like dough, and then pressed into molds of plaster of paris; the molds, being previously dried, absorb the superficial moisture of the clay, and thus allow it to part from them without injury. The two or three separate pieces composing the article are then united by means of slip. Spouts and handles of jugs and teapots are united with the body of the vessel in the same way. Small handles, beadings, moldings, etc., are formed by means of an iron cylinder having its bottom perforated, so as to mold the clay, as it passes through, into the required figure. A piston descends slowly in the cylinder, and drives the clay out through the perforation; it is then cut off in lengths. To form a plate, a lump of clay is beaten or rolled into a flat cake, which is then laid on a mold turned to the shape of the upper surface of the plate. A rotary motion is given to the mold, and an earthenware tool representing a section of the bottom of the plate is pressed on it. Cups, saucers, and basins, when rough turned, are dried on the block to keep them from warping. The ware, being thoroughly dried, is packed into saggars and burned in the kiln to biscuit. Patterns for flat or nearly flat surfaces are put on by printing the pattern from a copperplate with an ink composed of oxide of cobalt, oxide of iron, or other coloring matter, mixed with oil. The impression is taken on tissue-paper, and is applied without drying to the surface of the biscuit, and slightly rubbed to make the print adhere; the biscuit is then soaked in water till the paper may be stripped off, leaving the print or pattern behind. The ware is then dipped in the glaze, which is a mixture of flint slip and white-lead, and the bibulous quality of the biscuit causes a sufficient quantity to adhere; the piece is then dried and again passed into the furnace, which brings out the colors of the pattern, and at the same time vitrifies the glaze.

The finest patterns for curved surfaces are applied after the glazing has been completed, by taking the impressions from the copperplate on a flexible strap covered with a strong gelatinous mixture of glue and treacle. This strap is then pressed on the ware, and gives the impression in glue; the coloring powder is then dusted over it, and a sufficient portion adheres to the damp parts to give the pattern, after having been again in the kiln. The more elaborate patterns on earthenware, and all those on porcelain, are finished by penciling in.

Iron Ves'sel. The first iron boat was built in 1787, by J. Wilkinson, of Bradley Forge, England. It was 70 feet long, 6 feet 8½ inches beam. The plates were $\frac{5}{16}$ inch, secured by rivets. The stem and stern-post were of wood, the beams of elm planks. Her weight was 8 tons, capacity 32 tons; she drew 8 to 9 inches of water when light, and plied on the Birmingham Canal.

An iron pleasure-boat was launched on the Mersey in 1815 by T. Jevons of Liverpool. It was scuttled by jealous shipbuilders, and an iron *life-boat* launched by the same person in 1817 experienced the same fate.

The first iron steam-vessel launched and put to sea was projected and built for A. Manby of Staffordshire, for the river Seine, in 1821. She took in a cargo of linseed-oil and iron castings, and was navigated direct from London to Havre, and from that port proceeded to Paris, where she discharged her cargo. She navigated the Seine for many years, and may yet.

The iron steamboat "Alburkah," for the Lander Expedition up the Niger, was built in 1831. She was 70 feet long, 13 feet beam, and 6½ feet deep. When launched she drew 9 inches of water; when equipped she drew 40 inches. She was navigated to the scene of her exploits, twice ascended the river, and her ribs upon the strand of Clarence Cove were visible but a few years since, and may yet remain. Her engines were 16 horse-power. Her weight, without engine, 33,600 pounds.

The "Garry Owen" was the first iron vessel with water-tight bulkheads; suggested by C. W. Williams. See BULKHEAD.

Iron vessels for America, Ireland, France, India, and China were built in Scotland and on the Mersey, 1833–39.

The iron steam-vessels "Nemesis" and "Phlegethon" were used in the villainous Opium War of 1842. They were not the last vessels built on the Clyde for piratical expeditions.

The "Ironsides" was the first iron sailing vessel of any magnitude employed for sea voyages.

The "Great Britain," built at Liverpool, was the boldest effort in iron shipbuilding in her time, but was eclipsed by the "Leviathan," afterwards renamed the "Great Eastern," which was built from the designs of Brunel, by Russell & Co., at Millwall, on the Thames.

She was commenced in 1853, and was four years in building.

The proportions and capacity are as follows: —

Length between perpendicular		680 feet.
Length on upper deck		692 "
Breadth of the hull		83 "
Breadth, including paddle-boxes		118 "
Depth of the hull		60 "
Weight of iron in the hull		16,800,000 pounds.
Weight with engines, stores, and complement		56,000,000 "
Draft, loaded		30 feet.
Number of iron plates		10,000
Number of rivets		3,000,000
Passenger capacity, first class	800	
Second class	2,000	
Third class	1,200	
		4,000
Crew and engineers		400
Paddle-wheels, in diameter		56 feet.
Float-boards, in length		13 "
Screw-propeller, diameter		24 "
Screw-propeller, length of shaft		160 "

The design was to make the "Great Eastern" on the principle of a wrought-iron girder. For this purpose, the bottom, sides, and deck are cellular, and each shell water-tight. The distance between the shells is 34 inches, and is traversed by 35 ribs or webs running longitudinally from stem to stern. Similar webs traverse the cellular deck.

An elaborate system of transverse and longitudinal bulkheads divides the vessel into numerous compartments, so arranged as to form the required spaces for engines, boilers, coals, cargo, and passengers. Of these are 10 or 12 transverse, water-tight bulkheads, which have no openings below the lower deck.

The means of propulsion are paddles, screw, and sails; six masts carrying 6,500 yards of canvas.

The details of the donkey and pumping engines, gas and telegraph apparatus, the fleet of boats, and the two steam-tenders, 90 feet long, hanging from davits abaft the paddle-boxes, are highly interesting, and may be found in the journals of the day and in works specially devoted to marine and steam engineering.

I'ron-wheel. See CARRIAGE-WHEEL; CAR-WHEEL.

I'ron-work Paint. Graphite and hot coal-tar.

Solution of silicate of soda (20° Baume), 2 parts; zinc oxide, 1 part.

Asphaltum and resin, equal parts, dissolved in spirits of turpentine.

For machinery: caoutchouc, 2 pounds; resin, 4 pounds; shellac, 2 pounds; 5 gallons of benzine.

For wrought-iron structures: scrub with wire brushes, fill crevices with a putty of litharge, linseed-oil, varnish, and white lead; repeat the brushing; apply a paint of white-lead, 300 pounds; crude linseed-oil, 10 gallons; boiled linseed-oil, 2 gallons; turpentine, 1¼ gallons. Blow white sand on to a second coat of the same.

Rub the work with heavy petroleum.

Galvanizing-paint: zinc powder and oil varnish.

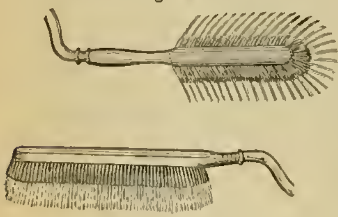
Rub the red-hot iron with wax, tallow, pitch, or coal-tar. See also Varnish.

For bright-work; during transportation and at sea: tallow, with a little white-lead to give it consistence. It is rubbed off when the machine is set up, or the vessel is nearing port.

Ir-reg'u-lar Wheel. Several varieties of gears may be termed irregular; but the variability of each is in regular terms, if the motion of the wheel be continuous; the parts passing through recurrent series of consecutive changes. See Angular Wheel; Cam Gear-wheel; Eccentric Wheel; Elliptical Wheel; Intermittent Wheel; Mutilated Wheel; Scroll-wheel; Sector-wheel; Spiral Wheel; Variable Wheel.

Ir'ri-gat-ing-brush. One having concealed holes through which jets or spray of water passes, in the line of the bristles. An elastic tube leads the water to the brush. It is especially used for cleaning carriages.

Fig. 2707.



Irrigating-Brush.

Ir'ri-ta'tion-in'stru-ment. An acicular instrument used to penetrate the skin as a local irritant. Sometimes used to introduce a vesicatory liquid beneath the epidermis. See Acupuncturator; Hypodermic Syringe.

I'sin-glass. A fine kind of glue or hardened gelatinous composition, composed of dissolved membraneous animal tissues.

The genuine is made in Russia from the sounds and air-bladders of sturgeon, but other kinds are made either of clean scraps of hide, etc., or the purified jelly derived from the digestion of skins, hoofs, horns, etc. In the latter case, it is glue purified by the discharge of fetid smells and putrid flavors.

I-sod'o-mon. A style of masonry in which the face is formed of squared blocks, the courses of equal hights, and the filling of smaller blocks in courses. The *pseudisodomon* had courses of varying hight. See Masonry.

I-so-met'ri-cal Pro-jec'tion. A mode of drawing machines or buildings, in which the plan and elevations are shown in one view. Three planes are projected at an equal angle upon a single plane.

I-tal'ian I'ron. A laundress's smoothing-iron for fluting and smoothing frills.

I-tal'ian Roof. A hip-roof.

I-tal'ic. Inclined type of a peculiar form, as, — *Italic type is said to have been copied from the handwriting of Petrarch, by the famous printer Aldus Manutius. He obtained a patent for the use of this character in type from Pope Leo X., surnamed The Great.*

I'vo-ride. An artificial ivory. A vulcanite whitened by abundant quantity of some white material. See Ivory, Artificial.

I'vo-ry. Specifically, the material constituting the tusk of the elephant.

In a more general sense the term includes the tusks of the walrus, narwhal, and even the teeth of some other cetacea.

The African ivory is preferred to the Asiatic; it has a greater proportion of animal matter, and is less liable to discoloration.

	Animal matter.	Earthy matter.
African ivory	51	50
Asiatic ivory	38	50

The consumption of elephants' tusks in Sheffield, England, is about 45,000 *per annum;* and, allowing for the occasional finding of shed tusks, and those of elephants found dead, it is estimated that 20,000 are slaughtered yearly to supply this *city of cutlers.*

Ivory is rendered flexible by steeping in a solution of hydrochloric acid. This extracts the phosphate of lime and gives flexibility to the ivory, without impairing its form. Tubes and probes of this material have been made, and the partial hardness which occurs on drying may be removed by surrounding the piece with wet linen, or placing pellets of wet sponge in the cavities of the instrument.

Or immerse ivory in a solution of pure phosphoric acid, s. g. 1.130, until the opacity is removed; wash and partially dry. Will become hard when perfectly dry, but again becomes flexible when placed in hot water.

Another mode of softening ivory is to soak it for three or four days in a mixture of 3 ounces of spirit of niter and 15 ounces of spring-water, when it will be soft enough to obey the fingers. To color it in this state, dissolve the proper pigment in spirit of wine, then immerse the ivory and leave until sufficiently tinged, then give it the proper form. To harden it, wrap in a sheet of white paper and cover with dry, decrepitated common salt, and leave for twenty-four hours. To whiten ivory that has turned brown, slack some lime in water, decant, and boil your ivory in this till white. It is also bleached by sulphurous acid, by chloride of lime, or by soaking in water and exposure to the sun.

Ivory brought from Nineveh in a fragile and crumbling state was restored by Professor Owen to a rigid condition by boiling it in a solution of gelatine. The animal matter had decayed out of it, leaving the phosphate of lime ready to fall to pieces.

A veneer of ivory was exhibited at the World's Fair in London, 1851, 41 feet long and 14 inches wide. It was sawn from a block in a continuous ribbon, the block rotating and its axis gradually approaching the plane of motion of the saw.

Russia affords a large supply of tusks from the remains of an extinct variety of elephant which once roamed the now inhospitable shores of the Siberian rivers. These bones, though not essentially changed in condition, are called fossil ivory, from the circumstances of their deposit and discovery.

The fruit of *Phytelephas macrocarpa*, a species of Peruvian palm, is the vegetable ivory of commerce.

Ivory has always been considered a luxurious article in countries where it is not indigenous. The Assyrians carried on a great traffic in ivory. In an Assyrian obelisk in the British Museum, the captives or tribute-bearers are represented as carrying elephants' tusks. The Egyptian monuments show the tusks, apes, and peacocks carried to Sesostris; the same articles were also brought to Solomon by the navy of Tarshish some hundreds of years later. Diodorus Siculus states that the Ethiopians brought to Sesostris "ebony and gold, and the teeth of elephants." Pliny states that ivory was so plentiful on the borders of Ethiopia that it was used for fences, door-posts, and cattle-stalls.

In regard to its ancient uses, it seems to have been essentially a regal luxury. "All manner of vessels of ivory" are enumerated as among the furnishing of opulent Babylon. Hiram fashioned the great ivory throne of Solomon, and overlaid it with pure gold. Ivory was freely used in the chairs and couches of

Egypt, as the paintings in the tombs yet testify. Ahab's ivory house, 900 B. C., and the palace of Menelaus, described by Homer, were probably paneled with ivory, or the walls and pillars inlaid therewith. Ezekiel records that ivory was used to ornament the Phœnician galleys.

Beds inlaid or veneered with ivory were used by those who, as Amos says, "are at ease in Zion," "that lie upon beds of ivory and stretch themselves upon their couches."

Two hunting inscriptions, one of which principally records the elephant hunts of Ptolemy Philadelphus, were discovered and copied by Lepsius from the colossi of Aboo Simbel. Since ancient times elephants have withdrawn more to the south in Eastern Africa also. According to the testimony of Polybius, when African and Indian elephants encountered each other on fields of battle, the sight, the smell, and the cries of the larger and stronger Indian elephants drove the African ones to flight. The latter were never employed as war elephants in such large numbers as were used in Asiatic expeditions, where Khandragupta had assembled 9,000, the powerful king of the Prasii 6,000, and Akbar as many.

The Numidian Metellus had 142 elephants killed in the circus. In the games given by Pompey, 600 lions and 406 panthers were shown. Augustus sacrificed 3,500 wild beasts in the festivities which he gave to the people; and a tender husband laments that he could not celebrate the day of his wife's death by a sanguinary gladiatorial fight at Verona, because contrary winds detained in port the panthers which had been bought in Africa.

To come down to a later date, ivory chairs and furniture were among the spoils of Seringapatam when Tippoo yielded up the ghost, and the government of Mysore.

The "Elephant's Tower" at Futtehpoor Sikra, a favorite residence of Akbar, the most illustrious Asiatic ruler of modern times (1556 – 1605), is ninety feet high, and is studded with elephants' tusks from top to bottom. It is conjectured to have been erected over the remains of a favorite elephant. This Akbar (very great), properly JELAL-ED-DIN MOHAMMED, was truly royal, and "kept house" on a very extended scale. Bayard Taylor gives a good account of Futtehpoor, a red sandstone city, deserted but not destroyed. Akbar had a fancy for chess-playing within a checkered court-yard of his palace, with beardless epicenes and troops of girls, who strutted and trotted from point to point as the dice were thrown and the moves called. See CHESS.

I'vo-ry, Ar-ti-fi'ci-al. A compound of caoutchouc, sulphur, and some white ingredients, such as gypsum, sulphate of baryta, oxide of zinc, or pipeclay.

Pinson's: immerse a sheet of gelatine in alumina, dissolved in acetic acid. When fairly combined, take out, hang up to dry, and polish.

Welling's artificial ivory is composed of 10 ounces of white shellac, $4\frac{1}{2}$ ounces acetate of lead, 8 ounces of ivory dust, and 5 ounces of camphor. The ingredients are reduced to powder, heated, and mixed, then pressed in heated molds into sheets or other desired forms. See PYROXYLINE.

Another: two pounds of pure india-rubber are dissolved in thirty-two pounds of chloroform, and the solution saturated with purified ammoniacal gas. The chloroform is then evaporated or distilled off at a temperature of 185° Fah. The residue is mixed with pulverized phosphate of lime or carbonate of zinc, pressed into molds and cooled. When the phosphate of lime is used, the resulting compound partakes in a great degree of the nature and composition of genuine ivory, for the phosphate replaces the lime, and the india-rubber takes the place of the gelatine.

Ivory dust mixed with albumen, rolled into sheets, dried, and polished.

Sulphate of baryta and albumen rolled into sheets.

Billiard-balls made of a mixture of paper pulp, sulphate of baryta, and gelatine, are said to be equal to those made of ivory.

Plaster of paris saturated with melted spermaceti.

The following United States patents bear upon this subject; the figures are day, month, year: —

Welling . .	4, 8, 1857.	Seeley . . .	23, 6, 1868.
Held . .	4, 8, 1857.	Welling . .	5, 5, 1868.
Hackert . .	31, 5, 1864.	Gradenwitz . .	25, 5, 1869.
Dupper . .	1865.	Hyatt and Blake	4, 5, 1869.
Wheeler . .	14, 11, 1865.	Welling . .	20, 4, 1869.
Wurtz . .	1, 1, 1867.	Welling . .	27, 4, 1869.
Hackert . .	19, 2, 1867.	Welling .	27, 4, 1869.
Starr . .	3, 3, 1868.	Hyatt . .	6, 4, 1869.
Starr and Welling	9, 6, 1868.	Hyatt . . .	6, 4, 1869.
Hyatt . .	14, 4, 1868.	Hyatt . .	15, 6, 1869.
Gardner . .	7, 1, 1868.	Welling .	17, 1, 1870.

I'vo-ry–black. A species of bone-black made by the calcination of ivory scraps, turnings, and sawdust. It is used as a pigment in the manufacture of paints and printers' ink.

I'vo-ry–pa'per. A superior article of pasteboard, with a finely prepared polished surface, used by artists.

Ainslie's process for making ivory-paper is as follows: —

Digest four ounces of clean parchment cuttings in water for four hours, and strain off the jelly. Digest again for a farther quantity. Keep these apart as Nos. 1 and 2. Saturate with No. 2 two sheets of drawing-paper, 15 × 17 inches, lay them together, and strain them over a smooth slate, pasting them on the back. Allow them to dry gradually. Wet three more sheets and add them to the former, one at a time. When dry, smooth with sand-paper; wet and add a perfectly clean sheet. Dry it and smooth with fine glass-paper. Heat one half-pint of size of No. 1, and stir into it three tablespoonfuls of plaster of paris; distribute it over the surface; dry; polish with glass-paper. Spread several coats of size No. 1 upon the surface, polishing each time with fine glass-paper. Plaster of paris, oxide of zinc, and carbonate of baryta give different tints.

I'vo-ry–saw. A thin saw stretched in a steel frame for sawing ivory from the solid. It has a blade $\frac{1}{10}$ inch thick, $1\frac{1}{2}$ inch wide, and 15 to 30 inches long. The teeth, 5 or 6 to the inch. A frame-saw with a blade made of a fine watch-spring is suitable for the purpose.

I'vo-ry–tab'let. Small leaves of ivory, arranged in pocket-book form, for receiving memoranda.

Artificial ivory tablets for photography are made by mingling finely pulverized sulphate of baryta or heavy spar with gelatine or albumen, compressing the product into sheets, and drying it.

The laws of the twelve tables of Rome were originally written on oak, then transcribed on ivory tablets, and hung up *pro rostris*; after approval by the people, they were engraved on bronze. The opulent Romans used their slips of ivory, called *libri eborici* or *libri elephantini*; and Ulpian states it was common to write on such with black ink.

I'vo-ry–type. (*Photography.*) A kind of picture in which two finished photographs are taken, one light in color, made translucent by varnish, tinted on the back, and placed over a stronger picture, so as to give the effect of a photograph in natural colors. Also known as *Hellenotype*.

I'vo-ry, Veg'e-ta-ble. The nut of the *Phytelephas macrocarpa*.

J.

Jab. (*Nautical.*) To catch fish by prodding; said of fishing with a *gaff*.

Jabb. A peculiar fishing-net for catching the fry of fish.

Jack. A handy tool. A name applied to a convenient implement which answers in the place of another hand or of an assistant. It is frequently compounded with other words, the associated word expressing either its purpose, structure, or relation.

As a simple word it has meanings: —

1. A lifting instrument. See JACK-SCREW; WAGON-JACK; WHEEL-JACK; CAR-JACK; FENCE-JACK; RAIL-JACK; HYDROSTATIC JACK, and others in the list below.

2. An instrument for turning a roasting joint of meat. A *bottle-jack*, or a *smoke-jack*.

3. (*Knitting.*) The pivoted bar or lever in a knitting-machine, from whose end is suspended the sinker which forms the loop. A *beater*.

4. (*Spinning.*) A coarse bobbin and fly-frame, operating on the sliver from the carding-machine and passing the product to the fine roving-machine, or fitting it therefor.

5. (*Weaving.*) The *heck-box*; a grated frame for conducting the threads from the *bank* to the *warping-mill*.

6. (*Mining.*) A wooden wedge used in mining for assisting in the cleavage of strata. A *gad*.

7. A saw-horse or saw-buck. Two X-shaped frames united by a round or rundle.

8. A small flag. The *union* without the *fly*. See FLAG.

9. (*Metal-working.*) A form of *metal planing-machine* which has short, quick motions, and is used in shaping objects, planing seats for valves, faces for the same, etc.

10. (*Nautical.*) The cross-trees.

11. (*Music.*) Formerly the hammer or quill-carrier of a clavichord, virginal, harpsichord, or spinet, but now an intermediate piece which conveys to the hammer the motion imparted to the key.

The piano-movement jack, which imparts the motion of the key to the hammer, is the invention of Christofori of Florence, 1711. Rimbault's "Pianoforte," London, 1860. See PIANO-FORTE.

As a compound word, see under the following heads: —

Boot-jack.
Bottle-jack.
Builder's jack.
Carriage-jack.
Chimney-jack.
Claw-jack.
Crick.
Fence-jack.
Hand-screw.
Hoisting-jack.
Hydraulic jack.
Hydraulic lifting-jack (see HYDRAULIC PRESSES AND LIFTERS).
Hydrostatic jack.
Jack-arch.
Jack-back.
Jack-block.
Jack-boots.
Jack cross-tree.
Jack-frame.
Jack-head pump.
Jack-in-a-basket.
Jack-in-a-box.
Jack-knife.
Jack-ladder.
Jack-pin.
Jack-plane.
Jack-rafter.
Jack-screw.
Jack-sinker.
Jack-staff.
Jack-stay.
Jack-timber.
Knitting-machine jack.
Lever-jack.
Lifting-jack.
Minute-jack.
Pegging-jack.
Piano-movement jack.
Post-jack.
Pulling-jack.
Pushing-jack.
Rack-and-pinion jack.
Rail-jack.
Railroad-jack.
Ratchet-jack.
Roasting-jack.
Rounding-jack.
Screw-jack.
Shackle-jack.
Shaft-coupling jack.
Ship-jack (see HYDRAULIC PRESSES AND LIFTERS).
Shoe-jack.
Smoke-jack.
Spinning-jack.
Swing-jack.
Telescopic jack.
Thill-jack.
Traversing jack (see HYDRAULIC PRESSES AND LIFTERS).
Tripod-jack.
Truck-jack.
Wagon-jack.
Warping-jack.
Wheel-jack (see HYDRAULIC PRESSES AND LIFTERS).
Windlass-jack.
Window-jack.

Jack-arch. An arch of the thickness of one brick.

Jack-back. 1. A vessel below the brewery-copper which receives the infusion of malt and hops therefrom, and which has a perforated bottom to strain off the hops.

2. A tank or cistern which receives the cooled wort in a vinegar-factory.

Jack-block. (*Nautical.*) A block used in sending the top-gallant mast up and down.

Jack-boots. 1. Large, overall boots, reaching up the thigh; worn by fishermen.

2. Large boots with a front-piece coming above the knee; worn by cavalry-men, and sometimes by huntsmen.

Jack Cross-tree. (*Nautical.*) An iron cross-tree at the head of a top-gallant mast.

Jack'et. An enveloping or outer case of clothing, steam, water, or other substance.

1. A *steam-jacket* is a body of steam between an inner and outer cylinder or casing; its usual purpose is to warm or maintain the warmth of the contents of the inner cylinder. It was invented by Watt.

The steam space around an evaporating-pan to heat the contents.

Other jackets are of wood or other non-conducting material. Cylinders of steam-engines are sometimes covered with felt and an ornamental wooden casing to prevent radiation of heat. Steam-boilers, for the same purpose, are jacketed with felt on the upper part. *Cleading, deading, lagging.*

2. (*Nautical.*) *a.* A double or outer coat.

b. A casing for a steam-chimney where it passes through a deck.

3. A swimming garment with cork lining. A *cork-jacket.*

Jack-frame. (*Cotton-manufacture.*) A device, formerly in greater favor, for giving a twist to the roving as it was delivered by the drawing rollers.

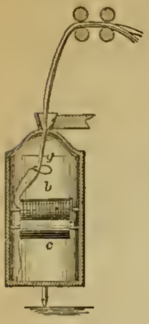
In order to give a certain degree of cohesion to the sliver, the can into which it was received from the drawing rollers received a rapid rotation, imparted by the table on which it stood. See DOUBLING; ROVING.

Following this process was that of winding it upon bobbins, so as to be fed from thence to the spinning-frame.

The *jack-frame*, or *jack in the box*, was devised to twist and wind the sliver and form it into a roving on a bobbin *in the can*.

The twist is given to the sliver by the revolution of the can on its vertical axis; but instead of being coiled up within the can as usual (see Doubling), the roving was wound upon a bobbin *b* lying upon a carrier cylinder *c* made to revolve by wheel-work (not shown) at such a rate that its surface velocity corresponded to that of the delivering drawing roller. A guide-wire *g* moved backward and forward in front of the bobbin distributes the roving equally thereon. The *jack-frame* was superseded by the Bobbin and Fly-frame (which see). The mode of rotating the bobbin survives in Mason's speeder.

Fig. 2708.



Jack-Frame.

Jack-head Pump. A form of lift-pumps for mines and deep borings, in which the delivery-pipe is secured to the cylinder by a gooseneck. See Plunger-pump.

Jack-in-a-bas'ket. (*Nautical.*) A basket on a pole marking a shoal. A beacon.

Jack-in-a-box. 1. A name conferred upon the *jack-frame*, a device for giving a twist to the drawn *sliver* and winding the same on a bobbin as it was received in the *roving* can. See Jack-frame.

2. *a.* A large, wooden, solid screw turning in a nut in a bridge-piece and rotated by means of a lever. It is a clumsy form of screw-press, used for various purposes.

b. A screw-jack for lifting and for stowing cargo.

Jack'knife. A horn-handled clasp-knife with a laniard, worn by seamen.

Jack-lad'der. (*Nautical.*) One with wooden steps and side ropes.

Jack-pin. (*Nautical.*) A belaying-pin in the fife-rail or elsewhere.

Jack-plane. (*Carpentry.*) The first and coarsest of the joiner's bench-planes; the others being the *trying*, *panel*, and *smooth* planes. It is about 18 inches long.

Jack-raft'er. (*Carpentry.*) One of the short rafters used in a *hip-roof*.

Jack-screw. A lifting implement which acts by the rotation of a screw in a threaded socket. In *A* the screw is double, the portion *a* turning in *b*, and the latter in the collar of the base *c*. The spanner *d* rotates the nut *e* and with it the screw *b*, which climbs out of *c* and at the same time projects *a*.

B is a railway-jack, moved by a lever (which is shown broken off), and acting by pawl and ratchet, either throughout a circle or by reciprocation where the position is confined.

C is a traversing-jack which moves the load along by a secondary screw *f* so that the standard *g* slips on the ways *h*.

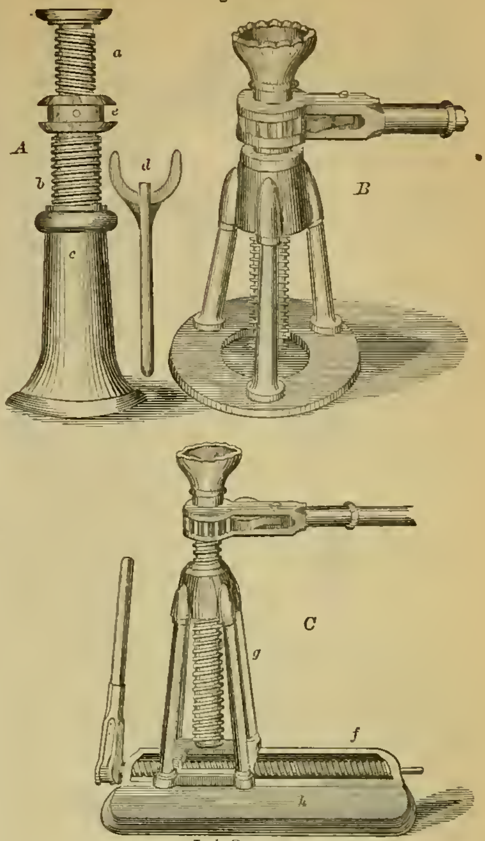
In another form the screw is rotated by bevel-wheel and pinion.

Jack-sink'er. (*Knitting-machine.*) A thin iron plate suspended from the end of the *jack*, and acting to depress the loop of thread between two needles. The jack-sinkers, alternate with *lead-sinkers*, the former being movable separately, but the latter are attached to a *sinker-bar*, and move together. See Knitting-machine.

Jack-staff. (*Nautical.*) A flag-staff on the bowsprit-cap for flying the jack.

Jack-stay. (*Nautical.*) A rib or plate with holes, or a rod running through eye-bolts, passing along the upper side of a yard, and to which the sail is bent.

Fig. 2709



Jack-Screws.

Jack-tim'ber. (*Carpentry.*) A timber in a building which is shorter than the other timbers, being intercepted by another piece; as, —

A *studding* in a partition, which is intercepted by a brace or a window or door frame.

A *rafter* in a hip-roof, which meets the hip and is shorter than those which run to a full length and meet at the comb or ridge.

A *rib* in vaulting or groining, shorter than the main rib.

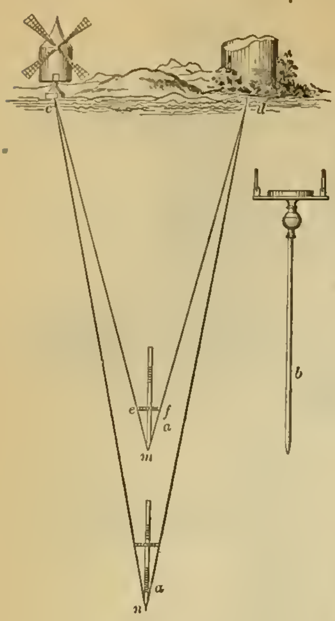
Ja'cob's Lad'der. (*Nautical.*) A rope ladder with wooden rounds.

Ja'cob's Staff. 1. An instrument for taking altitudes, having a brass circle divided into four equal parts by two diametric lines. At each extremity is a perpendicular riglet over the lines, with a hole below each slit for discovering objects. The cross is mounted on a staff. A *cross-staff*.

2. (*Surveying.*) An instrument (*a*, Fig. 2710) used to measure distances and heights. It has a square rod, with a cross or cursor, which has a set screw to keep it in position on the rod when required. The rod is three or four feet in length, and divided into four or five equal parts. The cursor has a square socket and slips on the staff; its length is equal to one of the divisions of the staff. The instrument is mounted on a tripod when in use, the cursor being in the plane of the horizon when measuring distances, and vertical thereto when measuring hights.

The cursor is adjusted on the rod to the second

Fig. 2710



Jacob's Staff.

division, and the observation taken from such a position that the direction of the staff bisects the angle subtended by a line drawn between the two objects. Retire or advance with the instrument until from the station m the visual line from m passing to c d will touch the ends c f of the cursor. Place a picket at m. Slip the cursor on to the third division of the staff and retire till from a new station n the visual rays from thence will reach the same objects, c d touching c f as before. Drive a picket. The distance between the pickets is equal to the distance between the objects. This is but one illustration of its application. See Cresy's "Encyclopedia Civil Engineering," edition 1865, pp. 832–835.

3. A straight rod b shod with iron, and with a socket joint and pintle at the summit for supporting a surveyor's *circumferentor*.

Jac-o-net′. (*Fabric.*) A fine, close, white cotton goods, like cambric.

Jac′quard Loom. A loom for weaving figured goods. A chain of perforated cards is made to pass over a drum, and the strings by which the threads of the warp are raised pass over an edge with a wire or leaden weight of small diameter suspended from each. These weights, at each stroke of the loom, are presented to each successive card, and some of them are intercepted by the card while others pass though the holes therein, the latter thus determining which threads of the warp shall be raised. In this way the figure on the card determines the nature of the figure on the fabric.

Jacquard, the inventor, was a straw-hat manufacturer at Lyons. His attention was first directed toward mechanical inventions by a reward being offered for the production of a machine for making nets. He produced the machine, but did not claim the reward. The attention of Napoleon was called to his inventive genius, and he was sent for to ascertain if he could not improve on a loom belonging to the government. This was designed for weaving shawl patterns in imitation of cashmere, and its setting up and arrangement were very troublesome and expensive.

The great war minister Carnot is reported to have said to Jacquard, "Are you the man who can do what the Almighty cannot : tie a knot on a stretched string?" Jacquard, improving on the model of Vaucanson, produced the apparatus which bears his name, and was rewarded with a pension of 1,000 francs. This was afterwards increased to 6,000. He was also awarded a bronze medal at the French Exposition in 1801.

On returning to Lyons, he met with great opposition from the weavers there, who endeavored to forcibly suppress the invention. The "Conseil de Prudhommes," a board of master workmen in the various branches of trade, who are appointed to look after the manufacturing interests, adjust wages, and settle disputes between masters and workmen, ordered his machine to be broken up in the public place, and, according to Jacquard's own expression, "the iron sold for iron, the wood for wood, and he, the inventor, was delivered over to universal ignominy." The value of the invention was, however, soon appreciated elsewhere, and was finally recognized by the Lyonese themselves, to whom it has since proved of inestimable value.

Jag. A barb or dovetail which resists retraction.

Jag-bolt. One with a barbed shank.

Jag′ger. 1. (*Domestic.*) A small wheel mounted in a handle and used for crimping or ornamenting edges of pies, cakes, etc., or cutting them into ornamental shapes. A *jagging-iron.*

2. A toothed chisel.

Jag′ging-board. (*Metallurgy.*) An inclined board in a *buddle* or *frame* on which *slimes* of ore are deposited to be gradually washed by a current of water to the inclined bed where the slimes are sorted according to gravity. See BUDDLE; FRAMING.

Jal-ou-sie′. A *louvre* or *Venetian* shutter.

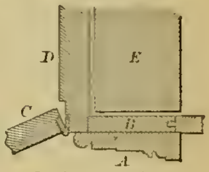
Jamb. 1. (*Architecture.*) The upright sides of an aperture, as a doorway, window, or fireplace, and supporting the lintel, entablature, or mantel.

The *jamb-linings* are the casing, and have a rabbet for the door to shut into.

Jamb-posts are framed into an aperture, and upon them the *linings* are attached.

Jamb-stones are employed in building sides of an aperture.

Fig. 2711.



Jamb and Fittings.

A, architrave.
B, plowed ground.
C, door.
D, rabbeted joint.
E, quarter.

2. (*Mining.*) A pillar of ore in a mine.

Jamb-lin′ing. (*Carpentry.*) The vertical boarding on the sides of a doorway.

Jamb-post. (*Carpentry.*) One of the uprights on the sides of a doorway or window.

Jamb-stone. (*Architecture.*) One of the stone pillars on the sides of a doorway or of a window.

Jam′da-ri. (*Fabric.*) A Dacca muslin woven with figures of flowers and other ornaments.

Jam-nut. An auxiliary nut screwed down upon another one to hold it. A *check-nut, lock-nut*, or *pinching-nut.* See NUT-LOCK.

Jam-weld. (*Forging.*) A weld in which the heated ends or edges of the parts are square butted against each other and welded.

Jank′er. (*Scotch.*) A long pole on two wheels, used in transporting logs.

Jan′tu. A water-raising device of great antiquity used in Bengal for land irrigation. It is a trough counterweighted by an extended arm and balanced across a bar. As the trough end descends it dips water, and, as it rises, the water runs towards the axis of vibration and escapes at a lateral orifice into a trough, which conducts it to the field. See GUTTER for a common device on this principle, excepting the counterweights. See also BAIL-SCOOP.

Ja′nus-cloth. A fabric having each side dressed, and different colors on the respective sides. Such fabric is used for reversible garments.

Ja-pan′. 1. A hard, black varnish, obtained from the *Stagmaria verniciflua* of the East Indies.

2. An asphaltum varnish. See VARNISH.

Ja-pan′–earth. (*Tanning.*) Terra japonica, catechu, cutch. An astringent matter obtained from the *Areca catechu* and *Acacia catechu*; used in tanning.

Jap-a-nese′ Silk. (*Fabric.*) A dress goods having a linen chain and silken weft.

Ja-pan′-ink. A writing-ink which has a dark, glossy color when dry. See INK.

Ja-panned′ Leath′er. Leather treated with several coats of Japan varnish and dried in a stove.

Ja-pan′ning. The art of coating wood, metal, or paper, with a thick coat of hard, brilliant, varnish. The art originated in Japan. *Japanning* involves the *baking* of the varnished article.

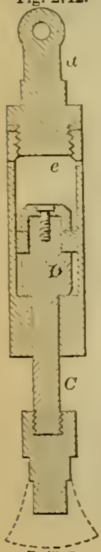
The Japanese employ a lacquer obtained from a tree by making incisions in the trunk and collecting the juice; this is at first like cream, but becomes black by exposure to the air. Their process is said to be as follows: After the juice has assumed a deep black color, finely pulverized charcoal is added to it. The lacquer is applied to an article in several successive coats, each being dried in the sun before the next is put on. It soon becomes extremely hard, and is polished with a smooth stone and water until it becomes as smooth as glass. On this surface ornaments and figures are traced with a brush dipped in a varnish of boiled oil and turpentine. Before this is quite dry, gold or silver leaf is laid on, and the whole afterward receives a finishing coat of varnish.

With us the work is first covered with a ground composed of anime (*Hymenæa courbaril*) varnish mixed with a pigment of the desired color; this is dried in a stove, after which three or four coats of varnish are applied. The varnishes employed are copal, anime, mastic, or seed lac. The latter gives the hardest surface, but is too dark for the more delicate grounds, and is therefore usually mixed with some other kind of varnish. Articles such as wood or *papier-maché*, which are too coarse, soft, or rough to receive the japanning immediately on their surfaces, are first covered with a priming composed of chalk or whiting. This is allowed to dry, and is then rubbed smooth.

Engravings or drawings are transferred to japan work in the following way: The engraving is printed or the drawing made on fine paper, previously prepared with a coating of isinglass or gum-water. This, when dry, is applied face downward upon the japan ground, which is covered with a thin coat of copal varnish; the paper is then moistened on the back with warm water, which loosens it so that it can be removed, leaving the print on the work. Or a print may be made on an elastic composition of glue, etc., which may be applied immediately on the japanned surface.

Jar. 1. (*Well-boring.*) A device used in boring by impact of the chisel, which is alternately lifted and dropped. As the rope attached to the piece *a* is lifted, the chisel-stock *C* slips until arrested by the enlarged portion *D*. When the piece *a* is dropped, by the sudden slacking of the rope, the chisel falls, and the portion *e* comes on top of the chisel-stock *D* to give it an effective blow.

Fig. 2712.



Drill-Jar.

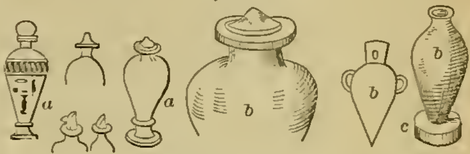
2. (*Domestic.*) A vessel of glass or earthenware for fruit, preserves, pickles, and various domestic uses.

The analogue of our modern fruit-jar is found in those of the ancient Egyptians, who seem to have been given to laying in great stores of provisions in this way. The paintings on the temples and tombs of Egypt show the storing of grain, wine, oil, poultry, and many other things, and the economy of their houses, pantries, and granaries shows that they made the most ample and profuse store of provisions. As an illustration, see Plate V. Vol. 2 of Wilkinson.

The jars of the accompanying cut have lids or stoppers, which are luted or rendered air-tight by liquid clay, pitch, gypsum, or mortar.

Some of the jars had flat bottoms *a*, and were set upon the cellar or store-room floor; and others, being pointed, were set in a stone ring, like the amphoræ *b b* and ring-base *c*. Late excavations on the site of Troy have exhumed ranks of enormous jars. See FRUIT-JAR.

Fig. 2713.



Egyptian Vases and Jars.

Jas′per. 1. A silicious mineral of several varieties.

2. Marble of a greenish color, with small red spots. There is an antique jasper with small spots of black and white.

3. A kind of earthenware prepared from pounded spar.

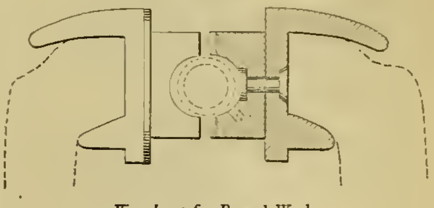
Jaunt′ing–car. An Irish vehicle having two seats, back to back, over the wheels, a well in the middle, and a seat for the driver in front.

Jave′lin. A hurling-spear, about 5½ feet long; it has a wooden shaft and an iron head. It is yet used in Europe in hunting the boar, and by many savage nations in ordinary hunting.

The *assegai* of the Caffre is a javelin of native iron.

Jaw. 1. (*Machinery.*) *a.* One of two opposing members capable of being moved towards and from one another; as the *jaws*, *cheek*, *chaps*, *chops*, or *mouth* of a vise or wrench.

Fig 2714



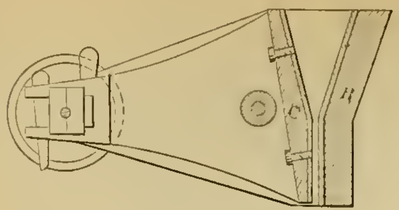
Vise-Jaws for Round-Work.

b. The cheeks of a stone or ore-crusher, one of which is moved relatively to the other, so as to break the material fed between them. In the example (Fig. 2715) *C* is the moving jaw, and *B* is a relatively stationary abutment. The movement of the jaw *E* is by an eccentric.

c. The opposed portions of a shearing-machine or punch, which, by moving past each other, cut the bar or sheet of metal placed between them.

2. (*Railway-cars.*) The guard-plates in which the axle-boxes of railway-cars play vertically as the springs yield and recoil. The *housings* or pedestals.

Fig. 2715.



Ore-Crusher.

3. (*Nautical.*) *a.* The forked end of a boom or gaff, which partially embraces the mast. The branches of the jaw are called *horns*, and are united by the *jaw-rope*.

b. The space in the shell of a tackle-block occupied by the sheave.

Jaw-lev'er. A veterinary instrument for opening the mouths of animals for the administration of medicine.

Jaw-tools. Tools having the capacity for grasping, as between jaws or fingers. See under the following heads: —

Animal-clutch.
Articulator.
Balance-vise.
Barrel-vise.
Bench-vise.
Bloom-hook.
Bolt-cutter.
Bottling-pliers.
Bullet-mold.
Burling-irons.
Burr-cutter.
Buttonhole-cutter.
Calipers.
Calking-vise.
Chimney-tongs.
Clamp.
Clincher.
Clothes-pin.
Clothes-tongs.
Clutch for hay-elevator.
Coal-tongs.
Compasses.
Costotome.
Crane's-bill.
Crimping-tool.
Crow's-bill.
Crucible-tongs.
Cutting-nippers.
Dividers.
Drawing-pliers.
Egg-tongs.
Elbow-tongs.
Entercotome.
Forceps.
Gas-fitter's tongs.
Glass-tongs.
Glazier's-vise.
Grapnalls.
Grapple.
Hand-vise.
Humbug.
Ice-tongs.
Inside-calipers.
Lasting-pinchers.
Lazy-tongs.
Monkey-wrench.
Nail-clincher.
Nippers.
Nut-cracker.
Pinchers.
Pinching-tongs.
Pipe-tongs.
Pipe-vise.
Pipe-wrench.
Pliers.
Pruning-shears.
Pucellas.
Punch-pliers.
Rivet-cutter.
Rotary shears.
Rounding-tool.
Saddler's-pinchers.
Saw-vise.
Scissors.
Shanks.
Shears.
Snipe.
Spring-vise.
Suspending-clutch.
Tongs.
Tube-cutter.
Tweezers.
Vise.
Wrench.

Jaw-wedge. A wedge to tighten the axle-box in the jaw or guard of a railway car-truck.

Jean. (*Fabric.*) *a.* A twilled, undressed cloth, having a cotton chain and woolen filling.

b. A twilled cotton goods, striped or white. *Satin jean* has a different twill, which gives it a smooth, glossy surface.

Jears. (*Nautical.*) A fourfold tackle by which a lower yard is *swayed* or *struck*. The upper block of this purchase usually hangs from the *trestle-trees*. *Jeers; jeer-bits.*

Jed'ding-axe. A stone-mason's tool. It has one flat *face* for knocking off projecting angular points, and a pointed *peen* for reducing a surface to the required form. A *cavil*.

The *sax* or *zax* is a slate-worker's axe.

Jeg. A templet or gage, one of several, for verifying shapes of parts in gun and gun-stock making.

Jem'my. 1. (*Fabric.*) A species of Scotch woolen cloth.

2. A small crow-bar.

Jen'ny. (*Spinning.*) A form of spinning-machine invented by Jacob Hargreaves. A playful adaptation of the word *engine*. See SPINNING-JENNY.

Jet. 1. The *spruc* of a type, which is broken therefrom when the type is cold.

2. A solid, dry, black lignite, harder than asphalt and glossy in its fracture.

3. A spout of water in a fountain.

Jet-pump. A pump stated to have been originally contrived to empty the pits of submerged water-wheels. It acts by the pressure of a column of air passing through an annular throat; or conversely, an annular jet around a central orifice. It has since been used in oil-wells. See EJECTOR.

Jette. The *starling* of a bridge. See STARLING.

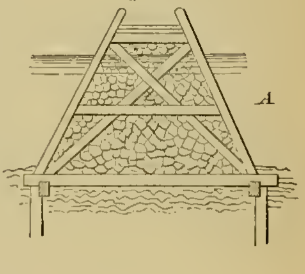
Jet'ting-out. (*Architecture.*) The projection of a corbel or molding beyond the general surface.

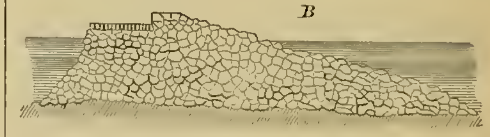
Jet'ty. 1. (*Hydraulic Engineering.*) *a.* A construction of wood, rubble-stone, or masonry projecting into the sea and serving as a wharf or *pier* for landing and shipping, or as a *mole* to protect a harbor.

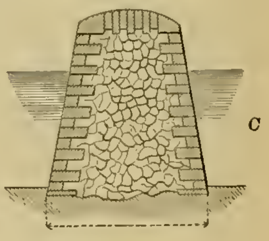
Although limited to no particular form, a very common construction of the jetty is a timber framing *A*, secured by piles or loaded with rubble. It is often built in the manner of a sea-wall; having a double row of sheeting piles, the interval filled in with rubble or béton. The latter is excellent. The term *jetty* is also applied to expensive and solid erections of masonry, and to *hards* or landing-places for boats.

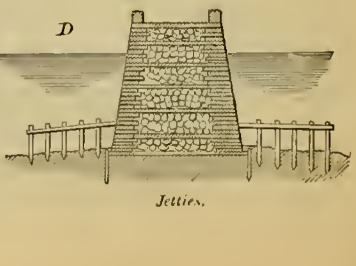
Tetord's jetty *B* at the eastern arm

Fig. 2716.









Jetties.

of Kingstown Harbor, Ireland, is an example of a jetty made of rubble, with a track and parapet of coursed masonry. The foreshore, in most works of this kind, is faced with pitched stones, that is, an outer layer in which the undressed stones are not laid at random, but deposited end on, beginning at the lower edge, and so caused to bind and become mutually sustaining.

Jetties of masonry (*C*) have usually *ashlar facings* and *heartings* of rubble or concrete. The walls filled in with béton will be nearly equal to a solid mass; in fact, béton itself makes a wall of such tenacity that its strength is equal to a homogeneous block. When the ashlar masonry is filled in with earth it requires a bond; when this is of masonry, the counterforts take the form of division-walls, which thus reduce the jetty to a series of compartments. The stones of these horizontal bonding courses should be cramped and joggled together, and the top carefully paved to prevent infiltration.

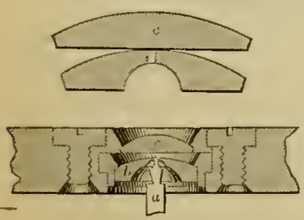
The southern jetty (*D*) of the port of Havre is exposed to violent storms and a powerful littoral current. It exemplifies the ashlar facing, horizontal bonding-walls, rubble filling, paving, parapets, aprons of piles and *pierre-perdue* to protect the foundations from the repercussion of the waves, all executed in a style which has provoked the admiration of those who have understandingly examined it.

In the course of the improvement of the mouths of the Rhine, the northern arm of the Maese is being widened, dredged, and extended into the sea by jetties of about 1,200 feet long and 1,000 yards apart. The mode of their construction is as follows: —

Long fascines are formed of brushwood and placed upon the shore near the site of the works; they are laid in courses, each course being at right angles or oblique to the previous one, until a thickness of about three feet has been obtained; strong stakes are then driven through the mass at frequent intervals, which project about 18 inches at the bottom, and 12 inches at the top. The stakes are then tied together with a willow binding. The work is made in sections measuring about 40 yards by 20 yards. When completed, it is floated to the site of the jetty, and sunk into its place by being evenly loaded with basalt stone, which is brought down the Rhine from quarries near Andernach. Piece after piece of this sort of work is added, until it covers the whole breadth of the base of the jetty for a portion of its length, after which another layer is formed in the same manner, and so on until the requisite hight and breadth of the jetty have been obtained, when a fresh length in advance is commenced. The projecting stakes soon take firm hold of the layers above and below them, the sand silts into the interstices of the brushwood, and in a few years forms an almost impenetrable mass, which, when consolidated, is covered with a paving of large basalt stones.

b. A structure round the piled foundation of a bridge pier.

Fig. 2717.



Watch-Jewel.

2. The part of a building which jets or juts over beyond the ground plan.

Jew'el. 1. (*Watchmaking.*) A crystal or precious stone forming a bearing for the pivot of an arbor; especially used in watches.

The balance jewel always has an *end-stone*, or cap *c*, the balance running on the end of its pivot in order that it may have the utmost freedom; the pivot being but the $\frac{1}{100}$ of an inch in diameter. Diamonds are sometimes used for end-stones, but rarely, if ever, for jewels, it being next to impossible to drill a hole sufficiently small in so hard a substance.

The invention of the process of drilling holes in rubies is attributed to M. Fazio, a native of Geneva, who introduced it into London in the year 1700.

Rubies are used as jewels in good watches. They are the hardest stone that can be drilled, but cheaper stones, such as crystals, garnets, etc., and even glass of hard quality, are often used.

The lower portion of Fig. 2717 represents on an enlarged scale the jeweled pivot-hole for the verge, or the axis of the balance of a marine chronometer. *a* is a hardened steel pivot, which is turned with a fine cylindrical neck, and is made convex at the end; the jewel consists of two stones; one *b*, usually sapphire or ruby, is convex above and concave beneath, of two different curvatures to thin it away in the middle, where the pivot-hole is drilled.

The other, *c*, called the *top-stone* or *end-stone*, is generally a ruby of plano-convex form, or else a diamond cut with facets. The flat side of this touches the end of the pivot.

The rubies or sapphires from which the jewels are made are sometimes split to the requisite thickness, but are commonly slit by a revolving iron disk charged with diamond-powder and oil. When sliced they are ground parallel on a flat plate of copper mounted on a lathe, into the face of which small fragments of diamond have been hammered, and afterwards polished on a similar plate with fine diamond-powder. They are afterwards turned circular and their edges beveled. In turning their faces to concave and convex form a fragment of diamond, mounted on a brass wire, is employed.

Drilling out the holes is also effected by a splinter of diamond mounted on a wire, this is usually accomplished at two operations, drilling into the two sides successively, after which the interior is polished with a fine steel wire and diamond-powder.

2. A precious stone; a gem. See Gem-cutting; Seal; Diamond; Strass; Doublet; Brilliant, etc.

The proficiency of the ancient Egyptians in the ornamental arts is well shown in collections of Egyptian jewelry. One ancient collection, dating back to 1900 B. C., is in the possession of the Sultan, and comprises ear-rings, necklaces, seal-rings, and amulets. The workmanship is of the most beautiful description. Many handsome specimens are also in the Museum of the Historical Society of New York. The museums of Europe are rich in specimens from Phœnician, Egyptian, Etruscan, Greek, and Roman sources.

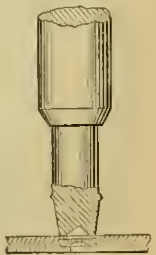
Jew'el-block. (*Nautical.*) A block at the yard-arm of a ship, for the halyard of a studding-sail yard to pass through.

Jew'el-ers'-red. Crocus.

Jew'el-set'ter. (*Watch.*) A circular steel cutter having a concave end with a circumferential angular edge, which slightly exceeds in circumference the bezel into which the jewel is to be fitted, and by which a circular burr of metal is pushed down upon the jewel.

Jew's-harp. 1. (*Nautical.*) The shackle by which a cable is bent to the anchor-ring.

Fig. 2718.



J wel-Setter.

2. (*Music.*) An instrument having a tongue vibrated by the finger and a frame held against the teeth for a sounding-board.

Jew's-harp Shack'le. A clevis and pin whereby the chain-cable is bent to the anchor.

Jews' pitch. Asphaltum.

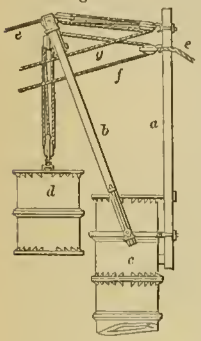
Jib. 1. (*Nautical.*) A large triangular sail set on a stay, forward of the fore stay-sail, between the fore-top mast-head and *jib-boom* in large vessels. It occupies a position between the mast-head and bowsprit in cutters, schooners, and small craft, and does not necessarily run on a stay.

Jibs are known by various names, according to position, etc., as *inner*-jib, *outer*-jib, *standing*-jib, *flying*-jib, *spindle*-jib, *storm*-jib, *jib-of-jibs*, etc.

A *jib-topsail* or *balloon-jib* extends towards the topmast head, and in cutter yachts is sometimes a very large sail.

2. (*Machinery.*) The extended arm of a crane; or that spar of a derrick which is stepped at the bottom and connected by tackle at the top to the vertical post. The post *a* is maintained vertical by guys, and the tackle affords a means for adjusting the inclination of the *jib b*, the *fall* being carried from the top of the post to a small *crab* on the ground, distinct from the larger crab which operates the hoisting-tackle. See CRANE; DERRICK.

Fig 2719



Jib and Post.

The jib of a derrick is stepped, and is adjustable in inclination. The jib of a crane is fast to the frame and rotates horizontally with it, or is journaled to the frame and is adjustable thereon. Sometimes vertically, for hight; always horizontally for sweep.

Fig. 2719 shows the mode adopted for hoisting the successive sections of the stand-pipe for the East London Water-Works. *a* is a jib-post, secured by a hoop to the standing portion of the pipe *c*; *b* is the jib; *d* is the section to be hoisted into place; *e e* are guy-ropes; *f g* the falls of the hoisting and the jib-tackles.

Jib-boom. (*Nautical.*) A movable spar running out beyond the bowsprit, for the purpose of affording a base to the jib in large vessels, and to the flying-jib in schooners and smaller craft.

Jib-door. A door made flush with the wall on both sides.

Jib-frame. (*Steam-engine.*) The upright frame at the sides of a marine-engine, connecting the cylinder, condenser, and the framing.

Jib-i'ron. (*Nautical.*) The traveler of the jib. An iron hoop fixed to the jib and sliding on the boom.

Jib-stay. (*Steam-engine.*) A portion of the stay-frame of a marine steam-engine. See JIB-FRAME.

Jig. 1. A handy tool. The name is applied to various devices, and in many trades small and simple machines are called jigs. In the armorer's set of tools we find cited, —

Drilling-jig.
Filing-jig.
Milling-jig.
Shaving-jig.
Tapping-jig.

2. A trolling bait, consisting of a bright spoon and an attached hook. A ball of light metal on a hook.

Jig'ger. 1. (*Pottery.*) *a.* A horizontal table carrying a revolving mold, on which earthen vessels are shaped. A potters'-wheel; a *throwing* wheel.

b. A templet or former which is used in shaping the interior of a crucible or other vessel when the clay is upon the wheel. See Fig. 1536, *supra.* See also "Leçons de Céramique," Vol. II. p. 122 *et al.*; also "Feldspath Porcellan," Weimar, 1835, Figs. 79, 80, 82, Taf. VII.

2. (*Felting.*) To harden and condense a felted fabric by repeated quick blows from rods, or by a platen or platens having a rapid vibratory motion.

A machine for felting fiber by an intermittent rolling action upon the material, which lies upon a table, and is kept warm and wet.

3. (*Nautical.*) *a.* A double and single block-tackle, used for such jobs as holding on to the cable, abaft the capstan, as the cable is heaved in. Also used in hauling home the topsail sheet and other similar work.

b. A small tackle attached to the bight of another rope, to increase the purchase.

c. A supplementary sail rigged on a mast and boom, from the stern of a cutter or other vessel.

d. A small mast erected on the stern of a yawl.

e. A fishing-vessel whose rig corresponds to that of a cutter, excepting a small mizzen in the stern.

f. A weighted line with several hooks, set back to back, dropped into the water, and suddenly jerked upward to catch fish.

4. (*Coopering.*) A drawing-knife with a hollowing blade.

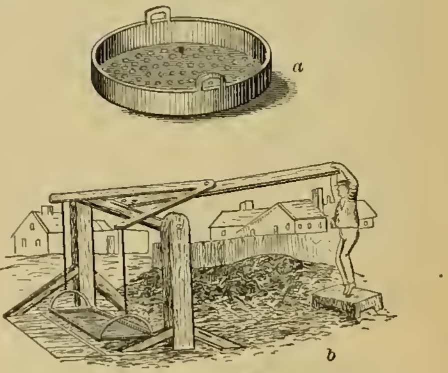
5. (*Leather.*) A machine for graining morocco leather, consisting of grooved boxwood rollers fitted in a frame suspended from the ceiling, and swung backward and forward like a pendulum.

6. (*Metallurgy.*) A riddle or sieve shaken vertically in water, to separate the contained ore into strata, according to weight and consequent richness.

The ancient Iberians washed gold-bearing earth in baskets in the time of Strabo.

The sieve *a* commonly consists of a hoop with handles, and a bottom of sheet-brass, finely perforated. It is used by striking it squarely upon the water, and giving it a semi-rotation simultaneously, to sort the pulverized ore according to gravity; the ore being lifted by the incoming water from below, and the heavier portions settling first. The lighter portions are scraped from the top, and the lower stratum removed for smelting or farther concentration.

Fig. 2720.



Jigger and Jigging-Machine.

The object is to keep the particles suspended for a short time in water, so as to give the heavier portions a chance, by rapid subsidence, to arrange themselves as the lower strata in the sieve; the finest portions pass through the meshes, settle in the vat, and are subsequently washed in a *buddle.*

Several applications of machinery to this purpose may be noticed.

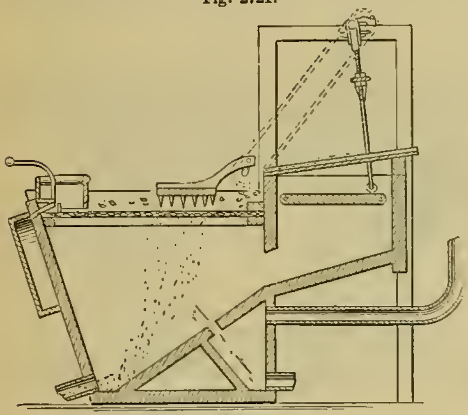
In one (*b*) a heavy sieve is suspended from a lever, which has a horizontal roller for a rocking axis. The lever is worked by a man, who, by a saltatory motion, alternately lifts the *jigger* from the water and allows it to slap down again, raising the ore in the sieve, as has been stated. There are several other applications of machinery, perhaps as nearly allied to this as any other, and may here be noticed.

1. Submerged sieves agitated by steam or water power.
2. Submerged sieves in which the water is introduced in an active current from below.
3. A box with a tight wooden floor, with an annular metallic trough pierced with holes, provided with movable sieves. In the middle of this circular system is a cylinder in which a piston plays, the effect being to alternately elevate and depress the level of water which passes through the sieves as it flows, and thus lifts the charges contained therein.
4. The jigging-sieve is attached to the end of a vertically reciprocating rod moved by a lever, which is oscillated by a wiper-wheel on a rotating shaft. The effect is similar to that just described, the layer of ore in the sieve being lifted as the sieve is slapped down into the water, the tendency of the heavier particles to settle first gradually sorting the charge into strata of varying weight and consequent richness.

Jig′ger-knife. A drawing-knife with a blade bent at one end and curved at the other, used by wheelwrights.

Jig′ging-ma-chine′. One in which the pulverized ore falls on to a sieve, where it is agitated by a rake, in water which is caused to pulsate by an intermittent plunger. The small and heavy particles fall through and are sorted by an opposing stream of water; the heavy and larger fall into a ragging-box, and the light are washed off.

Fig. 2721.

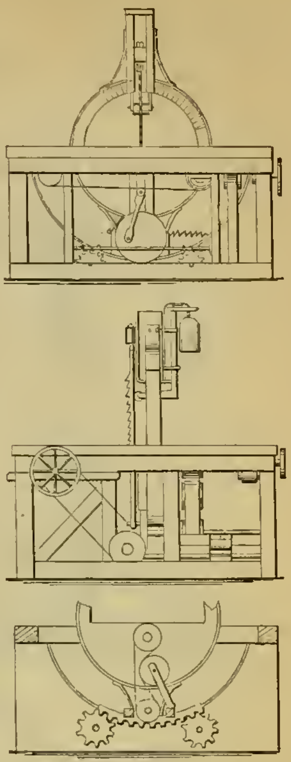


Jigging-Machine.

Jig-saw. A vertically reciprocating saw, moved by vibrating lever or crank-rod, as in Fig. 2722, in which the saw is arranged between two sliding head-blocks, to the upper one of which is attached an index to mark the bevel, a vernier plate being fixed to the circular iron-banded timber to which the blocks are secured by braces. It is moved by a segment of a cog-wheel under the carriage, gearing and working into pinions, and by a pulley-band over a drum.

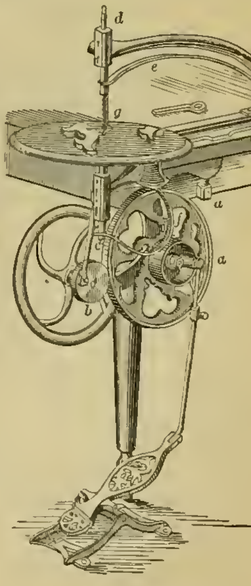
Fig. 2723 is a form of portable jig-saw, which is readily attached to a carpenter's bench or an ordinary table by means of a screw-clamp. The iron arm terminates in the guide *d*, in which works the spindle to which the upper end of the saw is attached, its lower extremity being similarly held in the guide underneath the table. A constant tension of the blade is maintained by the bent springs *e* and *f*. Motive-power is communicated from the treadle, which may be attached, at any convenient point on the floor, to a rod which forms a sleave for a smaller rod, which is connected with the crank of the large wheel *a*. The object of making the rod in two portions is that it may be adjusted to suit any hight of table, and afterward held in position by the set screw. Around the circumference of the wheel *a* is placed a covering of leather, by the friction of which the pulley *b* and the fly-wheel connected therewith are actuated. By means of the pitman, as shown, motion is transmitted to the saw. *g* is an adjustable metallic foot, designed for holding the work in place while being operated upon.

Fig. 2722.



Jig-Saw.

Fig. 2723.



Portable Jig-Saw.

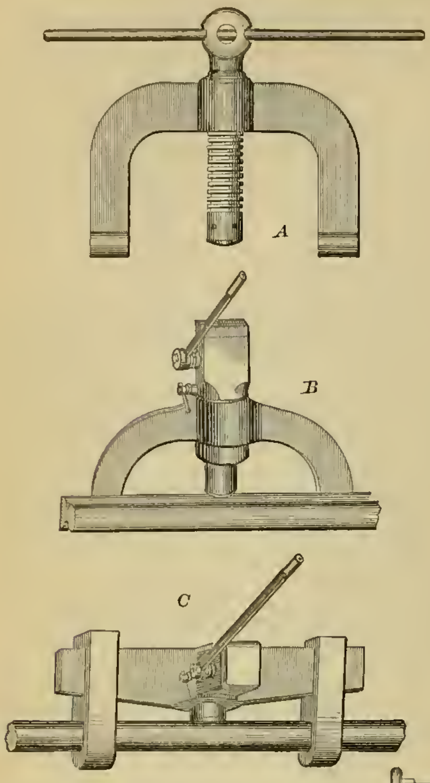
Jim-crow. 1. An implement for bending or straightening rails.

In the examples, *A* is a screw machine, in which the rail lies upon the hooked feet.

B C are hydraulic jim-crows with different modes of presentation, the upper one being a *rail-bender*, and the lower one (*C*) a shaft-straightener, and may be used on a rod in a lathe. The jack swivels round in the frame so that the handle may be worked in any direction.

2. The *jim-crow* planing-machine is furnished with a reversing tool, to plane both ways, and named from its peculiar motion, as the tool is able to "wheel about and turn about." The table is moved endways by a quick-threaded screw, which allows the driving motion to be placed at the end.

Fig. 2724.



Jim-Crow.

Jim'my. A short crow-bar.

Jin'gal. A large musket used as a wall-piece in China and India.

Jin'glet. A ball within a spherical bell, which acts as a clapper.

Jin'ny-road. (*Mining.*) An inclined road in a coal-mine, on which loaded cars descend by gravity and elevate empty ones. Also known locally in some parts of England as a *jig-brow.*

Jo'bent-nail. (*Locksmithing.*) A thick-headed nail (*cf.* Eng. *jobber-nowl ;* a blockhead ; a numskull). A *dog-nail.*

Jock'ey-pad. (*Saddlery.*) A knee-pad on the forepart of a saddle.

Jock'ey-stick. A stick five or six feet long, which is connected at one end to the hame of the *near* horse of a pair, and at the other end to the bit of the off-horse, to keep him at a distance. Used in connection with a single line, the favorite mode of driving a team in most parts of the West, many parts of the South, and worthy of adoption by all.

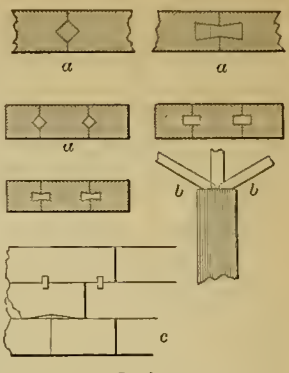
Jog. (*Machinery.*) A square notch.

Jog'gle. 1. (*Masonry.*) A joint-piece or *dowel-pin a a* let into the adjacent faces of two stones to preserve them in proper relative position. It may vary in form, and may approach in its shape either the DOWEL or CRAMP (which see).

The stones of the Parthenon at Athens were united by oak joggles.

2. (*Architecture.*) In *pl.* Shoulders *b* on a truss-post, which support the lower ends of *struts* or *braces.*

Fig. 2725.



Joggles.

Jog'gle-beam. (*Carpentry.*) A built beam, the parts of which are joggled together.

Jog'gle-joint. (*Masonry.*) A mode of uniting the stones of ashlar masonry. (*a a,* Fig. 2725.)

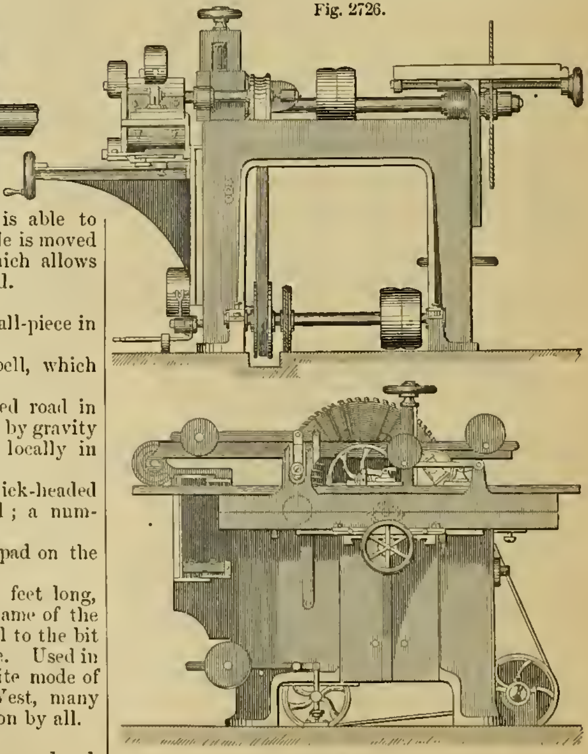
Jog'gle-piece. (*Carpentry.*) The upright member in the middle of a truss. A *king-post.*

Jog'gle-post. (*Carpentry.*) A post having shoulders to receive the feet of struts. See *b,* Fig. 2725 ; also KING-POST.

Jog'gle-truss. (*Carpentry.*) A hanging-post truss with only one post.

Jog'gle-work. (*Masonry.*) Work in which the courses are secured by *joggles,* as at *c,* Fig. 2725, so as to prevent their slipping on each other ; as the courses of an abutment under the thrust of an arch.

Fig. 2726.



Joiner.

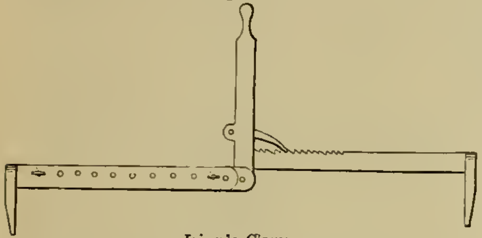
Join'er. A wood-working machine for doing various kinds of work, such as sawing, planing, and thicknessing, mortising, tenoning (single or double), cross-cutting and squaring-up, grooving, tongueing, rabbeting, mitering, molding and beading, chamfering, wedge-cutting, boring, and a great variety of other operations.

Attachable parts adapt the machine for certain duties, such as ripping out or for tenoning, for instance; the illustrations show it as adapted for cross-cutting and for planing or molding.

Join'er's-chis'el. A thin-bladed paring chisel.

Join'er's-clamp. A carpenter's appliance used in gluing up doors and other wide objects; the purpose of the arrangement in the example is to adapt it to fold into a small compass when not in use. See also Carpenter's-clamp.

Fig. 2727.



Joiner's Clamp.

Join'er's-gage. A scribing tool to make a mark on a board parallel to the edge of the latter.

Join'er's-plane. A bench-plane for facing and matching boards.

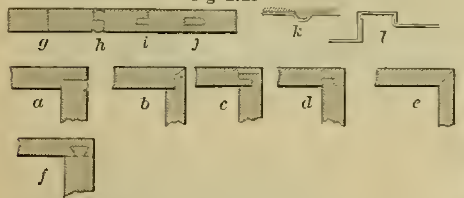
Join'er's Tools. See Wood-working Tools and Machines.

Join'er-y. As distinguished from *carpentry*, the art of framing the finishing work of houses; doors, windows, shutters, blinds, cupboards; hand-railing of stairs, balconies, and galleries; mantel-pieces (if of wood), the construction of permanent fittings, and the covering of all rough timber.

The carpenter is supposed to use the axe, adze, chisel, and saw, and has to make and place the wall-plates, joists, and other floor-timbers, floors, staircase, the woodwork of the roofs, wooden partitions, and those portions of the frames of windows, doors, and skylights which are built into place.

Joint. A junction or mode of joining parts in a structure.

Fig. 2728.



Joints.

1. (*Carpentry.*) A mode of securing together the meeting edges of wooden structures.

The *straight* joint is where the edges make a butt-joint, being planed straight.

a, the bead conceals the joint.

b, may be nailed from both edges, and has a *jog* to prevent slipping.

c, employed for pilasters; it has interlocking jogs, which give a positive hold.

d, employed for skirtings, dadoes, backs, and back linings of windows, doors, jambs, and internal angle-finishing.

e, miter-joint.

f, dovetail-joint.

g, square joint.

h, rabbet-joint, with beads.

i, tongue and groove joint.

j, feather-joint.

Other joints are known by some peculiarity or finish or application, as: *Bracket, chamfered, covering, diamond, frontal, plain, side, suspended joints.*

To *joint* is to plane straight the edges of boards.

2. (*Plumbing.*) The sheets of sheet-metal roofing are joined by a *drip-joint k* or a *flashing-joint l* in cases where they are not soldered. The drip is used when the joint is *with* the *current*, and serves as a conductor for water. The *flashing* is a cap strip where the edges of the sheets meet on a projecting ridge. See also Angle-joint.

A *flush* joint or jump joint is a *butt*-joint covered with a plate on the inner side, called the *butt-plate*.

In a *lap*-joint the pieces overlap each other.

3. (*Masonry.*) The *face-joints* of voussoirs are those which appear on the face of the arch.

The *vertical* joint is between stones of the same course.

The horizontal joint is between courses.

The *coursing-joint* is the joint between the courses of voussoirs.

The *heading-joint* is that between two voussoirs in the same course.

The *flush-joint* is filled up to the face by pointing with mortar.

4. (*Bookbinding.*) The lateral projection of the back to correspond to or cover the thickness of the sides.

See also under the following heads:—

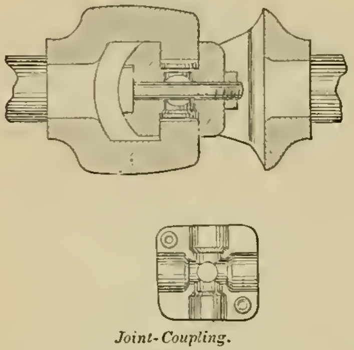
Abutting-joint.
Angle-joint.
Back-joint.
Ball and socket joint.
Bayonet-joint.
Beaking-joint.
Belt-clasp.
Bevel-joint.
Break-joint.
Butt-joint.
Calking-joint.
Carvel-joint.
Clincher-joint.
Close-butt joint.
Cog.
Compass-joint.
Cone-joint.
Coupling.
Coursing-joint.
Dovetail.
Dowel.
Drip-joint.
Elbow-joint.
Expansion-joint.
Face-joint.
Fantail-joint.
Faucet-joint.
Feather-joint.
Fish-joint.
Flange-joint.
Flashing-joint.
Flush-joint.
Folded-angle joint.
Gimbal-joint.
Ground-joint.
Halving.
Heading-joint.
Hinge-joint.
Joggle.
Joint-chair.
Jointer.
Joint-fastening.
Joint-file.
Jointing-plane.
Jointing-rule.
Joint-pliers.
Joint-saw.
Joint-stool.
Joint-wire.
Jump-joint.
Knee-joint.
Lute.
Miter-joint.
Mortise.
Notching.
Overlap-joint.
Pipe-joint.
Plumb-joint.
Prop-joint.
Rabbet-joint.
Rail-joint.
Rivet-joint.
Roll-joint.
Rule-joint.
Rust-joint.
Rustic-joint.
S-joint.
Scarf-joint.
Shift-joint.
Splice-joint.

Square-joint.
Strap-joint.
Surface-joint.
Sypher-joint.
T-joint.
Tenon-joint.
Thimble-joint.
Toggle-joint.
Tongue and groove joint.
Union-joint.
Universal-joint.
Weld-joint.

Joint-chair. (*Railroad.*) A railway chair which supports the ends of abutting rails.

Joint-coup'ling. A form of universal joint for coupling sections of shafting. In the example, the pivoting points enter recesses cast in the clamping-iron, which is made in two parts, held together by a bolt. See also JOINT, for list of varieties.

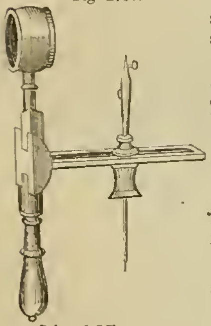
Fig. 2729.



Joint-Coupling.

Joint'ed-mi'cro-scope. A pocket microscope in which the handle and lens-holder shut down against the slide on which the object pliers are adjustable.

Fig. 2730.



Jointed Microscope.

Join'ter. (*Masonry.*) *a.* A tool for filling the mortar cracks between courses of bricks. A *pointing* tool.

b. A tool for marking the mortar-joints.

2. (*Coopering.*) The *stave jointer* is a large stationary plane on which the edges of the staves are worked.

The *heading jointer* has a straight-edged bit.

The *backing* or *side jointer*, otherwise called the *over-share*, has a concave-edged bit, and is used for dressing the backs of staves.

The *inshare* has a convex-edged bit, and is used for dressing the inner faces of staves.

3. A bent strip of iron inserted into a wall to strengthen the joint.

Joint'er-plane. (*Coopering.*) A plane five or six feet long, its lower end resting upon the ground, and its upper end supported upon a prop, the inclined sole being presented upward for the staves, which are jointed thereon.

The Hindoos and Chinese bore a hole through the front of a plane for a stick whereby a boy assists by pulling the plane across or along the work. When the plane is very large, the Chinese place it at an angle, resting one end on the ground, in the manner of our cooper's *jointer*.

Joint-fas'ten-ing. (*Railway.*) A fish-bar or other means of locking together the adjacent ends of two railway rails.

Joint-file. A small file without taper, and circular in its cross-section. It is used for dressing out the holes for the joint-wire in snuff-boxes, etc., and in preparing the apertures for the pintles of hinges.

Joint-hinge. A strap-hinge. See HINGE.

Joint'ing-plane. (*Joinery.*) A plane with a long stock, used to true the edges of boards or staves which are to be accurately fitted together. It is 2 feet 6 inches long, and the work is called *shooting the joints.*

Joint'ing-rule. (*Bricklaying.*) A straight rule about six feet long, used by bricklayers in marking with white paint along each joint of the brick-work. Otherwise called *penciling*, and designed to render the joint conspicuous.

Joint-pipe. (*Gas-apparatus.*) A short section of pipe, forming a connection between two lengths, and usually having threaded sockets into which the parts are screwed.

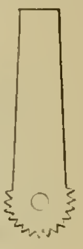
Joint-pli'ers. A pliers adapted for securing the joints of compasses and similar instruments; also one by which the hinging of watch-cases is assisted.

Joint-saw. A saw with a curved working face, used in making the joints of compasses and other similar work.

Joint-stool. A block holding up the ends of parts which belong in apposition, as railway rails, ways of vessels, etc.

Joint-wire. (*Watchmaking.*) The tubular wire, sections of which form the joints of watch-cases, lockets, etc.; a piece is hard soldered to each leaf, and a solid wire runs through to form the pintle. It is drawn upon a piece of steel wire, one end being tapered off with a file, so that the tube and wire are grasped together by the dogs and drawn after the manner of a solid wire.

Fig. 2731.

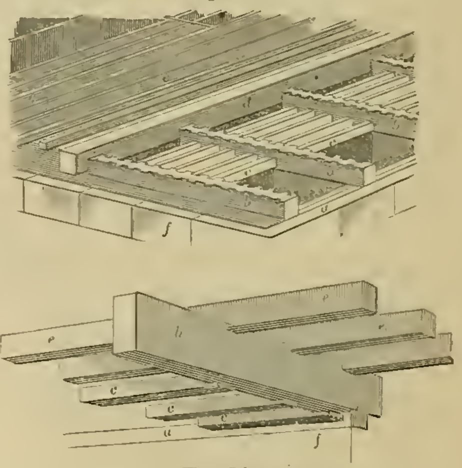


Joint-Saw.

Joist. (*Carpentry.*) A horizontal timber supporting a floor or ceiling, one or both.

Single flooring is formed with joists reaching from wall to wall, where they rest on *plates a* of timber built into the brick-work. The floor-boards are nailed on the upper edges of the joists, whose lower edges receive the lathing and plastering of the ceilings. Double floors are constructed with stout *binding joists b b*, a few feet apart, reaching from wall to wall, and supporting *ceiling joists c c* which carry

Fig. 2732.



Floor-Joists.

the ceiling, and *bridging joists c c* on which are nailed the floor boards.

When the main timbers of the floor are girders *d* which rest on the wall plates and support the *binding joists b b*, the floor is called a *framed floor*. The binding joists *b b* support the bridging joists *c e* and ceiling joists *c c* as before.

The *trimming* joists are short joists into which trimmers are mortised. Trimmers are pieces around a fire-hearth or a hatchway, where the continuity of the joists is broken.

The strength of joists, of equal thickness, is as the square of the height. A joist 4 × 6 has one quarter the strength of a joist 4 × 12. The latter is only twice as large.

Timber is weakened by sawing. A floor of 16 feet bearing, supported by 12 joists 8 inches square, 1 foot apart, is stronger than a similar floor of 24 joists, 8 × 4, placed edgeways, 6 inches apart. The quantity of timber is the same in both cases.

Jol'ly-boat. (Dutch *jol*; Danish *jolle*; a yawl.) A small boat used for the general miscellaneous work of a ship, such as bringing off marketing, etc.

A boat of this kind attached to United States vessels of war is called a *dingy*. It is clinker-built, from 16 to 20 feet long, with a beam from .33 to .29 of its length.

Jour'nal. (*Machinery.*) That portion of a shaft which rests in the bearings.

Jour'nal-bear'ing. (*Machinery.*) The support of a shaft or axle, generally boxes or brasses in a *pillow-block*.

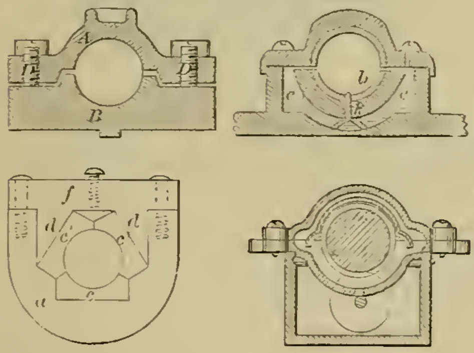
Fig. 2733 shows four varieties of journal-bearings for machinery.

In one *A* is the cap, *B* the pillow; *D D* are screws with set nuts for adjustment.

In another, the lower half *b* of the box rests in an oil reservoir *c*, from which the lubricant is led up by wicking *k*.

In the lower figure to the left, the bearing is made in three parts, *c c' c'*, movable by means of the wedge-faces *d d* of the block *f* towards a common center to compensate for wear.

Fig 2733

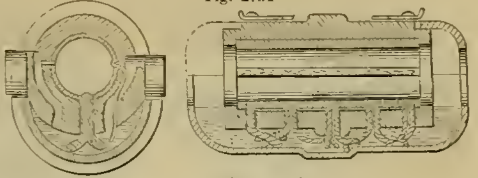


Journal-Bearings.

The right-hand figure below shows a shield above the journal to prevent the oil from being thrown through the joint between the two parts of the box.

Fig. 2734 shows a removable oil-reservoir, which can be detached without disturbance to the journal-box. The ends extend beyond the box, with caps to fit over such projections. An oil passage leads to the top of the box, for the conveyance of oil to the top of the box by means of a capillary substance, and a like passage on the other side of the box conducts back to the reservoir any surplus oil carried over by means of rapid motion.

Fig. 2734



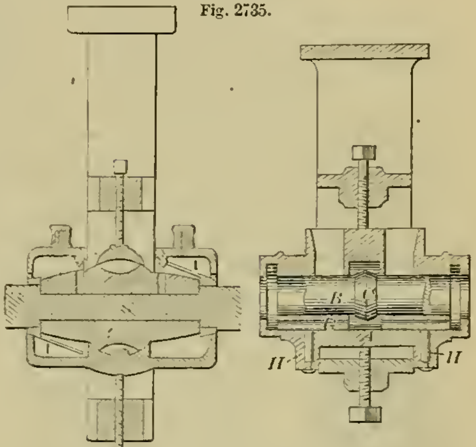
Journal-Bearing Lubricator.

Fig. 2735 shows two forms of journal-bearings in suspended hangers.

In the one to the left, the box is surrounded by a shell whose lower portion contains the oil which is raised by inclined wires in the shoulders of the shaft. The oil is carried up to the points which depend from the upper portion of the shell, and it then drops into the oil-holes of the box.

In the other view, the oil is carried up by the collar *C*, distributes right and left, and returns by the longitudinal channels *G*. *H H* are sediment-boxes.

Fig. 2735.



Hanger-Bearings.

Fig. 2736 shows a number of bearings for axles.

Above, to the left, is one in which the axle-arm *F* rests on a wheel *D* which revolves in the oil-reservoir.

To the right of this figure is one with anti-friction rollers around the shaft; these are prevented from shifting endways by the circular flanges *F* on the axle and in the box which project within the peripheral grooves in the rollers *D*.

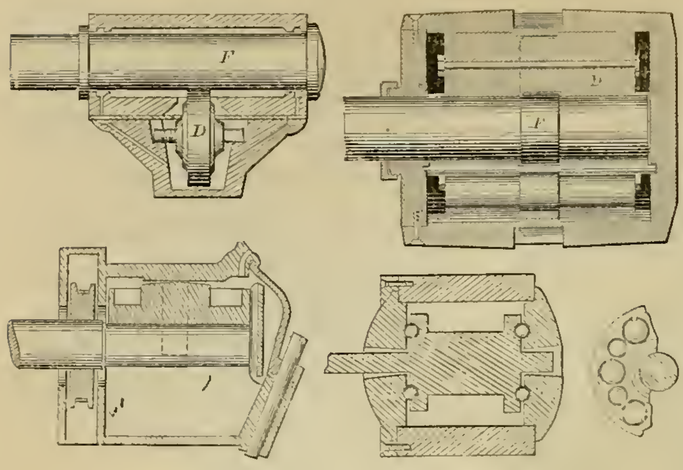
The circular system of anti-friction wheels for a journal-bearing is described in Tate's English patent, 1802.

Below this figure is one in which the anti-friction balls are used. The casing has annular grooves in which balls of different diameters are placed alternately, so that the large balls will all turn in one direction, and the small balls will keep the large ones in position.

To the left, below, is a view of a railway car axle and box. See Car Axle-box.

Fig. 2737 shows a journal-bearing for a vertical shaft, with journal-box *a* in one piece. The spindle *b* is inserted from below, and coupled by a screw coupling or otherwise. The bolt above affords a

Fig. 2736.



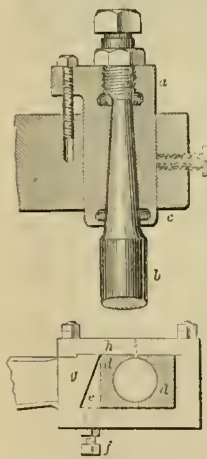
Bearings of Journals of Axles.

bearing for the end of the spindle, and the box has a receptacle for lubricant. Other lubricating chambers may be provided, as shown at *c*.

The lower portion of Fig. 2737 shows an adjustable box consisting of two portions *d d*, inside the strap *h* of a connecting rod.

The lubricity of oils or their comparative fitness for the lubrication of bearings and packing-boxes may be ascertained by a machine which determines the amount of frictional motion that is necessary to produce a given temperature.

Fig. 2737.



Journal-Bearing.

Girard's *palier glissant* employs water to act, first, by its pressure, to lift the journal to be lubricated; and, secondly, by its fluidity to form a liquid bed or cushion between the journal and its box, on which the journal may rest in its revolution without touching the metal of the box at all.

Water-bearing for steps and shafts is described in Bramah's English planing-machine patent, 1802. He describes it as a liquid bearing for steps of vertical shafts, and makes it adjustable by pumping in liquid. Known also as *palier glissant; hydraulic pivot.*

Babbitt's Anti-attrition Metal. Melt 4 lbs. copper; add, by degrees, 12 lbs. best banca tin, 8 lbs. regulus of antimony, and 12 lbs. more of tin. After 4 or 5 lbs. tin have been added, reduce the heat to a dull red, then add the remainder of the metal as above.

This composition is termed *hardening:* for lining, take 1 lb. of this *hardening*, melt with it 2 lbs. banca tin, which produces the lining metal for use. Hence, the proportions for lining metal are 4 lbs. of copper, 8 of regulus of antimony, and 96 of tin. See ALLOY.

Devlan's compositions for lining journal-boxes are various combinations of vegetable fiber, graphite, steatite, gum, bitumen; or paper pulp and silicate of soda or potash; or vegetable fiber, graphite, steatite, and silicate of an alkali.

Metaline is a material formed of metals, oxides of metals, and organic matter, reduced to powder, compounded with wax, gums, or fatty matters, and subjected to heavy pressure, so as to form solids of proper shape to form boxes and bearings for shafts or axles.

The following compositions are stated: —

Lignum vitæ and spermaceti.

Ivory-dust and spermaceti.

Tin and petroleum residuum.

Zinc and caoutchouc.

Plastic bronze and caoutchouc.

Type-metal and caoutchouc.

Anthracite and tallow.

Oxide of tin and beeswax.

Jour'nal-box. The carrier of a journal. See JOURNAL-BEARING; AXLE-BOX; CAR AXLE-BOX.

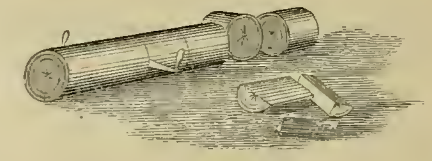
Jour'nal-box Met'al. See BABBITT-METAL; ALLOY.

Jour'ney. A corruption from JOURNAL (which see).

Juc'ten. A name by which *Russia leather* is known. *Juften.* See RUSSIA LEATHER.

Jug'gle. A block of timber cut to a length, either *in the round* or split.

Fig. 2738.



Juggles.

Jump. (*Forging.*) *a.* To upset by endwise blows, which contract the object in length, but thicken and spread it laterally. Applied to *jumpers*, tamping bars, axes, etc. See UPSETTING.

b. To attach by a *butt-weld*, in contradistinction to a *lap-weld*.

A transverse piece attached by welding is said to be *jumped on.* If formed from a portion of the rest, it is said to be *headed on.*

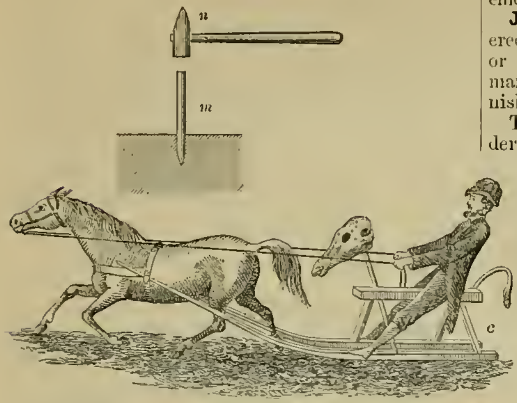
c. A gun-barrel made of a ribbon of iron, or laminated iron and steel, coiled around a mandrel at a red heat, then raised to a welding heat and placed on a cylindrical rod, which is struck heavily and vertically on the ground, is said to be *jumped.* The effect is to cause the edges of the ribbon to unite, a junction which is completed by the hammer on an anvil, the mandrel retaining its position. Such barrels are said to be *twisted.* The *twist* is *stub, wire,* or *Damascus*, according to the mode of manufacture of the ribbon. See TWIST; GUN-BARREL.

2. (*Mining.*) A fault or dislocation of a vein or lode.

Jump'er. 1. (*Quarrying.*) *a.* A quarryman's boring-tool. A rod of steel, or pointed with steel, which breaks the rock by being alternately jumped up and down to form a hole for blasting or for an artesian well.

b. A steel-faced chisel *m* held by one man while another strikes it with a hammer *n*. Used in drilling holes in rock for blasting or splitting.

Fig 2739.



Jumpers.

2. A cheaply formed sled *c*, in which supple pieces of wood form the shafts and runners, and support a box or trestle in or on which the person rides.

3. (*Horology.*) *a.* A spring used in repeating-clocks to assist the motion of the star-wheel.

b. A species of click in the repeating-watch, preventing the motion of a wheel in either direction.

4. (*Planing.*) A plow-bit or machine-jointer, having an intermediate bearing upon the board.

5. (*Husbandry.*) A plow having an upturned cutter in front of its share, and which, going below the share, prevents its being caught on roots, etc.

Jump-joint. 1. A butt-joint.

2. A *flush*-joint, in which the plates or planking make a smooth face. In shipbuilding it is equivalent to *carvel*-build.

Jump-seat. (*Vehicle.*) A kind of open buggy which has a shifting seat or seats. For instance, it may be arranged as a double or single seat vehicle. In the former case, the main seat is moved over backwardly, and the extra seat brought up in front. As a single-seat vehicle, the main seat is thrown into a central position, the extra seat being placed below the other one.

Junc'tion-plate. (*Boiler-making.*) A welt or break-joint plate riveted over the edges of boiler-plates, which make a butt-joint.

Junc'tion-rails. (*Railroad-engineering.*) Switch rails which connect tracks.

Junk. 1. (*Vessel.*) (Dutch, *jonk*, perhaps from Chinese *yong*, the sea.) A vessel employed by the Chinese, Japanese, and Malays in navigating their seas.

It is the largest kind of Chinese vessel. It has no prominent stem or keel. The bow on deck is square, and the anchors are on each side of the bow. The stern is full, the rudder suspended, and at sea is lowered beneath the depth of the bottom of the vessel. The immense masts are in one piece, the lug-sails are sometimes of matting.

2. Old cable and rope cut into lengths, to make *mats, swabs, gaskets, sinnet, oakum*, etc.

Junk-ring. (*Steam-engine.*) *a.* A metallic ring which is screwed down upon and confines the hemp packing of a piston.

b. A steam-tight packing around the piston of a steam-engine.

Junk-wad. (*Ordnance.*) A wad made of oakum bound with spun-yarn, and filling the bore of the gun. It is placed between the charge and the ball.

Ju'ry. (*Nautical.*) A term applied to temporary structures, such as masts, rudders, etc., used in an emergency.

Ju'ry-mast. (*Nautical.*) A temporary mast erected in place of one that has been carried away; or for navigating a vessel to a place where the permanent equipment of masting and rigging is furnished.

The temporary rig is termed *jury-rigged;* a rudder of the same character, a *jury-rudder.*

Jus'ti-fi-ca'tion. 1. (*Printing.*) The adjustment of distance between the letters in the words and the words in a line, so as to avoid any glaring disproportion, and make them fill the measure.

2. (*Bookbinding.*) Attention to keeping the matter of pages in exact register or correspondence, to secure even margins.

Jute. (*Fiber.*) The fiber of *Cochorus capsularis* and *C. olitorius*, which is used in India for making gunny-bags, matting, rope, and other coarse fabrics.

In the manufacture of fabric from this article, the jute, after being taken from the bale, is sprinkled with oil and water, spread out on a table for a day or two, and then passed between rollers to render the fibers soft and pliable. It is next passed between toothed rollers, which bring the fibers nearly parallel, arranging them into a species of ribbon or sliver, which is again passed between two rollers with finer teeth than the preceding pair. These two machines are called the *breaker-card* and the *finisher-card.* The slivers thus formed are received into cans and subjected to the action of the *drawing-frame*, which is similar in its operation to that employed in the cotton manufacture, drawing out, narrowing, and thinning the slivers. The sliver is then slightly twisted and wound upon bobbins by the *roving-machine*, and afterwards spun by a *throstle;* the throstles making from 3,000 to 4,000 revolutions per minute.

The finished yarn for the warp is wound on large bobbins in the *winding-machine*, and placed on the loom beam by the *beaming-machine;* the weft yarn is wound on the pirns of the shuttles by the *pirning-machine.* The loom and shuttle are larger and stronger than those employed for weaving cotton, the fabrics made being generally coarser.

The finest jute yarns bear the lowest numbers, while in cotton the reverse is the case.

Jute-twine is sized with glue-water, starch, tallow, and China clay.

Crossley's patent floor-covering has a foundation of coarse jute coated with a layer of wool, and the two united by felting. The surface is finished by printing.

In Monach's process for preparing jute as a substitute for wool, the jute or jute-yarn is boiled for two hours in a solution of caustic alkali of a gravity of 60° to 80° Twaddell. After washing, it is steeped a short time in a weak solution of sulphuric acid to neutralize the alkali, and is then washed and dried.

Jut'ting-out. (*Architecture.*) A projection; said of windows, corbels, cornices, etc.

Jutty. (*Architecture.*) A projecting part of a wall, as of a prominent course.

Jut-win'dow. (*Carpentry.*) A bow-window, projecting from the face of a building. A *bay-window.*

K.

Ka′jak. The boat of the Esquimaux. It is from 18 to 20 feet long, 18 inches broad in the middle, tapering to both ends, and about a foot deep. It has no outriggers, and is difficult to manage. It is covered with skins, and closed at top with the exception of a hole in the middle, which the boatman occupies, sitting on the floor of the boat.

The *kajak* is the men's boat. The *umiak* is the women's boat; has a flat bottom, and is much larger. It is made of slender laths, fastened with whalebone, and covered with seal-skin.

Ka-lei′do-phone. An instrument invented by Professor Wheatstone, to illustrate the phenomena of waves of sound. An elastic thin bar is fixed by one of its extremities, and at its free end carries a silvered or polished ball; a ray of light is reflected from this ball, and when the thin plate is put in vibration, the fine point of light describes various curves, corresponding with the musical notes produced by the vibrations.

Ka-lei′do-scope. An optical instrument, invented by David Brewster, 1814–17. An arrangement of mirrors produces a symmetrical reflection of beautiful images, derived from the association of pieces of colored glass, which assume new relations as the tube is slowly rotated.

This instrument is first noticed by Baptista Porta in his "Natural Magic," under the name of polyphaton. Kircher describes a similar invention of his own, but the application of two reflectors so inclined to each other as to form symmetrical images, changing as the instrument is rotated, was invented by Brewster.

"He subsequently found means to obtain multiplied images of such objects as flowers, trees, and even persons and things in motion, and thus the importance of the instrument was greatly increased. For this purpose, he caused the two mirrors to be fixed in a tube as before, but this tube was contained in another, from which, like the eye-tube of a telescope, it could be drawn at pleasure towards the eye. At the opposite end of the exterior tube was fixed a glass lens of convenient focal length, by which were formed images of different objects in the upper section, and which, being multiplied by successive reflections from the mirrors, produced in the field of view symmetrical patterns of great beauty. The properties of the instrument have been greatly extended; and when it is so constructed that there may be projected on a screen a magnified image of the whole pattern, and the tube is supported on a ball and socket joint, the figures in its field may be easily sketched by a skillful artist." — Timbs.

Kal′lif-thor′gan. A musical instrument played as a piano, and imitating the effect of a violin, violoncello, and double-bass.

Kal′muck. (*Fabric.*) A coarse, shaggy cloth, resembling a bear-skin.

A coarse, colored, cotton cloth made in Persia.

Kal′so-mine. A mixture of clear glue, Paris white, and water, laid on to a wall as whitewash. Commence by soaking 4 ounces of glue in a quart of warm water for 24 hours; then add a pint of water, and the tin vessel should be placed in a kettle of hot water over a fire, the glue being agitated till it is thoroughly dissolved and the solution quite clear. Put 5 or 6 pounds of powdered Paris white into a large bucket, and add hot water sufficient for the mixture to be of the consistency of cream; color according to taste. Then mix the glue-water with it, stir it well, and paint the walls with the mixture with the usual whitewash-brush.

Kamp-tu′li-con. A floor covering made of india-rubber, gutta-percha, and cork. The two former having been liquefied, the other is added in the form of fine dust. (Galloway's English patent, February 14, 1844.) The mixture, while warm and soft, is pressed into sheets between rollers. It is very elastic, and is printed like floor-cloth.

Ka′o-lin. The Chinese name for porcelain clay; which is derived from the decomposition of felspar. In the Chinese manufacture of porcelain the *kaolin* is mixed with a fusible earthy matter, call *petuntse*. See Porcelain.

Kas. 1. A horsehair sieve.

2. A negro drum.

Kath′e-tom′e-ter. See Cathetometer.

Keck′ling. (*Nautical.*) A mode of protecting a cable or hawser from chafing at the hawse-hole, or from being chafed by ice, etc., by means of a wrapping or serving of rope, small chain, or other envelope.

Kedge. A small and portable anchor, used in warping and other of the lighter duties of an anchor. See Anchor.

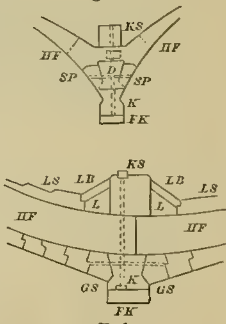
Keel. 1. (*Shipbuilding.*) *a.* The lower longitudinal beam of a vessel, answering to the spine, and from which the ribs proceed.

In wooden vessels, an additional timber beneath is called the *false keel.*

A timber resting on the flooring timbers and above the keel is the *keelson.*

Timbers secured parallel to the latter are the *sister-keelsons*, or *side-keelsons.*

Fig. 2740.



Keel.

Heavy timbers resting on the timbers before mentioned, and lying athwartships, are *cross-keelsons*, for sustaining the boilers and engines of steamships.

The *bilge*-keel is a longitudinal piece fastened on the bilge to protect it, or to prevent rolling, in the case of iron vessels without true keels.

The keel is *laid* upon blocks whose upper surfaces form an angle of about 3° with the horizon. The blocks are about three feet high and four feet apart.

In England the keel is usually of elm, the pieces being scarfed together to attain the requisite length. In a first-rate line-of-battle ship the keel is 20 × 20 inches. American elm does not suit for the purpose, and white oak is used.

A *sliding* keel is a board amidships, working in a trunk in the line of the keel and extending from the bottom to the deck. It is lowered to form a lee-board for a vessel when under canvas.

The upper portion of Fig. 2740 shows, in cross-section, the keel in the cant frames.

K, keel.
FK, false keel.
D, deadwood.
SP, stepping-pieces.
HF, half-floors.
KS, keelson.

The lower figure shows the keel nearer to midship.

K, keel.
KS, keelson.
FK, false keel.
HF, half-floors.
GS, garboard-strakes.
L, limbers.
LB, limber-boards.
LS, limber-strakes.

b. A small coal-carrying craft, used on the river Tyne.

2. A broad, shallow, cooling vat.

Keel-boat. A large, covered boat, used on American rivers. Before the time of steamboats, keel-boats were used for passengers and merchandise, being floated down stream and *poled* up stream.

Keel-fat. A cooler for wort, etc.

Keel'son. (*Shipbuilding.*) A longitudinal piece above the floor-timbers, binding them to the keel.

The *sister-keelsons* lie on each side of the keelson. Also called *side-keelsons.*

The *intercostal-keelson* is a short piece between frames.

Rider-keelsons are auxiliary keelsons placed above the *main-keelson* to give additional strength. See Keel.

Keep. (*Architecture.*) The tower or place set apart in a castle for the confinement of prisoners. A *redoubt.*

Keep'er. A ring, strap, pocket, or the like device for detaining an object; as, —

1. (*Harness.*) The *keeper* of a buckle-strap; a loop which slips upon the end of the strap, or into which the strap slides.

2. A ring worn on the finger to keep a larger one on.

3. A jam nut.

4. The box on a door jamb into which the bolt of a lock protrudes, when *shot.*

5. The armature of a magnet. A piece of iron which connects the two poles.

6. The mousing of a hook, which prevents its accidental disengagement.

7. The gripper of the flint in a flint-lock.

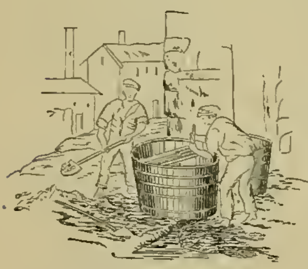
Keeve. A large vessel or vat, used for mashing, fermenting, or storing beer. See Beck; Vat.

For holding a bleaching liquor or alkaline lye. See Keir.

For elevating ores. See Corf.

An iron-bound tub of a truncate, conical form, set upon the smaller end, and used for collecting the fine grains of copper. In use it is kept half full of water, and the contents agitated by a shovel till the heavier particles seek the bottom, leaving the water to be dipped out and the refuse lighter upper stratum to be removed. In the illustration the *keeve* is shown with a central shaft and a paddle, which is revolved until all the mineral contents are involved in the gyration of the water, when the action is moderated and the heavier particles gradually assume the lower position and eventually reach the bottom. The action is called *tossing* or *tozing.* Other contrivances in which the comminuted ore is agitated in water are known as jiggers, etc. See Metallurgy.

Fig. 2741.



Tossing with the Keeve.

Keir. A vat for holding a bleaching liquor. The alkaline vat of a bleachery. See Bucking-Kier.

Kel'lach. A wicker sledge or cart used in Scotland.

Kem'e-lin. A brewer's vessel.

Ke-men'geh. An Arab violoncello, with two strings.

Kemps. 1. Impurities of fur; that is, knots and hairs which do not possess the felting property.

2. The coarse, rough hairs of some grades of wool.

Ken'net. (*Nautical.*) A *kevel* or large cleat.

Ken'nets. A coarse cloth made in Wales.

Kent-bu'gle. The key-bugle invented by Logier early in this century, and named after the Duke of Kent, the father of Queen Victoria. It has six keys, and is the predecessor of the great tribe of cornets.

Kent-ledge. Pigs of iron for permanent ballast, laid over the keelson-plates.

Ke'per. A German twilled linen goods resembling *marsella. Kofer.*

Ker'a-tome. A surgical knife used in the operation for *artificial pupil.* Also called *iridectome* or artificial-pupil knife. It is spear-pointed, double-edged, and may be straight or angular. It is used for making an incision through the cornea into the anterior chamber, and by slight movements of its cutting edges, upward or downward, the wound is made of proper dimensions, after which the operation is completed with other instruments. Also used in operations for cataract.

Kerb. (*Masonry.*) Called also curb.

1. The assemblage of stones surrounding the mouth of a well or similar opening. See Curb.

2. The line of stones set on edge which separates a foot pavement from the gutter or carriage-way.

Kerf. The slit or notch made by a saw.

Kerf'ing-ma-chine'. A machine for sawing a series of parallel kerfs on one surface of a board, in order to enable it to be bent.

It consists of a table and a series of circular saws upon a horizontal mandrel, the latter being vertically adjustable, so as to allow the saws to project above the surface of the table to an extent equal to the desired depth of kerf.

Ke'rite. A compound invented by Austin G. Day (patent October 9, 1866), and by him termed *kerite* or *artificial caoutchouc,* and in which the raw caoutchouc or rubber is replaced by tar or asphaltum, which, combined with animal or vegetable oils, is vulcanized by sulphur, the product closely resembling rubber, the hard and soft varieties being produced by different proportions, etc. The principal use of kerite has been as an insulating material in telegraphy.

Day, in his patent, gives the following formulas. Parts by weight. Heats to 260°, gradually increases to 300° F.

a. Linseed-oil, 2; cotton-seed oil, 1; raw turpentine, 2; sulphur, 2. Time, 1 hour.

b. Linseed-oil, 2; castor-oil, 1; liquid coal-tar, 2; petroleum, 1; turpentine, 2; sulphur, 2. Time, 30 minutes or more.

c. Linseed-oil, 2; petroleum, 1; crude turpentine, $\frac{1}{2}$; sulphur, 4. Time, 35 minutes.

Ke'rite-wire. Wire used in telegraphy, insulated by a covering of *kerite.*

Kern. 1. (*Printing.*) The part of a letter which overhangs the shank. It occurs more frequently in *italic* than in Roman: "*jolly old fag*" embraces the kerned letters of an *italic* font.

2. (*Milling.*) A hand-mill for grain. See Quern.

Ker'sey. (*Fabric.*) A probable corruption of Jersey, whence it came. A coarse ribbed cloth made from wool of long staple.

Ker-sey-mere'. (*Fabric.*) A light woolen twilled goods with an oil finish, for men's wear.

Named from *Kersey*, in Yorkshire, England. *Cassimere.*

Ker-sey-nette′. (*Fabric.*) A thin woolen cloth. *Cassinette.*

Ketch. (*Vessel.*) An almost obsolete form of two-masted vessel, carrying a tall, square-rigged main-mast forward, and a shorter fore-and-aft rigged mizzen abaft.

Being a favorite form of mortar vessel, we frequently read of *bomb-ketch* in the wars of a past age.

Ket′tle. A metallic vessel in which water or other liquid is boiled. In sugar-houses kettles are arranged in rows called *batteries.* Capacities and sizes of sugar pans and kettles are as follows: —

Shallow.

Size.	Diameter.	Depth.	Rim
25 gallons.	29½ inches.	10½ inches.	3½ inches.
30 "	31¼ "	12 "	3¾ "
40 "	33¼ "	13 "	4 "
50 "	39 "	13 "	4¼ "
60 "	42 "	15 "	4½ "
80 "	46½ "	16 "	4¾ "
100 "	49¼ "	17 "	4¾ "
125 "	53½ "	18 "	5 "
150 "	56½ "	20 "	5¼ "

Weigh about 5½ pounds to a gallon.

Deep.

Size	Diameter.	Depth.	Rim.
20 gallons.	27 inches.	9½ inches.	1⅝ inches.
30 "	29 "	13¼ "	1¾ "
40 "	31¼ "	15 "	2¼ "
50 "	35 "	13 "	2⅝ "
60 "	41 "	17 "	2½ "
80 "	42 "	18 "	2¼ "
100 "	47 "	17½ "	3 "
120 "	49½ "	18¼ "	3 "

Weigh about 5 pounds to a gallon.

Extra Sizes.

Size.	Diameter.	Depth.
200 gallons	70 inches	24 inches.
250 "	75 "	27 "
300 "	79 "	29½ "
350 "	81 "	30½ "
400 "	82½ "	31½ "
450 "	84 "	32½ "
500 "	85 "	33 "
550 "	86 "	34 "
600 "	87 "	35 "

Weigh about 7 pounds to a gallon.

The old mode of making brass kettles was by hammering upon a sheet of metal, until by degrees the required shape was assumed. The plan now in use is known as "Hayden's patent," December 15, 1851. Square blanks of sheet-brass are cut into circles of a diameter corresponding to the size of kettle required. After annealing, the metallic disks are brought in contact with cast-iron chucks revolving horizontally with great velocity. A small steel friction roller, resembling a button, is then brought in close contiguity to the metal, and, running along the outer surface of the blank, spins it out to the shape of the mold. Four such operations are commonly required before the kettle assumes its finished form, the metal requiring to be annealed after each. The course of the roller is marked by the concentric rings which are found upon most of the brass kettles in market. The processes of wiring, fixing on the ears and bales, are all required to make the kettle complete. Sizes range from ½ gallon to 32 gallons capacity.

Ket′tle-boil′er. An old form of steam-boiler whose lower portion was shaped as an inverted conical frustum, and the upper part a dome. The form resembles that of a tea-kettle.

Ket′tle-drum. The *kettle-drum* is so named from its resemblance to a hemispherical kettle. It is formed of thin copper, and has a head of parchment or vellum. Kettle-drums are used in pairs, slung on each side of the withers of a cavalry horse. One drum was tuned to the key-note and the other to the fifth of the key in which the piece in which they are to figure is written. The tuning is by a hoop and screws.

They are now usually supported upon tripod and used in orchestras. The *tam-tam* is the original kettle-drum, and has for its congeners the *darabookah* of Egypt, the *derbekkeh* of Syria. These are the lineal descendants of the Egyptian drum so commonly used in the festivities of the Pharaonic Egyptians. See Drum.

This brass band or orchestral instrument is classed with those of *percussion,* in contradistinction to *stringed* and *wind* instruments. *Kettle-drums* are used in pairs, of which the larger is used for the lower sound.

Drumsticks are of three kinds: *wooden, wood covered with leather, sponge ends.*

Drums are also played *open* or *muffled.* The latter is by a piece of cloth covering the head and deadening the sound. See Drum.

Ket′tle-fur′nace. (*Metallurgy.*) *a.* A basket-furnace or cresset in which lead or solder is melted for plumbing.

b. A furnace in which a kettle or kettles are set in a brick arch, as in sugar-boiling furnaces; or above a box-furnace, as in agricultural boilers. See Evaporator.

Ket′tle-stitch. (*Bookbinding.*) The stitch made in sewing at the head and tail of a book.

Kev′el. 1. (*Nautical.*) *a.* A large cleat for belaying. Sometimes formed by the ends of the top timbers which rise above the gunwale, or formed by timbers projecting at a small angle from the sides to belay large ropes, such as the sheets and tacks of the main-sail and fore-sail. See Cleat.

b. A frame for spreading the main-sail.

c. An anchor-*palm.*

2. A stone-mason's hammer, used in spalling stone, and having a blade and point at the respective ends.

Kev′el-head. (*Nautical.*) The end of a top timber projecting above the gunwale and acting as a bitt or kevel, to belay large ropes, to fasten or *veer away* a warp, etc.

Key. 1. (*Machinery.*) *a,* a joggle-piece forming a lock or draw-pin in a joint. See Hook-butt.

b, a wedge-piece of iron used for tightening the brasses of a bearing.

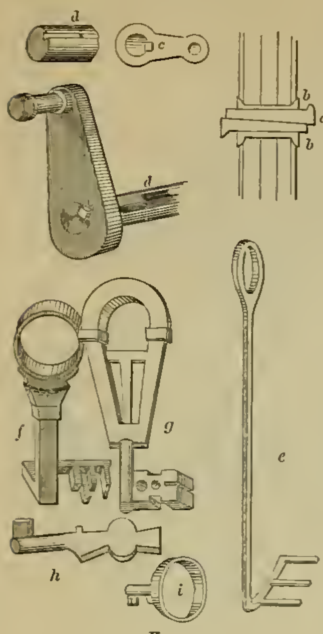
c, a fastening piece, such as a wedge or cotter in a chain. A *fore-lock.*

d, a piece *a* sometimes used in a mortise in connection with *gibs b,* in attaching a strap-head to a connecting rod.

e, a fin or wedge *c* fastening a crank on its shaft *d.* A long key on a shaft, which prevents the revolution of the wheel thereon, but permits longitudinal motion, is called a *spline.* See Spline; Feather.

2. A spanner or wrench by which to turn a coupling-piece.

Fig. 2742.



Keys.

3. A portable instrument for shooting the bolt of a lock.

The locks of Egypt were sliding bolts, moving in keepers attached to the doors, and were probably moved from the outside by keys, somewhat similar to that shown in the illustration *c*, which is an ancient iron key brought from Egypt by Wilkinson. Ancient iron keys have been found at Thebes, and are preserved in the British Museum. They are from $1\frac{3}{4}$ inches to 5 inches long. See LOCK.

We read also in Judges iii. 23 – 25, that "Ehud went forth through the porch and shut the doors of the parlor upon him and locked them," and "his servants . . . . took a key, and opened them."

The modern key of Mosul, in the vicinity of what remains of the ancient Nineveh, is a long bar of wood, with two projections towards the end about a foot in length. As one traveler remarks, it is "well qualified, not only to open a door, but to knock down any one who might attempt to enter without permission."

The invention is ascribed by Pliny to Theodore of Samos, 730 B. C., but keys are mentioned in the siege of Troy, 1193 B. C. The bolt of the lock mentioned in the Odyssey was moved by pulling a latch-string which passed through the door and hung outside. Denon has engraved an Egyptian lock which no doubt had a key.

The Roman keys were very various (see *f g h i*, Fig. 2742), some like the old Egyptian and others like the modern. The *ring*, or *bow*, *stem*, and *bit* are all there. Some have hollow barrels, like our trunk keys. Thirty varieties are shown by Montfaucon.

The keys found at Herculaneum show that the art of lock-making (A. D. 79) was well understood.

4. (*Joinery.*) *a.* A piece of timber let transversely into the back of a board, which consists of several breadths, for the purpose of preventing warping.

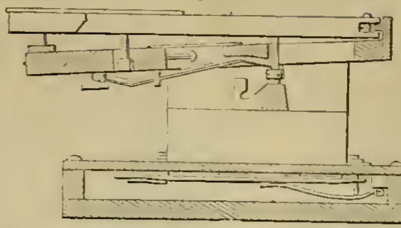
b. The last board of a floor or platform which is driven into position and keys up the others.

c. A tenon piece, of the nature of a dowel entering coincident parts in matched boards, and holding them together, or in correspondence.

d. The roughing on the under side of a veneer, which is made by a *toothing-plane*, and is designed to give the glue a better chance of adhering.

e. One of the wedge-shaped pieces or *striking-plates* beneath the ribs of a bridge *centering*, and by driving in which the *centering* is struck and the arch left self-sustained.

Fig. 2743.



Melodeon-Key.

5. (*Music.*) *a.* One of a series of levers in a piano, organ, etc., which are operated by the fingers of the performer. (See PIANO MOVEMENT.) Keys are *manual* and *pedal*. *b.* The fundamental tone of a movement; or of an instrument, and to which its modulations are referred.

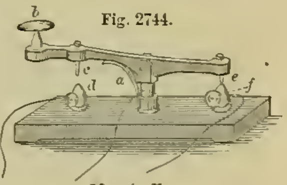
An illustration may be afforded by giving a comparative statement of the different keys of the *cornet-à-pistons*, the *trumpet*, and the *horn*.

	Cornet-à-Pistons.	Trumpet.	Horn.
1st,	C typical key.	A ♭	C high.
2d,	B ♮	G ♮	B ♮ "
3d,	B ♭	G ♭	B ♭ "
4th,	A	F	A ♮ "
5th,	A ♭	E ♮	A ♭
6th,	G	E ♭	G ♮
7th,	G ♭	D ♮	G ♭
8th,	F	D ♭	F
9th,	E ♮	C typical.	E ♮
10th,	E ♭	B ♮	E ♭
11th,	D	B ♭	D ♮
		A	D ♭
			C typical.
			B ♮
			B ♭
			C

See Berlioz's "Instrumentation and Orchestration."

6. (*Telegraphy.*) A device for breaking and closing electric circuits, so that the current may be interrupted to give signals.

Fig. 2744.



Morse's Key.

Morse's key for transmitting the currents by which the characters of his alphabet are indicated, consists of a pivoted lever provided with a spring *a*. When a message is being transmitted, the operator, by tapping on the button *b*, brings the points *c d* in contact, connecting the battery and line wire, and producing the combination of dots and dashes which form the Morse alphabet. When not in use for transmitting, the spring *a* keeps those points out of contact, and currents arriving by the line wire are conducted by the points *c f* to the indicator or to the relay.

7. A tooth-drawing instrument.

8. (*Masonry.*) The highest stone of an arch.

9. (*Plastering.*) That portion of the *rendering* or first coat of hair plaster which forces its way between the laths, and holds the body of the plaster in place.

10. (*Well-boring.*) A bent bar of iron spanning

the boring-rod just beneath a coupling, and serving to support the train of rods at the bore-mouth.

11. A term applied to instruments which are inserted and turned. See under the following heads:

Bedstead-key.
Bit-key.
Box-key.
Clicket.
Dental key.
False-key.
Faucet-key.
Foot-key.
Fore-lock key.
Fox-key.
Key-bed.
Key-board.
Key-bugle.
Key-fastener.
Key-file.
Key-grooving machine.
Key-hole guard.
Key (*carpentry*).
Key (*lock*).
Key (*machinery*).
Key (*musical instrument*).
Key (*plastering*).
Key-seat.
Key-screw.
Keystone.
Key-valve.
Key-way.
Latch-key.
Linch-pin.
Master-key.
Pass-key.
Pick-lock.
Press-key.
Screw-key.
Skeleton-key.
Spanner.
Stepped key.
Telegraph-key.
Tuning-key.
Turn-key.
Watch-key.
Wrench.

12. A *quay* or wharf.

Key-bed. The groove or seat of a key, which secures a wheel on its shaft.

Key-board. The finger-board of an organ, piano, or melodeon, on which the keys are exposed to view and touch.

Before the end of the sixteenth century, the present chromatic scale and key-board were introduced, the latter having the seven white and five black keys in each octave. The octave was divided into twelve equal parts about 1548.

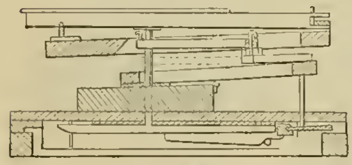
Key-bolt. One secured by a cotter or wedge instead of a thread and nut.

Key-bu'gle. (*Music.*) A brass wind-instrument with keys, seven usually. It will traverse chromatically a compass of more than two octaves, beginning from B♮ beneath the stave up to the C above the stave.

The bugle with pistons or with cylinders has a lower compass than the preceding.

Key-coup'ler. An attachment in a melodeon or parlor-organ to couple keys in octaves when desired. The coupling-levers cross each other, have their fulcrums at their rear ends, and are attached at their intersection. When the levers do not act, an additional pressure is put upon the valves.

Fig. 2745.



Key-Coupler.

Keyed Har-mon'i-ca. (*Music.*) An instrument in which plates of glass are struck by keys. The *glockenspeil* has bells struck by keys; a variation of the latter approaches the character of the keyed harmonica, having bars of steel for sounders.

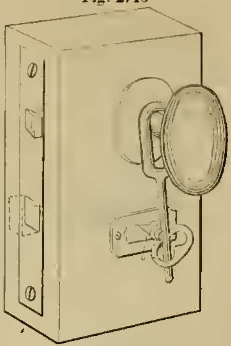
Key-fas'ten-er. An attachment to a lock to prevent the turning of the key by an outsider.

Key-file. A flat file having a constant thickness, and used in filing the ward-notches in keys.

Key-groov'ing Ma-chine'. (*Metal-working.*) One for slotting the center-holes of wheels to make a groove for the key, which fastens the wheel to its shaft, so that it may not turn thereon.

It is a modification of the planing-machine, which grew out of the slide-rest. It was invented by Roberts of Manchester, England. The wheel to be grooved is dogged to the sliding-bed and fed beneath the tool, which is reciprocated vertically above it by means of a crank or eccentric. To make the groove taper, the work is tipped to the required extent; to make several key-ways, the wheel is mounted on a turn-table with notches cut in its edges, to indicate the exact relative positions, as in planing squares, hexagons, etc. See Fig. 2748.

Fig. 2746.

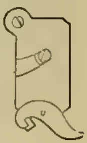


Key-Fastener.

The *slotting*-machine is an outgrowth of the *key-grooving* machine.

Key-guard. A shield which shuts down over a lock-key to prevent its being pushed out of the lock from the outside. In the example, a slotted escutcheon on the plate shuts over a flattened portion of the key-shank to prevent its being turned by an outsider. A pawl acts as a detent for the escutcheon.

Fig. 2747.



Key-Guard.

Key'hole-pro-tect'or. Mitchell and Lawton's English patent, 1815, has a revolving curtain for closing the keyhole.

Day and Newell's parautoptic lock has a revolving ring or curtain, which moves with the key and shuts the hole, so that wires and tools cannot be introduced alongside the key.

Mordan's keyhole protector (English), 1830, has a short pipe which, after the door has been locked, is thrust into the keyhole; attached to the pipe is a small lock so contrived that, on turning its key, two lancet-shaped pieces fly out laterally and bury themselves in the wood. The escutcheon cannot be removed until the small key has reacted upon the small lock; and until this removal has taken place, the large key cannot reach the keyhole.

Key'hole-saw. A long, thin saw. See Compass-saw.

Key-mod'el. A mode of modeling vessels by shaping boards according to the horizontal lines, and laying them upon one another horizontally.

Key-pipe. The pipe of a lock in which a key is turned.

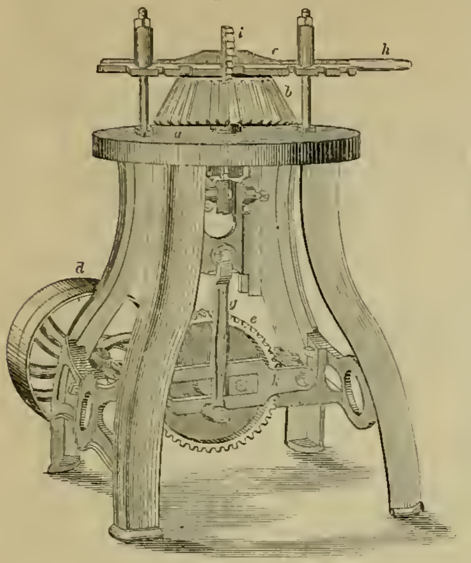
Key-screw. A lever, wrench, or spanner, for turning screws.

Key-seat. The groove in a wheel and shaft to receive the key which secures them together.

Key-seat Cut'ter. A machine for cutting grooves for keys in the center-holes of pulleys and gear-wheels. The wheel *b* is clamped by binder *c* and bolts to the table *a*. The cutter or saw *i* is reciprocated by wheel *e*, lever *k*, and pitman *g* below, driven by band applied to the pulley *d*. The saw is passed up to its work by means of the lever *h*, by the arrangement of the wrist-box sliding in the slotted lever *k*; a slow downward movement is attained, and a quick return, at which time the pressure on the lever *h* is slacked.

The machine for cutting key-seats has a horizontal plate for attachment to the table of a planing-machine, and the plate has a vertical portion, to which a wheel may be clutched. A mandrel, having a planing-tool, is secured by a jointed section to the head-stock of the planer, and is made to reciprocate within the eye of the wheel. The forward end of the mandrel passes through a guide-ring, which has trunnions with bearing in a frame vertically adjusted in the guide-standards by means of a screw.

Fig. 2748.



Key-Seat Cutter.

Key'stone. 1. (*Masonry.*) The central voussoir at the vertex of an arch. The row or course of said stones along the crown of an arch is the *key-course.*

The length of the keystone, or the thickness of the archivolt at top, is $\frac{1}{15}$ or $\frac{1}{16}$ of the span.

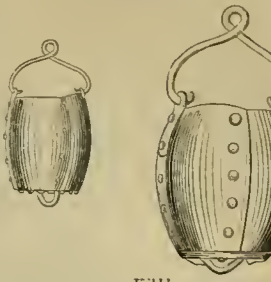
2. In chromo-lithographic printing, the stone on which a general outline of the picture is drawn or photo-lithographed. Its object is to furnish a guide for the production of the work upon the several color-stones. Transfers from the keystones in common printing-inks, more properly called "offsets". to distinguish them from transfers from which impressions can be printed, are made upon as many stones as there are colors required. The outlines thus obtained are identical in form and size, and when, by means of the crayon or fluid litho-ink, — with subsequent etching, — certain portions of each are given the power of printing, the superimposition of impressions from all upon a single sheet of paper, each being printed with its proper color, will give the desired result in perfect register. The keystone may be one of those used in printing, but in the higher class of work it is an outline merely, used to aid the artists in the manner described.

Key-valve. (*Music.*) The pad or plug which closes an aperture in a wind-instrument. The valve being retracted the wind passes through, and the note is sounded. Valves are applied to the openings in the reed-board of a reed or organ, melodeon, accordeon, or concertina; on the faces of the keys of flutes, clarinets, flageolets, cornets, bugles, etc.

Key-way. A slot in the round hole of a wheel for the reception of the *key*, whereby the wheel is fastened to the shaft.

Kib'ble; kib'bal. (*Mining.*) A strong iron kettle with a bail, made of $\frac{1}{4}$-inch sheet-iron, riveted, and used as a bucket in raising ore from a mine. The term is used in copper-mining, and may have a Cornish origin.

Fig. 2749.



Kibbles.

Kib'bling-mill. A hand-mill of steel attached to a post, and used for crushing or grinding beans or other grain for feed. A *kibbling-machine.*

Ki-bit'ka. A Russian one-horse vehicle with two wheels. The kibitka is of various sizes, and may be either completely covered, entirely open, or provided with a hood behind. It has a single pair of long runners, and, to prevent upsetting, is provided with a guard-frame, which, starting from the body of the sleigh in front, spreads out some twelve or eighteen inches from the sides at the rear end. As soon as the vehicle tips, this framework touches the ground, and must break before the vehicle can capsize.

Kick. (*Brickmaking.*) The piece of wood fastened to the upper side of a *stock-board* to make a depression in the lower face of the brick as molded.

Kid. A bundle of bushes or sticks planted on a beach to stop shingle or gather sand, to act as a *groyne.*

Kid'der-min-ster Car'pet. A carpet so called from being made somewhat extensively at a town of that name in England. The carpet is also known as Scotch, for a similar reason. Another of its names, *ingrain*, signifies that it is made of wool or worsted dyed *in the* grain; that is, before manufacture. Its names *two-ply* or *three-ply* indicate the number of webs which go to the making of the fabric.

It is composed of two webs, each consisting of a separate warped woof; the two are interwoven at intervals to produce the figure, one part being above and the other below. When different colors are used, the pattern will be the same on both sides, but the colors reversed.

Kid'dle. A weir or fish-trap.

Kid'ney-link. (*Harness.*) A coupling for the harness below the collar.

Kid'nip-pers. (*Molding.*) Nippers used in gun-molding for bringing the hoops taut around the mold.

Kil'las. (*Mining.*) The clay-slate in which the ores of copper and tin are found in Cornwall, England.

Kiln. A furnace for calcining; as plaster of paris or carbonate of lime in its shapes of marble, chalk, or limestone. See LIME-KILN.

Or for baking articles of clay in the biscuit condition. A *biscuit-kiln.* See GLAZE-KILN.

Or for drying malt, hops, lumber, grain, fruit, starch, biscuit, etc.

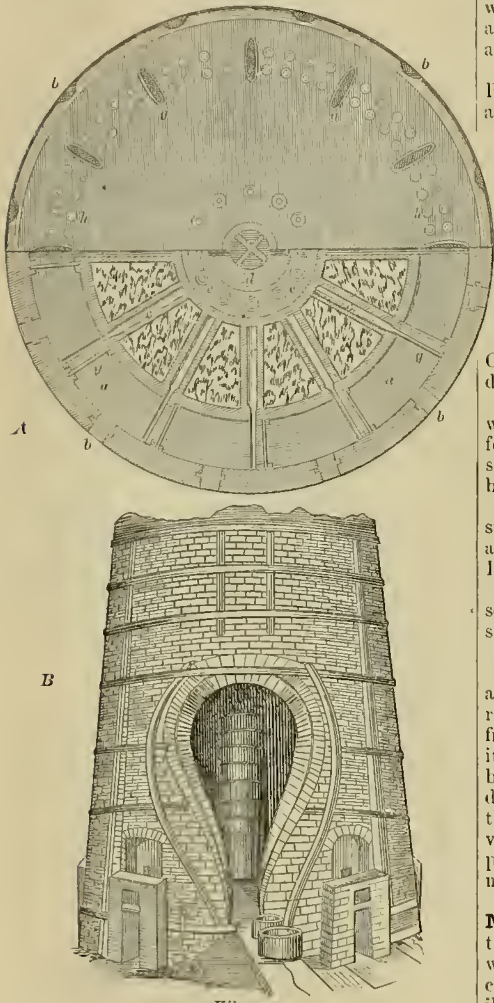
Or for vitrifying articles of clay, such as pottery, porcelain, bricks. See PORCELAIN; BRICK.

Herodotus speaks of baking bricks in kilns. The latter word may refer to a clamp, however. They certainly used kilns of some kind for their pottery, which was made of many kinds.

Hoffman's annular kiln (*A*, Fig. 2750), patented June 13, 1865, consists of a circular channel, *a a*, which receives the objects to be fired, introduced through doors, *b b*, in the outside wall. Flues, *c c c*, lead from the hearth of the kiln to the smoke-chamber, *c c c*, which surrounds the base of the chimney, *d*. The communication of each flue can be cut off at will, by means of a cast-iron, bell-shaped damper. An intercepting slide can be lowered in grooves, *g g*, built into the walls of the kiln, immediately after each flue, so as to separate it at any distinct or equidistant compartment. The fuel passes through apertures *h h*, which are constructed in the arch, and falls through channels formed by the objects to be burned to a chamber in the hearth of the kiln, from which a certain number of small flues radiate to produce a free current from fire to fire.

The kiln has twelve compartments, to which there are twelve entries or doorways *b b*, also the same number of flues *c c c*, communicating with the smoke-chamber *c c*, and just as many openings *g g* in the arch for the reception of the large intercepting damper slide ; thus the kiln can be divided at any one of the twelve parts.

Fig. 2750.



Kilns.

The apartments are used successively ; while one is being charged with bricks, tiles, or pottery, others are being burned, others are cooling, and one or more may be discharging.

The kiln-fire is supplied with warm air drawn through the apartments which are being cooled. The heat passing from the apartments where the fire is burning heats the one next in series to such an extent that the fuel introduced into the latter is ignited, and it commences burning on its own account.

Dampers in the flues connecting the apartments, and in the radial flues leading to the chimney stack, permit the caloric current to be turned as required.

An older form of pottery kiln for burning crockery is shown at *B*.

The piles of seggars are introduced through the large opening in front ; when the kiln is fully charged this is bricked up, and fires started in the furnaces surrounding the kiln. The heat is maintained until, in the judgment of the operator, the ware is sufficiently baked, when the fires are drawn, and when sufficiently cool the brick-work is removed and the seggars withdrawn.

A peculiar kiln is employed in the vicinity of Paris for burning plaster of paris. This substance, a sulphate of lime, frequently contains a proportion of the carbonate, as is the case in that obtained from the great quarry of Montmartre, near Paris, where it is employed instead of lime for making mortar.

The kiln is about ten feet long, and has walls at two sides and one end. Within, longitudinal walls are built up of the blocks of gypsum as they come from the quarry, the interspaces being filled with billets of wood. Over these, arches are built with the gypsum blocks, sufficiently stable not to fall in when the fuel is consumed. Over these are laid alternate layers of charcoal or dry wood to the depth of eighteen or twenty inches. An aperture about six inches square in the end wall provides for draft. Fire is kindled in the flues formed at the other end, and maintained by farther supplies of small wood for from twenty-four to forty hours, until the calcination is complete.

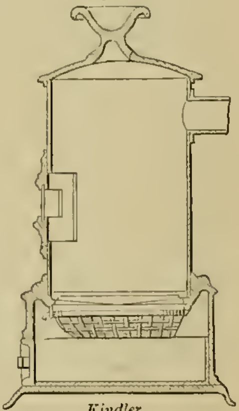
The cement made by combining the calcined gypsum with water and sand sets quickly, and is better adapted for stone, the common building material of Paris, than for brick.

Kin. A Chinese instrument having a body, a sounding-board, and five silken strings of different sizes.

Kin'cob. (*Fabric.*) An East-Indian laced satin.

Kin'dler. An attachment to a stove, by which a body of easily lit material is brought against the fuel in the stove to kindle it. In the example, the basket to contain kindlings is hinged beneath the grate, and when elevated in front is in a proper position for the ignition of the fire.

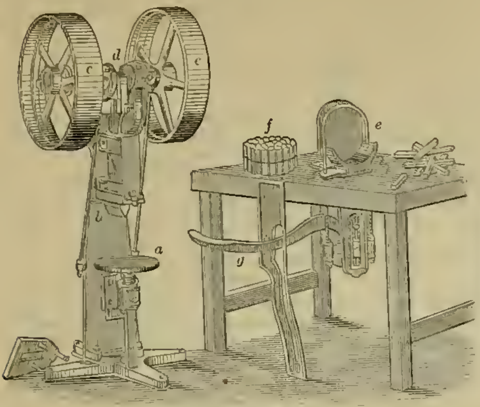
Fig 2751.



Kindler.

Kin'dling-wood Ma'chine. An apparatus for splitting the short wood used for kindling coal fires, etc. In that illustrated in Fig. 2753 the vertically reciprocating cutter is operated by a crank shaft rotated by pulley and belt connections, making about 125 strokes per minute ; the wood is placed on a circular table below the cutter, and the machine is adjusted to cut different lengths by varying the elevation of the table and by a clearing plate, shown detached to the left of the base of the machine. The bundling-machine is operated by a lever, which works a toggle-joint, causing a loop to compress the bundle, placed in a semicircular rest, while being tied.

Fig. 2752



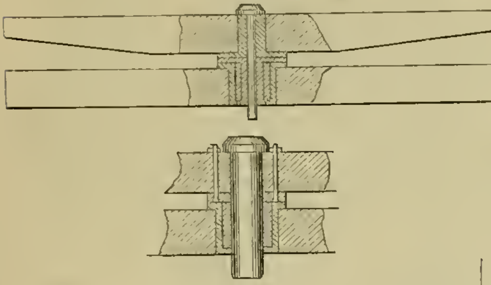
Kindling-Wood Machine.

In another bundling-machine, the split wood from the cutter falls into boxes on an endless belt, and is conveyed to the clamps into which the charges are dropped. These are closed by cam movement, a wire is passed around the bundle and automatically cut and twisted.

Still another machine has a cutting-edged cylinder, to which the bundles are delivered by a feed-wheel being forced through by a plunger and trimmed smooth.

Ki-ne′to-scope. An instrument invented by Perigal, for illustrating the result of the combination of circular movements of different radii in the production of curves. Also called *kinescope*.

Fig. 2753.



King-Bolt.

King-bolt. (*Vehicles.*) *a.* A vertical bolt which attaches the front of the body to the fore-carriage, and forms the axis of oscillation when the said carriage is turned sideways.

b. A similar part in a car, which forms the axis of revolution of the car upon the truck in turning curves. See CAR-TRUCK.

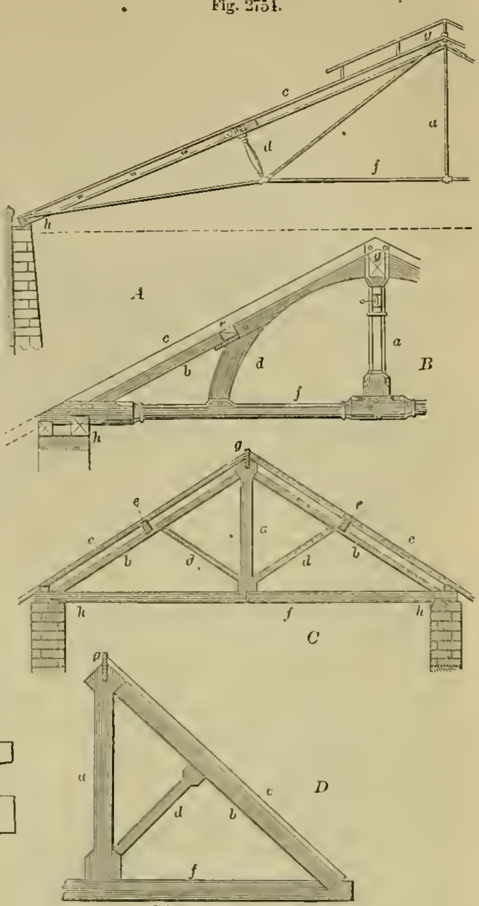
In the example, an elastic sleeve intervenes between the king-bolt and the metallic bushing, to absorb the jar.

King-post. (*Carpentry.*) A main post beneath the crown or ridge of a roof-frame.

Also known as *crown-post* or *joggle-post*. King-post trusses have several minor variations: —

a, king-post. (*King-rod* in the upper figure).
b, principal rafters.
c, rafter.
d, strut or purlin-post.
e, purlin.
f, spring-beam or tie-beam.
f, tie-rod (upper figure).
g, pole-plate.
h, wall-plate.

Fig. 2754.



King-Posts and Trusses.

A is a roof on the quay Jemappes, Paris.

B is from the roof of the church of Lagorce, France, twelfth century.

C is an ordinary barn-roof.

D a Gothic roof.

King-post Truss. See KING-POST.

King-post Roof. (*Carpentry.*) One having but one vertical post in each truss.

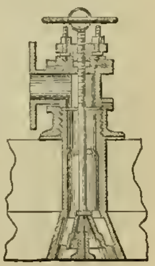
King-rod. A tension rod depending from the ridge of a roof and uniting with the tie-rod; occupying the position of the king-post in wooden roofs. See KING-POST (*A*).

King′ston's Valve. A conical valve, forming the outlet of the blow-off pipe of a marine engine; it opens through the side of the vessel by turning a screw.

King-truss. A roof or bridge-truss framed with a KING-POST (which see).

Kink. (*Nautical.*) A sharp bend in a rope or cable which prevents its reeving through a block or a hole.

Fig. 2755.



Kingston's Valve.

Kinsh. A crowbar used in quarrying.

Ki'o-tome. (*Surgical.*) A knife for cutting membrane; especially certain pseudo-membraneous bands in the rectum and bladder.

Kip. Leather of yearlings or small cattle. A grade between calf and cowhide. *Kip-skin.*

Kirb. See CURB.

Kish. (*Smelting.*) *a.* A carburet of iron which, when cold, appears in bright shining scales, but which is in the liquid form in the iron-smelting furnace, where, owing to its levity, it floats upon the surface. It possesses most of the properties of graphite, but contains less carbon.

b. The impurities which float on the surface of molten lead in a furnace.

Kit. 1. (*Photography.*) Also known as "inside frame." A thin, flat, rectangular frame of wood which fits within a plate-holder for the purpose of enabling the latter to carry a sensitized plate smaller than that for which it was originally designed. There may be many of these for one holder, and they often fit one within the other, forming a "nest." The inside corners, as is the case in the plate-holder itself, are provided with glass or hard rubber angle-pieces, upon which the plate rests to prevent contact between the wood and nitrate of silver solution adhering to the wet plate, which would cause stains upon the negative.

2. (Ger. *Kitt.*) A cement for stuffing canvas to place over the vents of carcasses to keep out the damp.

3. A small fiddle.

4. A large bottle.

5. A milk-pail or churn.

6. The tools of a workman or outfit of a tourist.

7. A flaring-bottomed tub for fish or butter.

Kite. 1. A light frame covered with paper or cloth, and flown at the end of a string.

Centuries of use among the Chinese, and the remarkable use by our Benjamin Franklin, have aided to make the kite respectable. Benjamin had a roughly made kite, two cross-sticks, over which was stretched a silk handkerchief, and this was flown in June, 1752. Franklin was not a boy at this time, but a mature man of 46. Betsy Trotwood observed, "Franklin used to fly a kite. He was a Quaker or something of that sort, if I am not mistaken, and a Quaker flying a kite is a much more ridiculous object than anybody else"; so he might have appeared to some of the Philadelphians. Some of his propositions for conducting and using the electric current seem strangely modern. He proposed to fire spirits, kill animals, drive machinery, and discharge guns. Some of these things he performed.

The kite has been used in scaling eminences; two remarkable occasions may be cited: the ascent of "Pompey's Pillar," a pillar of red granite 114 feet high, near Alexandria; and in the ascent of the Peter Botte Mountain in the Mauritius. It is also used for lodging a cord on steeples and other structures, to enable them to be fitted with lightning-rods or for the purpose of repair. The first wire of the foot Suspension-Bridge at Niagara was carried over by a kite.

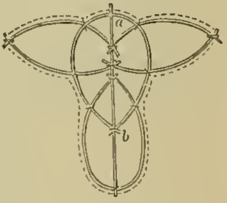
In 1827 Pocock yoked a pair of kites to a carriage, and traveled from London to Bristol. He determined that a 12-foot kite gave the power of a man, with a moderate breeze, and, when the wind is brisker, a power of 220 pounds. (This is an incomplete statement, but the figures are not ours.) The force, he states, in a rather high wind, is as the squares of the lengths of the kites; and two kites, of 12 and 15 feet respectively, will draw a carriage and four or five passengers at the rate of 20 miles per hour. (Grade not stated.) Pocock had an extra line to vary the angle of the surface of his kite, so as to adjust its tractile force, and side lines to vary the direction of the motion till it came nearly to a right angle with the course of the wind. His kites were made of varnished linen on jointed frames, so as to be folded and stored compactly.

The Indian and Chinese kites are made of Chinese paper, thin and tough, and the frames of finely split bamboo. They are gayly colored, and are sometimes made in the shape of dragons, — whatever that may be, — eagles, or spiders. The string is made of the silk obtained from a wild species of worm, and is called *nuck*; after spinning, it is treated with gum or glue, and then drawn through pounded glass. Being dried in the sun, it is ready for duty. This gritty coat is to enable it to saw asunder an adversary's line, should it become fouled, when flying on a wager or for sport. The Celestials put as much enthusiasm into the business as do the owners of trim wherries, fast nags, fleet greyhounds, rampant game-cocks, surly bull-dogs, dapper terriers, or the other thousand and one devices or excuses for actively wasting time.

Chinese kites are sometimes furnished with various æolian attachments which imitate the songs of birds or the voices of men. The pigeons also in Pekin are frequently provided with a very light kind of æolian harp, which is secured tightly to the two central feathers of their tails, so that in flying through the air the harps sound harmoniously.

The frame of the Japanese bird *kite* is made of thin bamboo, and is covered with colored paper. The wings, which are somewhat concave, and fall back a little, are dark maroon, and the body and tail represent a bird. Small white twine is used. By various devices, the hovering and soaring of a hawk can be admirably imitated. Length of middle cane 20 inches, spread of wings 26 inches; *a b*, points where the "belly-band" must be attached. Dotted lines show the paper.

Fig. 2756.



Japanese Bird-Kite.

2. (*Nautical.*) One of the unusual sails above the royal; *sky-sails*, *moon-rakers*, etc.

Kit-ty-sol'. (Sp. *Quitasol.*) The Chinese paper parasol.

Klick'et; Klink'et. (*Fort.*) A gate in a palisade for the passage of a sallying party.

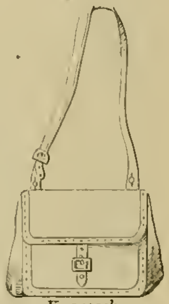
Kli-nom'e-ter. An instrument for measuring the angle of the dip of strata.

Knap'ing-ham'mer. (*Scotch.*) The stone-breaker's hammer.

Knap'sack. A soldier's or tourist's case or wrapper for clothes, etc., to be carried on the back during a march. See ACCOUTERMENT.

A tourist's or traveler's satchel. That shown has a pocket *A* and strap *B*.

Fig. 2757.



Knapsack.

Knead'ing-ma-chine'. A machine for incorporating dough. It usually consists of certain stirring-blades and stationary arms, and a spiral blade for discharging the homogeneous dough.

The *petrisseur*, or mechanical bread-maker, of Cavallier & Co., Paris, consists of a strong wooden trough, nearly square, with its two longest sides inclined. The bottom of the trough is semi-cylindrical, and the ends support the axis of a cast-iron roller. A knife-edge is placed above the roller in a longitudinal position, and forms a practical division of the trough space into two semi-cylinders on the line of the axis of the roller. The roller being rotated, the dough is drawn between it and the bottom of the trough, which space is governed by lever adjustment. The knife-edge arrests it above; and when all has passed to one side the motion of the roller is reversed, when it is drawn back again. This is repeated until the materials are perfectly commingled and the quality uniform.

Another English *kneading-machine* has separate cells and heavy balls. A third has an agitator with a revolving axis and a series of rings angularly attached, and operating in a trough.

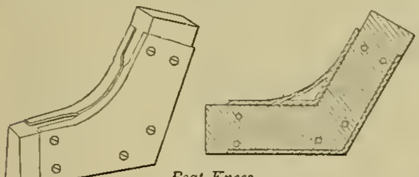
The *mixing-machine* of the ship-biscuit factory of the Victualing Department, Portsmouth, England, is a mixing-trough with a revolving axis furnished with two sets of knives, which mix 280 pounds of flour with 13 gallons of water in 2½ minutes. The *kneading-machine* is a cast-iron roller weighing 1,500 pounds, which rolls back and forth upon a bench, flattening out the slab of dough, which is again and again doubled and laid in the track of the roller. See Biscuit-machine.

Repeated passage between rollers, doubling the sliver between passages, is the ordinary mode of machine kneading. Harrison's biscuit-machine (English) operates thus (see Biscuit-machine), and so do the American Cracker-machines (which see). The hard-baked, unfermented cake called a *biscuit* by the French, English, and seafaring people generally, is a cracker among the landsmen of the United States, where it assumes many forms and is variously qualified as to ingredients, consistence, etc., *e. g.* sugar, water, butter, soda crackers.

Cracker-dough was formerly kneaded by an instrument called a *break*. It was a lever, pivoted at one end to a ring in the wall, and operating on a semicircular bench on which the dough was laid. The man who operated it was called a breakman, and brought his weight to bear on the lever, giving it and himself a dancing motion as the break traversed in its curved path, giving a succession of radiating impressions upon the slab of dough beneath it.

Knee. 1. (*Shipbuilding.*) A *compass-timber*. A naturally grown bent piece used to secure parts together, acting as a brace and tie. The *back* or outside bent portion is fayed to the parts to be united.

Fig. 2758.



Boat-Knees.

The exterior angle of a *knee* is the *breech*; the interior angle is the *elbow* or *throat*.

The *square* knee has a right angle.

The *knee without a square* has an obtuse angle.

The *knee within a square* has an acute angle.

The knee derives its specific name from its position, or the parts to which it is accessory, as, —

Cheek-knee: a compass timber at the head; also known as, —

Head-knee; a molded timber fayed edgeways to the cutwater and stem.

Hanging-knee; one fayed to the side, in a vertical position. The *knee up and down*.

Lodging or *deck-beam knees*; fayed to the side horizontally to secure the deck beams.

Dagger-knees, i. e. *diagonal knees*; fixed obliquely to avoid a port.

Standard-knee; one arm bolted to the deck, and the other against the ship's side.

The *carling-knee* is in the angle formed by the junction of a carling with a deck beam.

Heel-knee; a compass timber which connects the keel and stern-post.

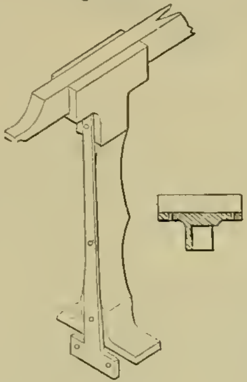
Transom-knee; *helm-post knee*, etc.

2. (*Carpentry.*) A piece of wood having a natural bend, or sawed to shape and fitting into an angle as a brace and strut.

3. An elbow piece which connects parts as that shown in Fig. 2759, in which the side plates are let into the pieces of timber and bolted thereto. The flanges lap around the edges.

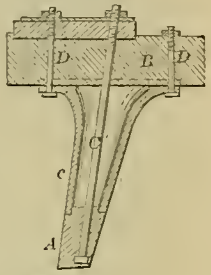
4. A piece framed into and connecting the bench and runner of sled or sleigh. It is usually mortised into the respective parts, but in the example the knee is sunk in the sockets of the metallic blocks. Fig. 2760 shows a hollow metallic knee *c* secured by a straining-bolt *C* and screw-bolts *D* to the bench *B* and runner *A*.

Fig. 2759



Sleigh-Knee.

Fig. 2760.



Metallic Knee.

5. An elbow or toggle-joint.

Knee-cap. (*Harness.*) A padded or leather cap secured by straps over the knees of racing, hunting, and other valuable horses when at exercise, to protect the part against abrasion in case of an accidental fall.

It is made of fabric, leather, caoutchouc, gutta-percha, compressed cork in a double pad, etc.

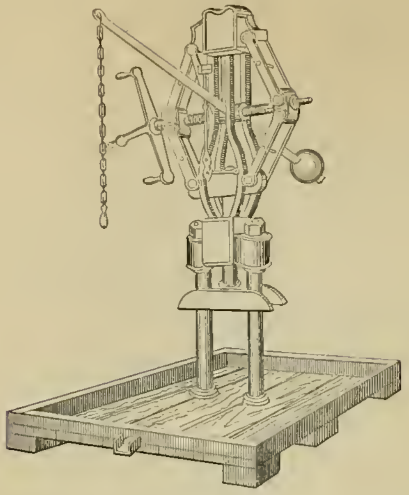
Knee-joint. A joint consisting of two pieces articulated endwise to each other, like the human knee. A *toggle-joint*. See Toggle.

Knee-joint Press. One in which power is applied by means of a double knee-joint articulated at the top to the upright framework, and at the bottom to a cross-head, from which proceeds the shaft which applies the force, and which works through a guide. At the junction of the branches the articulations are made with masses of metal forming screw-nuts, through which passes a horizontal screw, right-handed for one half its length, and left-handed for the other half. This screw is operated at first by means of a set of crank-handles at one end of it; and when the resistance becomes very great, by means of a counterpoised ratchet lever, which is shown in the middle of the frame. The force applied in this way is very great, since the operator can act on the lever with his whole weight.

Knee-stop. (*Music.*) A lever operated by the knee to work the swell of a cabinet organ.

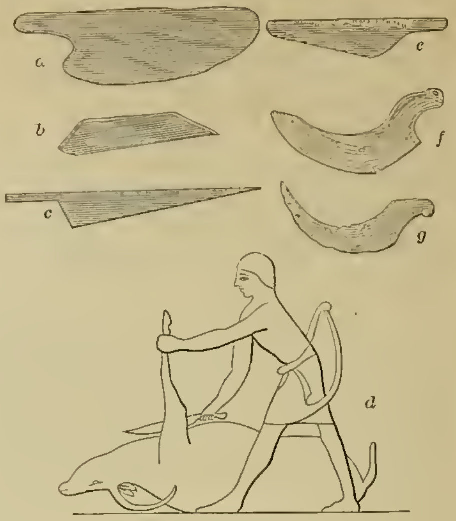
Knee-swell. (*Music.*) An arrangement in an

Fig. 2761



Knee-Joint Press.

Fig. 2762.



Ancient Knives.

organ by which a greater or lesser amount of wind may be turned on to the reeds to vary the loudness of the tone.

Knife. 1. A cutting-implement having a blade sharpened on the edge, and distinguishable from a sword, a colter, and other things, by its form and uses.

The earliest forms of knives are made of flints (*a*, *b*, *e*, *f*, *g*, Fig. 2762), and after the introduction of bronze (*c*) they were still retained for the performance of religious observances. This is shown by the use of a "sharp stone" in performing the operation of circumcision, as recorded in Exodus iv. 25, where Zipporah operated upon her child in conformity to the Jewish law. Herodotus says that an Ethiopic stone was used for making the incision in the body of persons brought to be embalmed, in order to remove the intestines. Diodorus Siculus says that "it was not lawful to use metal." In the Berlin Museum are two flint knives (*a*, *b*) of ancient Egypt, which, no doubt, were used in their religious observances; for the embalming of bodies was of this character, and was under the control of the priests.

c is the knife as represented in the Egyptian hieroglyphics.

d shows an old Egyptian butcher with his dismembering-knife, and his steel stuck into his belt.

e f g are from Assyrian knives in the British Museum.

In the Egyptian museum of the late Dr. Abbott, New York City, are several of the Egyptian knives of Ethiopic stone. The operation of circumcision is now performed in Barbary with an ordinary pair of scissors.

The knives of ancient Egypt were usually of bronze, though blades of iron and steel were not unknown. Those of the latter metal have seldom, if ever, come down to our times, as they so readily rust and fall to pieces. They are, however, clearly distinguished from the bronze by being colored blue in the paintings of Byban el Molouk, the bronze being red or brown. Blue swords (steel) are shown in the paintings of Thebes.

These old knives had tangs like our case-knives, and for the same purpose.

Among the first mentions of knives is that of Abraham, who took his knife to slay his son on Mt. Moriah. The history of edge-tools would include the history of the knife, and would carry one back to the Lacustrians and other remote inhabitants of the globe. History opens with men using knives of metal, but still retaining the flint knife for sacrificial occasions, as in Egypt, Mexico, and among the Hebrews. Other isolated races contented themselves with shells, as among the Caribs; Obsidian among the Peruvians, Mexicans; flint in ancient Europe and many other places. The first metallic knives were made of copper, and these were afterwards hardened by the addition of tin, making bronze. From the time of Osirtasen and Jacob down to the time of the Cæsars and Pliny, bronze maintained its ascendency, but eventually gave way to iron and steel.

The Mexicans had no iron tools; the material was bronze or obsidian, known by them as *itztli*. Of this they made knives, razors, and serrated swords.

The knife of the Tahitians, previous to the advent of Europeans, was splinter of bamboo. All the tools of the islanders were of bone, wood, shell, or stone. Metal was unknown, and iron was at first supposed to be a very hard wood. The first nails they received were planted in the gardens, in the hope that they might sprout.

The pruning-knives of the Feejees, when first discovered, were of tortoise-shell on wooden backs. Their hoes were a bone from the back of a turtle, a plate of tortoise-shell, or an oyster-shell. With their tortoise-shell knives they dexterously cut up their *bakolo* (long pig), as they call a baked human carcass, to distinguish it from short pig, the swine, whose meat it is said to resemble.

Whittling is not a modern or merely American pastime: —

> "A Shefeld thwitel bare he in his hose."
> CHAUCER.

Stow says that one Matthews on the Fleet Bridge was the first in England who made fine knives, and that he obtained an act, 1563, against the importation of foreign ones.

Clasp or spring knives came to England from Flanders, and were common in 1650.

In the manufacture of pocket-knives, a bar of steel destined to furnish a number of blades is heated to redness. A length is cut off, and the forger speedily *moods* this, that is, shapes it roughly into the form of a pocket-knife blade. Another heating is then required to fit the end for being fashioned into the tang, and another before the operation of *smithing*, the last stage of which is the stamping of the mark of the thumb-nail to facilitate opening. The tang is then ground and the blade marked with the name of the firm. The slight bulge on the reverse side caused by this operation is removed by fire or the grindstone. The blade is then hardened by heating it to redness and then plunging it into water up to the tang. Then follows the tempering to a light straw color. After this the various kinds of blades undergo sundry grinding operations to fit them for being hafted. Twelve distinct processes have by this time been gone through, and many more are necessary before the knife is completely finished, although the number of hands which it has yet to pass through depends in a great measure on the finish to be given to the handle, and the quality of the blade.

For varieties of knives, see under the following heads :—

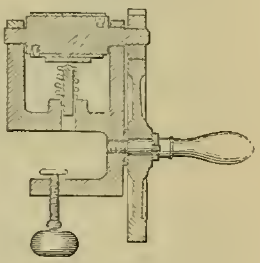
Amasette.
Amputating-knife.
Arteryotome.
Balance-knife.
Bark-knife.
Beam-knife.
Bill.
Bistoury.
Board-cutting knife.
Bowie-knife.
Bread-knife.
Bronchotome.
Budding-knife.
Butcher-knife.
Butteris.
Butter-knife.
Cane-knife.
Cane-stripping knife.
Can-opening knife.
Canvas-cutter.
Carving-knife.
Case-knife.
Cataract-knife.
Catling.
Catty.
Cephalotome.
Cheese-knife.
Chondrotome.
Chopping-knife.
Cionotome.
Cirsotome.
Clasp-knife.
Cleaver.
Cleaving-knife.
Clipper.
Coreotome.
Cork-cutter's knife.
Corn-knife.
Corn-stripping knife.
Costotome.
Cradle-scythe.
Craniotome.
Cream-slice.
Currier's knife.
Cutlery.
Cystitome.
Cystotome.
Desk-knife.
Dirk-knife.
Dissecting-knife.
Doffing-knife.
Double-knife.
Drawing-knife.
Edge-tools.
Entereotome.
Erasing-knife.
Fish-knife.
Fleshing-knife.
Flint-knife.
Floor-cloth knife.
Folder.
Fruit-knife.
Gardener's knife.
Glazier's knife.
Grafting-knife.
Grainer.
Hack.
Hacking-out knife.
Half-moon knife.
Ham-knife.
Hay-knife.
Heading.
Hoof-paring knife.
Howel.
Hysterotome.
Jack-knife.
Jigger.
Keratome.
Kiotome.
Knife-cleaner
Knife-edge.
Knife-file.
Knife-polisher.
Knife-rest.
Knife-sharpener.
Lancet.
Leather-knife.
Ledger-blade.
Machete.
Meat-knife.
Meatus-knife.
Metrotome.
Microtome.
Mincing-knife.
Moon-knife.
Neurotome.
Opening-knife.
Oyster-knife.
Palette-knife.
Paper-knife.
Parallel-knife.
Paring-knife.
Pen-knife.
Pharyngotome.
Plow-knife.
Pocket-knife.
Pruning-knife.
Putty-knife.
Race-knife.
Raising-knife.
Razor.
Rhinoplastic knife.
Round knife.
Rubber-knife.
Saddler's-knife.
Scalpel.
Scythe.
Serpette.
Shave.
Shoe-knife.
Slicker.
Sorghum-knife.
Spatula.
Splitting-knife.
Sportsman's-knife.
Spring-blade knife.
Steel.
Stopping-knife.
Striking-knife.
Stripping-knife.
Swing-knife.
Synosteotome.
Syringotome.
Table-knife.
Tenotomy-knife.
Tobacco-knife.
Trachitome.
Tonsilitome.
Trimmer.
Unhairing-knife.
Urethratome.
Uterotome.
Valentin's knife.
Welt-knife.

2. A blade in a machine, as in a *straw-cutter*, *rag-engine*, and what not.

Knife-board. (*Domestic.*) One with powdered bath-brick to clean knives upon.

Knife-clean'er. (*Domestic.*) An implement for cleaning knives. In the example, the frame is clamped by a set screw to a bench or table, and the cylinder is rotated by driving wheel and pinion ; the guard holds a supply of polishing material, and the knife lies on a block which is pressed by a spring against the cylinder.

Fig. 2763.

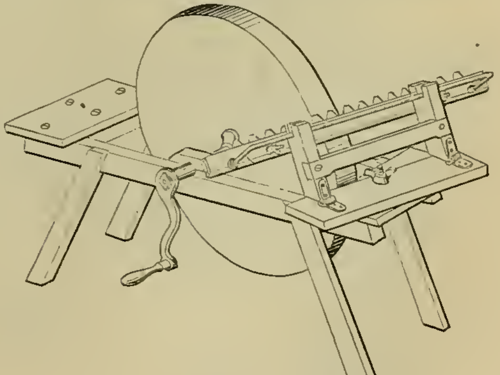


Knife-Cleaner.

Knife-edge. A sharpened steel edge resting against a horizontal surface, the two serving as a means of suspending a scale beam, or the scales from the beam, of a delicate balance, so as to obviate friction as much as possible.

Knife-file. A file with a very acute edge, the cross-section being an isosceles triangle with a short base. Known also as a *feather-edge* file. It is used

Fig 2765.



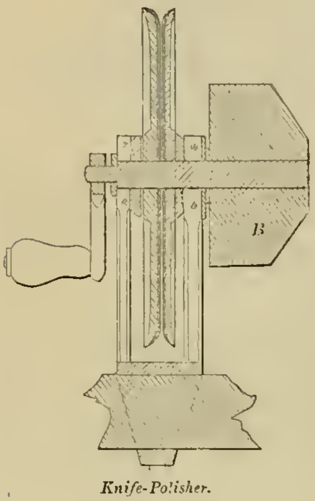
Mowing-Knife Grinder

in cutting narrow notches, and in making an entering kerf for saws and for files with broader edges. Also in beveling or chamfering the sides of narrow grooves.

Knife-grind'er. 1. A grindstone or emery-wheel for grinding knives. See Grindstone; Emery-wheel; Tanite; Lap; Glazer, etc. See list under Grinding and Polishing.

2. A machine for special service, as in the example, which is a stone for grinding the knives of mowers and reapers. It has a holder set at such an angle with the frame, and also at such an inclination as to present the triangular knife-sections to the grinding face of the stone.

Fig. 2765.



Knife-Polisher.

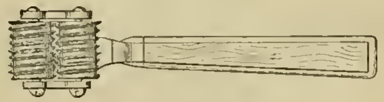
Knife-pol'ish-er. (*Domestic.*) A machine for cleaning the rust and stain from table-knives. In the example the knife-blade is slipped between a pair of disks, which are revolved by the crank. The disks are covered with a felted fabric, composed of linen and wool. The fabric is made by enclosing a linen bat between two bats of wool in the process of felting.

B is a bevel-faced grindstone for sharpening knives.

Knife-rest. A little pillow of metal or glass to rest the blade of a knife upon, at table. *Balance-handle* knives have rendered it unnecessary except with *carvers.*

Knife-sharp'en-er. (*Domestic.*) *a.* A steel. *b.* An implement for sharpening table-knives by drawing them between two steel edges. In Fig. 2766 it consists of two screw-threaded rolls set in a frame, secured in a handle, and between which the knife is to be drawn.

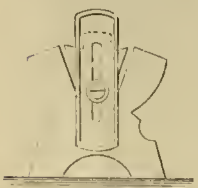
Fig. 2766.



Knife-Sharpener.

In Fig. 2767, there are two inclined jaws with a plate which crosses them obliquely. The middle plate is adjustable between the oblique side slots, and forms one side of each cutting jaw.

Fig. 2767.



Knife-Sharpener.

Knife-tool. A graver shaped like a knife.

Knight. (*Nautical.*) A wooden block with a sheave abaft the fore or the main masts, and known respectively as the *fore*-knight and *main*-knight.

Knight'head. (*Shipbuilding.*) One of the first *cant*-timbers on each side of the stem, which rise obliquely from the keel and pass on each side of the bowsprit, to secure its inner end.

Knit'ting-burr. A wheel having wings arranged radially and diagonally across its face, and adapted to operate upon the yarn and the fabric. There are several kinds, as follows: —

A *loop* wheel, whose wings are notched, and which take the yarn delivered by the guide, and push it up under the hooks or beards of the needles. A *sinker* wheel, which presses the yarn into loops between the needles, to insure that there shall be enough to form the proper-sized stitch in the fabric. A *landing* heel, which raises the loops of the fabric a short distance above the points of the needle-beards while they are closed by the *presser.* And a *stripping* or *knocking-over* wheel, which throws the loops of the fabric entirely over the tops of the needles to complete the stitch. See Knitting-machine.

Knit'ting-gage. The number of loops contained in three inches of breadth.

Knit'ting-ma-chine'. The art of knitting is modern; it cannot be traced back farther than about A. D. 1500, and is believed to have originated in Scotland shortly previous to that date. It consists in the construction of a looped fabric in which for the first row a succession of loops are *cast on* or preferably *knitted on* to a needle, and in succeeding rows each loop is passed through the loop of each succeeding row. It differs distinctly from *braiding, netting,* and *weaving,* which is, perhaps, the order of invention; *knitting* being scores of centuries later than either of the others.

Braiding is synonymous with *plaiting,* and is found among the most barbarous nations; none so ignorant that they cannot plait strips of hide or of bark, or braid a number of vines together to make a band. This is one degree of advance upon what nature provides them ready made, a rope of twisted tendrils or vines which, in reaching after a support, have mutually embraced and climbed upward. The natives of Tahiti, when discovered by Cook, were very skillful in making mats, which were plaited so as to resemble a woven fabric, and in other countries such are farther embellished by tufts. The process of making, however, was not by *warp* and *weft,* — was not *weaving,* — but was by braiding or plaiting a given number of strands arranged on two sides of a square, like the crosses we used to make of strips of differently colored papers when at school.

Netting is quite another matter, and is a fabric whose meshes are made over a mesh-stick and knotted at the intersections; as Dr. Samuel Johnson learnedly defines: "Network. Anything reticulated or decussated at equal distances, with interstices between the intersections."

The width of the mesh-stick determines the size of the meshes, which are knotted upon it. References to netting are frequent in the Hebrew chronicles, the Book of Job, the Prophets, in Homer, Virgil, and elsewhere. Oppian distinguishes many kinds. They are frequently shown in the Egyptian tombs and temples. See Net.

Weaving involves a machine, though this is sometimes of an extremely simple kind. It involves a beam or a means of stretching out the yarns into a flat row; also some means of dividing the yarns into a series above and one below, the space between being the *shed* into which the weft is laid; the upper and lower sets of yarns, changing places, lock the weft, and form another shed for a second weft thread, and so on. See Loom; also, for list of parts and appliances, see Weaving.

Knitting consists in making a fabric by enchaining a single thread. It is thought to have originated in Scotland about A. D. 1500. It was in use for superior articles of hose in England and France in the first half of the sixteenth century. Knitted silk stockings were worn by Henry II. of France, 1547, and by Queen Elizabeth in 1560. About this time knitted worsted stockings were made by William Rider of London, after the pattern of some imported from Mantua. Silk and worsted stockings were imported from Spain and Italy into England during the reign of Henry VIII. Spain was always famous for its sheep and wool. (See MERINO.) In 1530 the word *knit* was common in England, and occurs in Palgrave's grammar. In 1577 the country folks knitted their own stockings.

In 1589, William Lee, M. A., of Cambridge, England, invented and made a model of a knitting-frame. He applied to Elizabeth for help, and then to Henry IV. of France, who promised it. The assassination of Henry threw him into poverty and obscurity, in which he died. His workmen, with their stocking-frames, settled in Derbyshire and started a factory, which soon threw the hose of woolen cloth and leather entirely out of the market. Queen Elizabeth refused a patent to William Lee on account of the value of his invention; as it would interfere with the employment of a great number of her subjects, and to make the stockings for a whole people was too large a grant for any individual. About the same style of remark as was urged by Jefferson against one of Oliver Evans's patents, the "hopper-boy," so called.

Cotton stockings were first made by hand about 1730. The Derby ribbed stockings were patented by Jeremiah Strutt, in 1759.

The knotter frame patented by Horton, 1776.

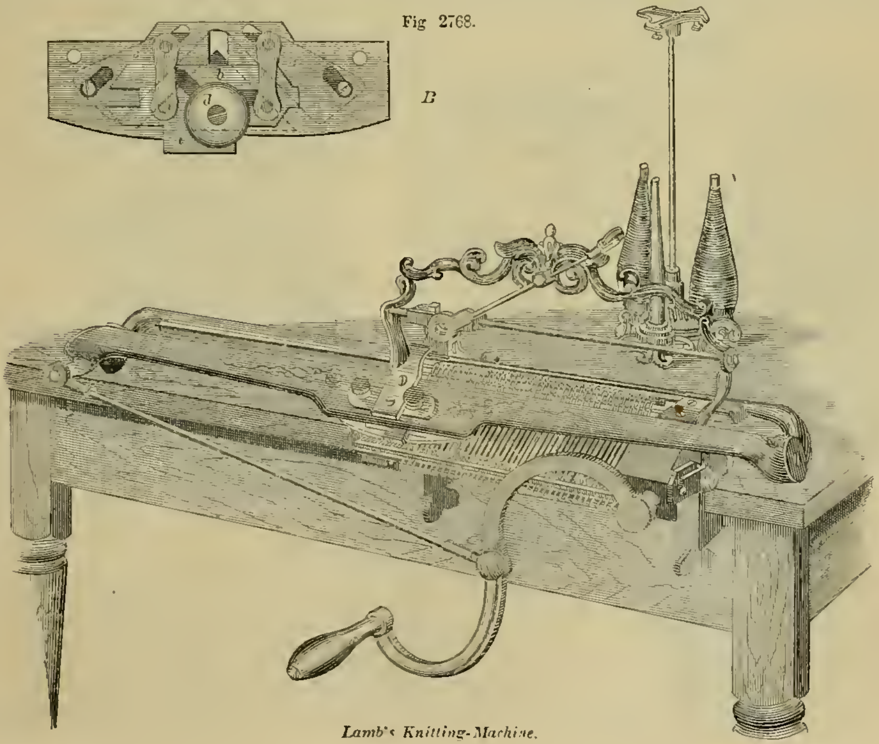
Of a Chinese village called "the old Duck," the Abbé Huc writes: "What struck us most in this place was that the art of knitting, which we had imagined unknown in China, was here carried on very busily; and, moreover, not by women, but by men. Their work appeared to be very clumsy; the stockings they made were like sacks; and their gloves had no separation for the fingers. It looked very odd, too, to see moustachioed fellows sitting before their doors spinning, knitting, and gossiping like so many old women."— *Travels in Tartary.*

Lamb's knitting-machine (Fig. 2678) is given as an example of that class which employs straight rows of needles in contradistinction to the machines using a circular system of needles, and to the single-needle machine. In the Lamb machine, a tubular web is produced by the operation of two straight parallel rows of needles, widening and narrowing being accomplished by increasing or diminishing the number of needles in action.

The frame is attached by thumb-screws to the edge of a table, and has its two upper sides inclined towards each other, their upper edges being separated far enough to allow the fabric produced to pass down between them. Supported by the needle-bed is a carriage, reciprocated by means of a crank. Through the arch that passes over the top of the machine is a horizontal rod upon which moves a slide that carries the guide for delivering the yarn into the hooks of the needles. Parallel grooves or channels are cut across the bed in which the needles are placed. In these grooves the needles can be moved their entire length, and can thus be brought into operation for widening, or thrown out of operation for narrowing, without removing them from the machine.

The needles employed are self-knitting, being constructed in such a manner that when fed by the yarn and carried an inch forward and back they form the loops by their own action. The lower ends of the

Fig 2768.



Lamb's Knitting-Machine.

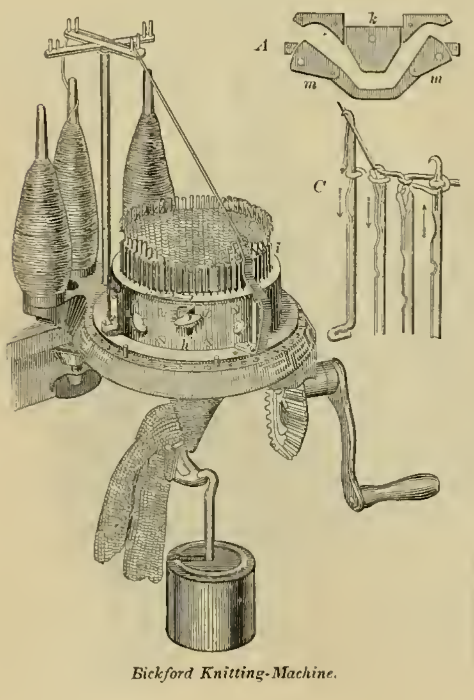
needles have an upright shank, extending above the face of the needle-bed, and are operated upon by cams that are attached underneath the center of the carriage in such a manner as to move the needles forward and back. There are two sets of these cams, one for each row of needles.

B is a representation of one of the sets of cams, which consists of the plate *a*, the two wing-cams *c c*, and the V-shaped cam *b*, which is held in place by the screws that pass through the washer *d*, in the diagonal slot of the plate *a*. As the carriage to which these cams are attached is drawn back and forth over the needle-bed by the crank, the needles are carried up on one side of the V-shaped cam in the groove or space between that and the wing-cams, the yarn-guide at the same time delivering the yarn into the hooks of the needles, which are then drawn down by the wing-cam on the other side of the V-cam, thus forming the loops.

The slide *a* is made to shift by its lower projection coming in contact with adjustable cam-stops, that are placed at the ends of the needle-bed. When the plate comes in contact with the right-hand cam-stop, the screw through the washer *d* is forced up the diagonal slot, and brings up the V-shaped cam, thus closing the space between it and the wing-cams. When closed, the needles pass below the cam without operating. By the adjustment of the cam-stops either or both of the cams may be left open or closed at the same time, so as to operate the two rows of needles separately, alternately, or together; thus forming three entirely distinct webs, — tubular web, plain flat web, and ribbed flat web.

As any number of needles can be moved up at the start, or be moved up or down at either end of the rows of needles at any time, so any size of web can be set up and any number of loops can be added to or taken from it at will. By thus knitting the fabric, either tubular or flat, plain or ribbed, in any desired shape, a great variety of staple and fancy-knit goods may be produced.

Fig. 2769.



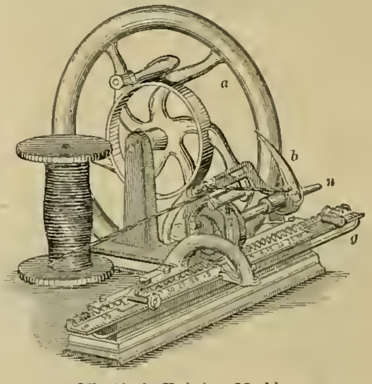
Bickford Knitting-Machine.

The loops are formed on precisely the same principle as in hand-knitting.

The Bickford knitting-machine (Fig. 2769) is a specimen of the circular system. A bed-plate having a vertically projecting and grooved needle-guiding cylinder or bed *i* is secured to a table or suitable support. On the bed-plate is a loose ring, provided with a thread-guide for conducting the thread to the needles, and about the needle-cylinder is a revolving cylinder *h* having an annular groove interrupted by a cam portion (see *A*) and provided with adjustable cams *k m*, which govern the downward motion of the needles, and consequently the length of the loops, and raise the needles; and two of these latter cams are needed to provide for reversing the machine for knitting the heel or a flat web. The cam-cylinder is moved by a bevel gear connected to a driving-crank, and when moved continuously in one direction knits a circular web; and this web may be narrowed as desired to fashion the leg by removing needles, and placing their loops on adjacent needles. The needle on the left, at *C*, is receiving the thread within its hook, and it is subsequently moved by the cam-cylinder into the positions shown to form the thread so taken into a loop. When the heel is to be formed, a portion of the needles are drawn up, thus retaining their loops, and the number of needles left in action correspond with the width of the heel to be formed. The cam-cylinder is now to be reciprocated in opposite directions, and in order to keep the thread-guide in advance of the descending needles sufficiently far, so that the thread will be caught, pins are inserted in the bed-plate, and engage the heel of the thread-carrier, and stop it just before the cam-cylinder is stopped.

Fig. 2770 is an example of what is known as the single-needle machine. The loops are formed and held on the teeth of a comb, which is moved along, one tooth at a time, by means of a rack on its rear side, whose teeth are engaged by a fin on a wheel *c* on one end of a shaft *n*, that is driven by the main wheel *a*, one part of the fin being movable, so that it can be swung from side to side, to vary the direction of the motion of the comb by a tri-armed lever located in the wheel *c*, and which strikes one or the other of the movable stops *g*.

Fig. 2770.



Hinckley's Knitting-Machine.

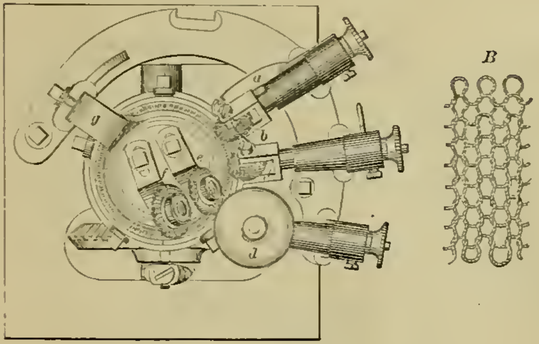
A single needle *b*, carrying the yarn, and a looper, are used, the former being shown in the cut as thrown up out of operation, for the purpose of being threaded.

When in operation, it reciprocates in an arc under the comb, the slot in its actuating arm engaging a crank-pin on the side of the wheel *c*. The looper reciprocates in an arc above the comb, a pin in its actuating arm projecting into a groove in the side of the wheel.

The needle and looper being in their rearmost position, and there being a loop on each tooth of the comb, the needle advances under the comb and through one of the loops, which it removes from the comb and holds a while. The looper then advances above the comb, and its point enters between the yarn and the side of the needle. The needle then recedes, leaving its yarn in the form of a loop on the looper, and dropping the old loop, and the looper also receding, deposits its loop on a tooth of the comb, the latter being then moved forward one tooth for the formation of the next loop in the same manner.

Fig. 2771 is a machine of the ordinary circular kind, and produces a plain tube. The needles are bearded and fixed around the periphery of a rotating cylinder. They have no endway motion, but the stitch is formed as follows, it being assumed that there is already a row of them upon the needles and near their lower ends. The yarn delivered through the eye in the end of the guide *a* is taken and pushed by the notched wings on the *loop-wheel b* up under the beards of the needles. The wings of the next or *sinker wheel c* then press the yarn in between the needles to insure that there shall be a sufficient quantity to form the proper-sized loops. The needle-beards are then pressed in, so that their points enter a depression in the stems, by the *presser-wheel d*, the yarn being thus inclosed between the beard and the stem, the old loops being at the same time raised, by the *landing-wheel e*, a short distance above and outside of the points of the beards. The *stripping* or *knocking-over* wheel *f* then throws the old loops entirely over the tops of the needles, and the fabric, with the newly formed row of loops, is pressed down to the lower ends of the needles by the curved cloth-presser *g*.

Fig. 2771.

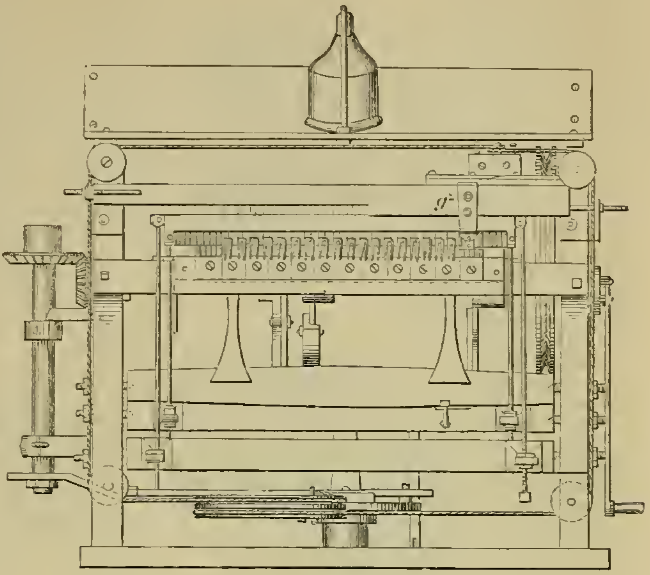


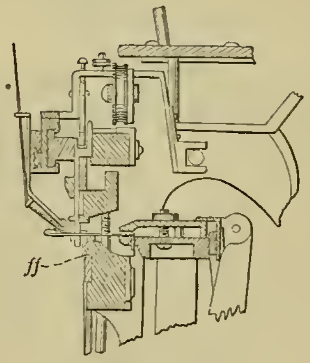
Circular Knitting-Machine.

B, Fig. 2771, shows a piece of ordinary knitted goods with loops distended.

Fig. 2772 is a machine of the kind which produces a plain, flat strip of fabric; it is an ordinary straight machine, and operates as follows:—

Fig. 2772.





Flat-Web Knitting-Machine.

The meshes being in their extreme forward position, and the last-formed row of stitches being near their rear ends, the guide *g*² moves along the front of the machine, laying the yarn on the stems of the needles. The sinkers *c* are at the same time depressed, one after another, by the cam or *slur* above them, and depress the yarn into loops between the needles, which latter are then drawn slightly backward so that the yarn may pass under their beards. The presser-bar then descends upon and closes the beards, which then enter the old loops of the fabric, and the sinkers are raised in a body by the lifting bar in their rear (shown below in the sectional view). The needles receding to their extreme backward position, the old loops are thrown over their heads by being drawn against the plates *f f*. As the needles move forward, the sinkers are all depressed in a body in front of the fabric, by the bar in front of the sinkers, to keep the loops back on the needle-stems. The needles then move entirely forward, and the looping operations are repeated.

The following are the technical names of the parts employed in knitting-machines: —

Beard; a long flexible hook on the upper end of the needle, and over and under which the yarn is moved to form the loop or stitch.

Dividing (or *bar*) *sinkers;* sinkers placed intermediate of the *jack-sinkers*, and which, after the jack-sinkers have operated, descend in a body to divide the yarn into proper-sized loops between the needles.

Fashioning-needle; one of a series, placed at each or either end of the row of needles, which are brought into or thrown out of operation to *fashion*, that is, widen or narrow the fabric.

Jack; a lever connected directly to and operating the sinkers.

Knocking-over bar; the bar against which the loops and fabric are drawn as the needles retreat, so that the loops shall be thrown or knocked over the heads of the needles.

Latch; a pivoted piece on the shank of a needle, and which swings forward to cover the hook and allow a loop to pass over its head, or back to uncover the hook, so that it may receive yarn to form a new loop.

Latch-opener; a device operating between the latch and the hook of the needle to throw back a closed latch, so that the yarn shall be surely laid under the hook.

Lead; a block of lead cast around and holding the shanks of two or more needles.

Point-shifter, or *tickler;* a pointed instrument which takes a loop from one needle and transfers it to another for narrowing the fabric.

Presser; a device which closes or depresses the beards of the needles.

Presser-bar; the bar which carries the presser in a straight machine.

Shifter. See POINT-SHIFTER (*supra*).

Shogging; giving endway motion to a bar carrying yarn-guides.

Shifter-bar; the bar which carries the *shifters*, *points*, or *ticklers*.

Sinker; a device which presses the yarn down on to and between the needles.

Slack course; a row of long loops made at the end of a piece of ribbed fabric (a sock-top, for instance), to facilitate its being placed upon the needles of another machine.

Sley; a grooved or partitioned bed or bar in which the needles or sinkers slide.

Slur-cock; a cam which depresses the sinkers.

Spring take-up; a spring-actuated device which bears against the yarn to prevent slackness.

Thread or *yarn guide* or *carrier;* a device which delivers the yarn or thread to the needles.

Tickler. See POINT-SHIFTER (*supra*).

Welt; a portion of the knit fabric turned over on itself and fastened down, to prevent raveling; resembling a hem in woven fabrics.

Work-roller; the roller upon which the finished fabric is wound.

Besides these are some other terms, some local, probably, some synonyms: —

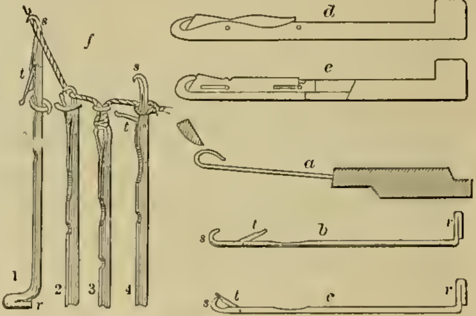
Beater.
Bowl.
Catch-bar.
Clawker
Fly.
Hook.
Knock-off.
Jack-sinker.
Latch-closer.
Lifting-bar.
Neck.
Shifter.
Slur.
Warp roller-reel
Wiper.

Knit'ting-ma-chine' Jack. (*Knitting-machine.*) One of the set of horizontal levers, to whose ends the *jack-sinkers* are suspended. The *jacks* are moved in succession by a *slur*, which traverses beneath their points, thus moving in consecutive order the jack-sinkers which depress the loops between the needles.

Knit'ting-ma-chine' Nee'dle. The hooked member of the machine which passes through a previously made loop catches the yarn, and retreats through the loop, bringing the bight of the yarn with it, forming another loop. The essential feature of a knitting-machine needle is that it shall catch and draw the yarn to form the loop, and shall cast it off by allowing it to slip over, at another period of the action. The devices for this purpose are flexible beards and latches.

a (Fig. 2773) shows the English knitting-machine needle, which has a hook at one end with a pliable barb, which bends down into a groove in the shank when depressed by a presser-bar. The barbed hook then becomes a closed eye; and if a thread looped over the stem of the needle be drawn forward while the barb is thus closed, it will pass over the barb of the needle and come off at the end. If the thread be drawn forward while the barb is open, it will be caught under the hook. The principal action of the machine depends upon this feature.

Fig. 2773.



Knitting-Machine Needles.

b c show two positions of the *latch*-needle: one with the latch lying back, the hook being in condition to catch the thread; the other showing the hook closed by the latch, which acts as a mousing.

d e are two views of a needle which has a closing slide. The lower view of the two is a section showing the slots which traverse on the pins.

f shows a group of needles with the yarn looped thereon, as when the machine is at work. The needle employed is shown complete at 1. In the other numbers a portion of the lower part is broken away. The needle consists of a body, an angular bent portion or foot *r*, a hook *s*, and a latch *t*. The latter is pivoted to the body of the needle, and works partly in a slot formed in the body. The latch has, moreover, a spoon-shaped end, which, when the latch is closed, as shown in needle 2, meets and partly shuts over the point of the hook *s*, so that the loop formed on the needle easily slips off when the latter makes its downward movement. The needle 1 has passed up through a loop of the previous row, and the hook *s* has caught the yarn; the mousing-latch is thrown back, as shown also at *b*, same figure. The needle 1 descends, drawing with it the yarn, as shown at 2, the position of the previous needle; the loop on the shank has come against the latch *l*, and closed it against the point of the hook, so that the hook and its yarn slip through the loop, which is cast off, as shown at needle 3. Presently the needle commences to rise again, as its turn of work recurs, and, as it does so, as shown at needle 4, the loop lying in the hook slips down the shank, capsizes the latch *l*, and falls over it into the depression in the shank, as shown at needle 1. This is one round of work for a needle. Knitting by machinery is a rapid repetition of these motions.

Knitting-machine needles are made in machines by which the wire is reduced. In Aiken's machine the blanks are clamped in the arbors and brought singly between the grooved rest and rotating cutter, and are reduced by the cutter, which turns in a longitudinal plane, the arbors rotating meanwhile. After the blank has been reduced, it is drawn back from between the rest and cutter, the arbor-wheel is unlocked from the spring detent-pin, and another blank brought into position.

In another machine, for making the tongues of knitting-needles, the machine first forms the bowl and nick of the tongue, and simultaneously forces back the feeder upon the wire. The wire is then moved between the flattening dies; it is then moved to the punching dies, then to the dies rounding the end next the hole. The tongue with the sharp piece projecting from it is then cut off.

Knit'ting-nee'dle. A plain wire with smoothed ends, used in pairs in hand-knitting of flat goods and in fours for tubular work.

Knit'tle. 1. (*Nautical.*) A small line composed of two or three yarns laid together and twisted with the finger and thumb against the twist of yarn. Used for miscellaneous purposes on board, such as seizings, lashings, hammock-clues, pointing, grafting, etc.

2. A *draw-string* of a bag.

Knob. 1. (*Glass.*) The boss or central bulb of a *table* of glass when cut for use.

2. The handle on the spindle of a lock or latch.

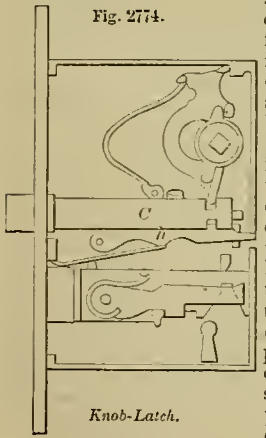
3. A rounded handle of a door, lock, drawer, etc.

4. (*Architecture.*) A *knop*, bunch, or boss.

5. (*Ordnance.*) The cascabel of a gun.

Knob'bing. (*Masonry.*) The rough dressing, or knocking off the projections of stones in the quarry.

Fig. 2774.



Knob-Latch.

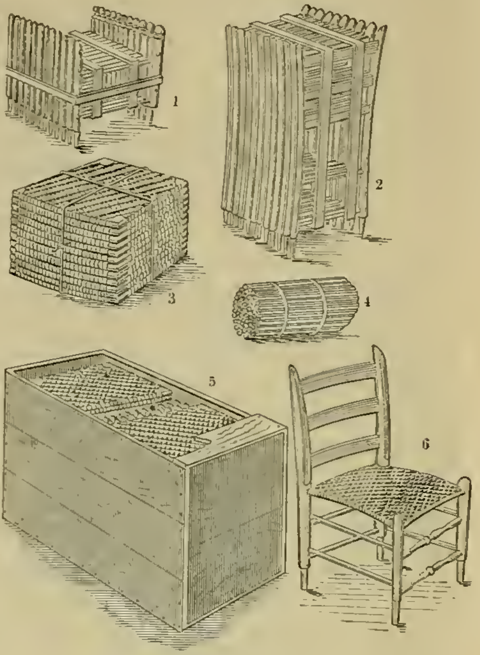
Knob'bling-fire. A sunken refining hearth, of small size, in which crude or partially refined iron is worked into a ball or *knob* in contact with charcoal and under influence of blast. A *bloomary*.

Knob-latch. One in which the bolt is retractable by the knob or rotary handle, in contradistinction to one which is moved by a key. In the example, the latch-bolt *C* rests upon a horizontal bar *h*, one end of which is pivoted to the lock-case, while the other, supported by a spring, protrudes through an opening in the edge of the case, so that the bolt can be disengaged from the arms of the hub by simply depressing the end of the bar.

Knock-down. A piece of furniture or other structure adapted to be disconnected at the joints so as to pack compactly.

The *shook* may be said to be a knock-down barrel. The example shows the parts of chairs down, bundled, and tied. The different figures show respectively a dozen front legs and rounds, as many backs, seats, side rounds; also a chair complete and box to hold a dozen knocked down.

Fig. 2775.

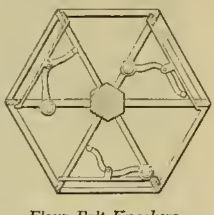


Knock-down Chairs.

Knock'er. 1. An attachment to an exterior door of a house, to give notice to those within that some one stands without.

2. An attachment in a flour-bolt to jar the frame and shake the flour from the meshes of the bolting-cloth. In the example, the knockers are pivoted weighted arms; as the bolt revolves, the weights tilt the arms and strike the bolt-frame.

Fig. 2776.



Flour-Bolt Knockers.

Knock'er-off. (*Knitting.*) A wheel with projections to raise the loop over the top of the needle and discharge it therefrom. A similar wheel, called a *sinker*, depresses the yarn between the needles. See BUR.

Knock'ing. (*Bookbinding.*) Setting even at the edges, by taking a bunch or pile of sheets or leaves and striking an edge on the bench.

Knock'ing-down I'ron. (*Bookbinding.*) An iron for pounding down the projecting twines (*slips*) to which the sheets are sewed, so that they shall not project and mark the back cover.

Knock'ings. 1. (*Metallurgy.*) The larger pieces of ore and gangue which are picked out of the sieve. The sorting of lead ore by the sieve develops three qualities, *knockings*, *riddlings*, and *fell*. The former are large scraps, which are picked out.

The *ridd'ings* are what remain in the sieve.

The *fell* is the smallest, and falls through.

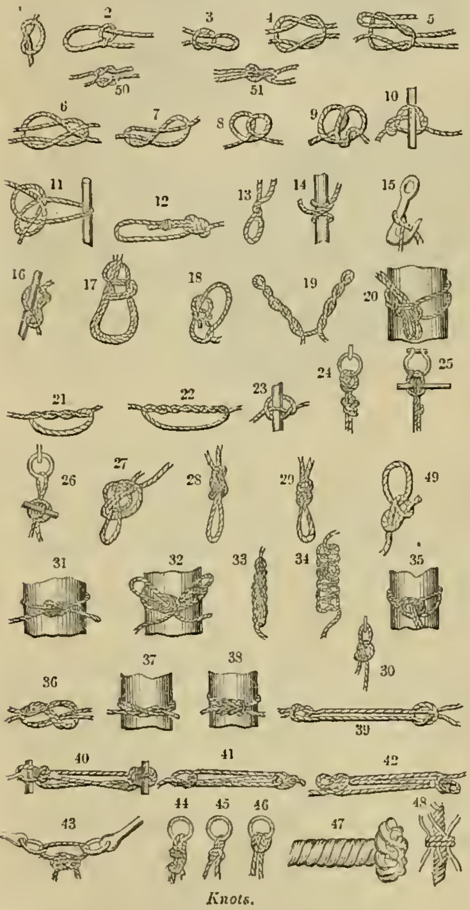
2. (*Masonry.*) The small pieces broken off from stone by hammering or chiseling. Large pieces are *spalls*.

Knock-off. (*Knitting-machine.*) The piece which, at the proper moment, removes the loops from the tier of needles.

Knock-stone. (*Mining.*) A block on which ore is broken.

Knot. 1. (*Nautical.*) *a.* A device formed by intertwining a rope or cord so as to attach one part of it to another part of itself, to another rope, or to any other object. The kinds of knots employed, especially by nautical men, are too numerous to admit of description, and we content ourselves with exhibiting a few of the more prominent.

Fig. 2777.



Knots.

Those shown are generally in open position, so as to more clearly explain the way in which the parts of the rope run previous to being drawn taut in order to join them together and prevent slipping.

Some kinds of knots are called *hitches* and *bends*, which terms usually indicate that they are chiefly employed for making the rope fast to another object, or for securing two objects together.

1, simple overhand knot.
2, slip-knot, seized.
3, single bow-knot.
4, square or reef knot.
5, square bow-knot.
6, weaver's knot.
7, German, or figure-of-8 knot.
8, two half-hitches, or artificer's knot.
9, double artificer's knot.
10, simple galley-knot.
11, capstan or prolonge knot.
12, bowline-knot.
13, rolling-hitch.
14, clove-hitch.
15, blackwall-hitch.
16, timber-hitch.
17, bowline on a bight.
18, running-bowline.
19, catspaw.
20, doubled running-knot.
21, double-knot.
22, sixfold-knot.
23, boat-knot.
24, lark's head.
25, lark's head.
26, simple boat-knot.
27, loop-knot.
28, double Flemish knot.
29, running knot, checked.
30, crossed running-knot.
31, lashing-knot.
32, rosette.
33, chain-knot.
34, double chain-knot.
35, double running-knot with check-knot.
36, double twist-knot.
37, builder's knot.
38, double Flemish knot.
39, English knot.
40, shortening knot.
41, shortening knot.
42, sheep-shank.
43, dog-shank.
44, mooring-knot.
45, mooring-knot.
46, mooring-knot.
47, pigtail, worked on the end of a rope.
48, shroud-knot.
49, a bend or knot used by sailors in making fast to a spar or to a bucket-handle before casting overboard; it will not run. Also used by horsemen for a loop around the jaw of a colt in breaking; the running end, after passing over the head of the animal and through the loop, will not jam therein.
50, a granny's knot.
51, a weaver's knot.

The principle of a knot is, that no two parts which would move in the same direction if the rope were to slip should lie alongside of and touching each other.

The *standing-part* of one rope and the *end* of the other should not lie side by side. This feature distinguishes the *sheet-bend*, *bowline-knot*, *carrick-bend*, *reef-knot*, etc., from the *granny's-knot*, *slippery-hitch*, etc.

b. A nautical or geographical mile; $\frac{1}{60}$ of a degree of latitude; about 2,025 yards. The English statute mile is 5,280 feet.

A *log-line* is a *knotted* cord, the distance between the *knots* being $\frac{1}{120}$ of a nautical mile apart, that is, 50 $\frac{75}{120}$ feet. The log line is allowed to run out for 30 seconds, which is $\frac{1}{120}$ of an hour, so that the distance between *knots* on the cord bears the same ratio to a degree that the time does to an hour.

Thus if 8 knots on the log-line run through the hand of the seaman while the sand in the $\frac{1}{2}$-minute glass is running out, it is an indication that the vessel is traveling 8 nautical miles per hour. See Log.

2. (*Brush-making.*) The brush-maker's term for a tuft of bristles ready for insertion into a hole drilled in the stock.

3. So many skeins. See Hank.

Knot'ter. (*Paper-making.*) A sieve which detains knots in the pulp, so that they do not pass to the moving wire-plane on which the paper is formed. See Paper-machine.

Knot'ting and Stop'ping. 1. (*Painting.*) A process preliminary to painting, consisting of painting over the knots of wood with red-lead, and the stopping of nail-holes, cracks, and faults with white-lead.

A silver leaf is sometimes laid over the knots in superior work.

2. (*Cloth-making.*) Removing weft knots and others from cloth by means of tweezers.

Knout. The Russian whip for criminals and other offenders.

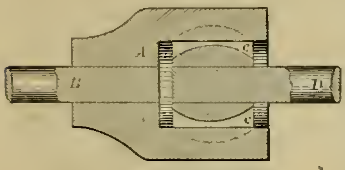
It has a handle 2 feet long, and a thong 4 feet long terminating in a brass ring. To the latter is attached the tail, 2 feet long, and running from 2 inches wide at the ring to a point. This is soaked in milk and dried to harden it. The tail is changed every sixth stroke.

Knubs. The offal or waste silk in winding off from the cocoon.

Knuck'le. 1. (*Mechanics.*) The joint-pieces of a hinge through which the *pintle* passes.

Knuck'le-joint. A joint in which a projection on each leg or leaf of a device is inserted between corresponding recesses in the other, the two being connected by a pin or pivot on which they mutually turn. The legs of dividers and the leaves of butt-hinges are examples of the true knuckle-joint. The term, however, has been somewhat commonly applied to joints in which the motion is not confined to one plane. Such are really universal joints, a form illustrated in the *ball and socket* and the *gimbal*. A *ginglymus.*

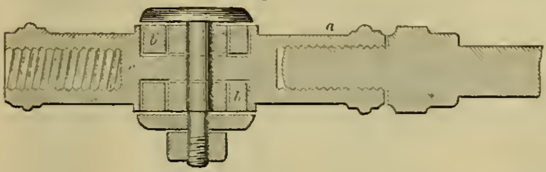
Fig. 2778



Knuckle-Joint.

The example (Fig. 2778) differs somewhat in character from those just described. In this, designed for coupling the tumbling-rods of thrashers, and for other couplings which require play, the head of the shaft *D* has projections *c* which fit in corresponding grooves in the socket *A*, enabling the rods *B D* to be turned either to the right or the left, as desired.

Fig. 2779.



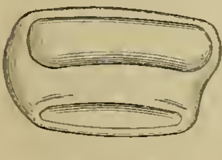
Knuckle-Joint.

In Fig. 2779 the rings *b b* are let into annular recesses in the arms *c a* of the two parts to be coupled, relieving the center-pin from all strain. See Coupling.

Knuck'le-shield. One to save the knuckles in washing and scrubbing. The example shows one made of india-rubber.

Knuck'le-tim'ber. (*Shipbuilding.*) A top timber in the fore body, where a reverse of shape causes an angle on the timber.

Fig 2780.



Knuckle-Shield.

Knurl'ing. Providing with ridges to assist the grasp, as in the knurled (or milled) head of a set-screw.

Koff. (*Vessel.*) A two-masted, Dutch fishing-vessel, carrying a sprit-sail on each mast.

Kom'pow. (*Fabric.*) A strong, white linen of China.

Kreel. 1. A fish-basket of osiers.

2. A framework fish-trap.

Kris. A short sword of the Malays. A *creese.*

Krum-horn. (*Music.*) A old musical instrument resembling a cornet.

After a singular change of orthography, it is represented by the *cremona* stop in an organ.

Kus'si-er. (*Music.*) A Turkish musical instrument, having a hollow body, a skin covering, and five strings.

Kutch. (*Gold-beating.*) The packet of vellum leaves in which gold is placed to be beaten.

The package of gold-beater's skin in which gold-leaf is placed for the second beating is called the *shoder.*

After the second beating, the pieces are cut up and re-arranged in gold-beater's skin, the package being called a *mold.*

Ky'an-iz-ing. Named from Kyan, the inventor of the process (1832). To prevent the decay of wood, cordage, or canvas, it is saturated with a solution of corrosive sublimate in open tanks or under pressure.

The timber is prepared as follows: A wooden tank is put together so that no metal of any kind can come in contact with the solution when the tank is charged. The solution consists of corrosive sublimate and water, in the proportion of 1 pound of corrosive sublimate to 10 gallons of water as a maximum strength, and 1 pound to 15 gallons as a minimum, according to the porosity or absorption of the timber subjected to the process.

Oak and fir timber absorb nearly alike, but some other woods, such as beech, poplar, elm, etc., are more porous.

The period required for saturating timber depends on its thickness; 24 hours are required for each inch in thickness, for boards and small timbers.

The timbers, after saturation, should be placed under a shed or cover from the sun and rain, to dry gradually.

In about 14 days timber not exceeding 3 inches in thickness will be perfectly dry and seasoned, and fit for use. Large timbers will require a proportionate time, according to their thickness.

Some processes of similar import may be shortly stated.

In Bethel's process, creosote is employed and forced under heavy pressure into the pores of the wood. (1838.)

Robbins expels moisture by heat and then saturates with coal-tar, resin, or bituminous oils, at 325° Fah. (1865).

Blythe treats with steam combined with hydrocarbon vapor.

Burnett employs chloride of zinc in solution, under pressure. (1838.)

Boucherie used pyrolignite of iron. (1840.)

Payne, sulphate of iron. (1842.)

Margary, acetate or sulphate of copper. (1837.)

Van der Weyde, solution of silicate of potash.

Heinemann: boil wood in alkaline solution, and treat, under pressure and heat, with resin, carbolic acid, and tar.

Nicholson, tar and petroleum.

Behr, solution of borax.

Earl, protosulphate of iron.

Payen, superficial carbonization. See Wood, Preservation of.

L.

La′bel. A placard or slip attached to an object to indicate contents, destination, or ownership. See Baggage-check, for instance.

1. Animal labels are of many forms: —

a. A metallic strip bent into a link-shape, the ends being passed through two slits in the ear. On the outside is shown the name of the owner or the number of the animal on the stock-book.

b. A plate secured by rivet to the ear.

c. A button is inscribed with the name of the owner and fastened to the ear by means of a locking plate, which enters the tubular shank of the button.

d. A tag attached to the horns, wool, mane, etc., to indicate ownership, class, prize, merit, etc.

2. A card or tablet attached to a bottle, jar, drawer, etc., by a chain, or placed in a panel.

One on a can of fruit or other vegetables. In one case, the whole series of customary contents are placed on the margin of the can, and the kind contained in the can is indicated by a mark.

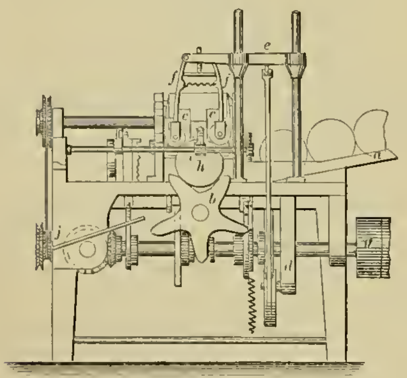
3. A brass rule with sights, formerly used in connection with a circumferentor to take altitudes.

4. (*Architecture.*) A molding over a doorway or window. A *head-molding* or *hood-molding* in the interior; a *drip, drip-stone,* or *weather-molding,* on the exterior.

La′bel-cor′bel Ta′ble. (*Architecture.*) A corbel-supported head-molding over a doorway or window. Known also as a *drip-stone* or *hood-molding.*

La′bel-ing-ma-chine′. A device for attaching labels to cans, jars, or bottles. The example shows one form, in which the can is fed in at the chute *a*, and is taken up by the revolving star *b*. It is there retained in place long enough to receive the label from the gumming-wings *c*. The cam *d* gives downward motion to the cross-head *e*, and thence to the arms *f f* with the smoothing-rollers attached thereto. The can is then discharged by a partial revolution of the star *b* on to the chute *j*. Power is applied at *g*. The finger *h* holds the label in place while the gumming-wings return for another label. It takes in four sizes of cans, and has labeled 9,000 in ten hours.

Fig. 2781.



Labeling-Machine.

Lab-i-dom′e-ter. A forceps with a measuring attachment for ascertaining the size of the fetal head.

Lab′o-ra-to-ry. 1. A house or apartment in which chemical experiments are conducted.

2. A manufactory of chemical articles.

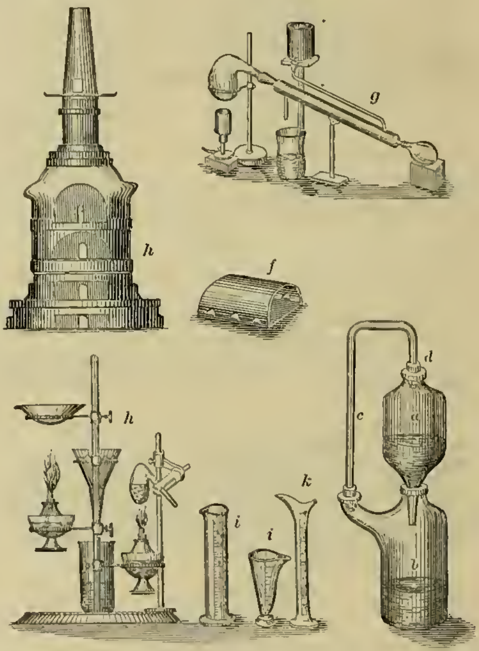
3. A place where fireworks are prepared.

4. A department in an arsenal where cartridges, fuses, primers, etc., are made, shells charged, etc.

Lab′o-ra-to-ry-ap-pa-ra′tus. Instruments and appliances used by the chemist in his study. Among them may be cited the cupellation-furnace *h*, cupel *f*, Liebig's condenser *g*, the retort and filter-stand *h*, measuring-glasses *i i*, pipette *k*.

A *filter* for chemical solutions, without access of fresh bodies of atmospheric air, is also shown in the figure; the vessel *a* containing the solution and the filtering-matter occupies the neck. As the liquid reaches the vessel *b* it displaces a body of air, which passes by the pipe *c* to the chamber *a*, entering through the stopple *d*, which is ground or provided with cork. See also Balance.

Fig. 2782.



Laboratory-Apparatus.

Lab′y-rinth. (*Metallurgy.*) *a.* A sinuous channel in which the ground ore (*slime*) and water are conducted, in order that the metallic portions may be deposited according to their respective gravities.

b. A chamber of many turnings in which fumes, derived from dry distillation of mercury, etc., are condensed. See Condenser.

Lac. A resin obtained from the *Ficus indica.* See Resin.

Lace. A kind of network of threads of flax, cotton, gold or silver wire, or other suitable material, forming a fabric of transparent texture. Its origin is not known, but it appears to have been used by the ladies of ancient Greece and Rome. It was early used in Northern Italy, and is said to have been introduced into France by Mary de Medicis. In 1483 its importation into England was prohibited.

The systematic manufacture was introduced into England by refugees from Flanders.

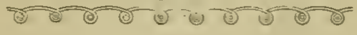
Lace was anciently worked by the needle. The invention of lace *knitting* is attributed to Barbara, wife of Christopher Huttman, a German miner, in 1560. A manufactory was established in France by Colbert, in 1566.

Point lace was embroidered with the needle. *Bone* lace (temp. of Charles I.) was a kind of thread lace, and received its name from the bobbins being made of bone. About 1768, a stocking-weaver of Northampton produced a machine for making lace; it was called the *pin-frame*, and is still employed in France for making the lace called *tulle*.

The method of Barbara Huttman is as follows: The lace-maker has a hard cushion in her lap on which the pattern, traced on parchment, is laid, and pins passed through the parchment into the cushion at places determined by the pattern. She has also a number of bobbins on which the threads are wound, fine thread being used for the meshes or net. The work is begun by attaching the threads in pairs to the pins. The threads are then intertwined by means of the bobbins, so as to form the required pattern.

In *lace-weaving*, the threads of the weft are twisted round those of the warp. The manner of twisting determines the character of the net and its name, as *whip*-net, *mail*-net, *pattern*-net, *drop*-net, *spider*-net, *balloon*-net, *Paris*-net, *bobbin*-net.

Fig. 2783.



Lace-Weaving.

The classification of laces at the English exhibition of 1851 was as follows: —

1. *Pillow-lace*, the article or fabric being wholly made by hand (known as *Valenciennes*, *Mechlin*, *Honiton*, *Buckingham*); or *Guipure* made by the crochet-needle; and *silk lace*, called *blonde* when white, and *Chantilly*, *Puy*, *Grammont*, and *black Buckinghamshire*, when black.
2. Lace, the ground being machine-wrought, the ornamentation made on the *pillow* and afterwards applied to the ground (known as *Brussels*, *Honiton*, or *appliquée lace*).
3. Machine-made net or quillings, wholly plain, whether warp or bobbin (known as *bobbin-net*, *tulles*, *blondes*, *Cambraie*, *Mechlin*, *Malines*, *Brussels*, *Alençon*, etc.).
4. Lace, the ground being wholly made by machine, partly ornamented by machine and partly by hand, or wholly ornamented by hand, whether tamboured, needle-embroidered, or darned.
5. Lace, wrought and ornamented by machinery, comprising *trimming laces* of every description, *veils*, *falls*, *scarfs*, *shawls*, *lappets*, *curtains*, etc.

The dates of some of the inventions connected with lace-making are as follows: —

Bobbin-lace invented by Barbara Huttman of St. Annaberg, Germany	1561.
Pillow-lace making taught at Gt Marlow, England	1626.
Strutt's machine for making openwork stockings	1758.
Crane's Vandyke machine	1758.
Else and Harvey's "pin" machine	1770.
Frost's point-net machine	1777.
Dawson's point-net machine	1791.
Heathcoat's bobbin-net machine	1804.
Hill's plain ground net machine	1816.
"Limerick" lace made	1829.

Laced-stock'ing. A bandage support for varicose veins, weak legs, etc.

Lace-mak'ing Ma-chine'. Lace is a delicate kind of network composed of silk, flax, or cotton threads, twisted or plaited together. See LACE.

The meshes are of an hexagonal figure, in which thick threads are also interwoven to form the pattern, according to some design; and these threads, which are called *gymp*, form the ornament of the lace.

The *point-net frame* was invented by Morris (England) in 1764, and is a variety of the stocking-frame, making a stitch or loop like that of a stocking, and formed by a continuance of one thread. The thread is by the machine formed into loops, a whole course at once, by pressing it down alternately over and under between a number of parallel needles. A second course is then made of similar loops on the same needles, and the loops of the first are drawn through those of the second in such a manner as to form meshes by retaining the first loops; the second are then retained by a third, and these by a fourth, and so on.

The *warp-net frame* is also a variety of the stocking-frame, but the parts are very differently arranged, the movements being produced by treadles, leaving the hands of the workman to manage the machine, which is a piece of mechanism applied in front of the row of needles of the frame. In the *warp-net frame* the piece of lace is not formed of one continuous thread, as in the *point-net frame*, but there are as many different threads as there are needles in the frame; these threads are *warped* or wound upon a roller or beam the same as a loom, and it is from this circumstance that the machine is called a *warp-frame*. These threads pass through eyes in the ends of small points, called *guides*, which are opposite the needles; and these guides are fixed on two bars, each of which has half the guides fastened on it; that is, one guide is fast to one bar, and the next to the other, and so on alternately of the whole. Each of the guides presents a thread to its needle, and all are at once moved by the hand to twist the threads two or three times round the needles that are opposite to them. The loop is now made in a manner similar to that in the *point-net frame*. The next time, the alternate guides are shifted endways, so as to apply themselves to other needles than those they were opposite to before; this crosses the thread so as to make a net, but the quantity that is shifted endways is changed every time by means of the machinery, so as to move a certain number of needles, which number is changed every time to produce the pattern.

The lace-making machine for weaving the real twisted lace, like that made on the pillow, was invented by Heathcoat, 1804.

The groundwork of the invention is to extend those threads which form the warp of the lace in parallel lines, and dispose the diagonal threads upon small bobbins, which are detached, and are capable of passing round the extended warp-threads so as to twist with them; by this means the number of bobbins is reduced to one half. In this machine there are two horizontal beams or rollers, one to contain the thread and the other to receive the lace; also a number of small bobbins to contain the thread.

Mr. Hebert thus enumerates the varieties of bobbin net-lace machines: —

The Loughborough double-tier	*Heathcoat's.*
The single-tier	*Stevenson's.*
The improved double-tier	*Brailey's.*
The improved single-tier	*Lever's.*
The Loughborough improved; with pumping-tackle.	
The pusher principle	
The traverse warp	*Bevan & Freeman's*
The traverse warp, rotary	*Lindley & Lacey's.*
The straight bolt	*Kendal & Mauley's.*
The circular bolt	*Mauley's.*
The circular comb	*Harvey's.*
The improved circular comb	*Hervey's.*
The farther improved single-tier	*Lever's.*

Lace-pa'per. Paper having an openwork pattern and perforations made in imitation of lace. The process usually consists in grinding off the elevated portions of embossed paper, which is accomplished by passing the paper between two rollers, one of which is covered with ground glass or emery, the other is impressed with a duplicate of the design on the paper. The grinding-roller is made to revolve at high velocity.

Lace-piece. 1. (*Shipbuilding.*) The main-piece of the head, or beak-shaped projection from the *head* of a vessel. See MAIN-PIECE; STEM.

2. (*Nautical.*) The rope used to fasten a sail to its yard or gaff.

Lach'ry-mal-duct Di-lat'or. (*Surgical.*) A probe, by means of which the normal caliber of the nasal duct, in cases of obstruction, is restored. They are made of eight different sizes, of silver, lead, whalebone, hard rubber, and *laminaria digitata.* The silver is the most useful; whalebone and hard rubber are easy to guide, and less liable to injure the mucous membrane. The *laminaria*, after introduction, gradually swells up from imbibition of the tears, and thus dilates the canal.

Lac'ing. 1. A fastening by a cord, thong, or whang, which passes through holes prepared in the respective parts of the object so fastened. The term is applied to fastening up the front opening of some kinds of boots; also to the fastening together of the pieces which constitute a machine belt.

2. (*Bookbinding.*) Securing the book to the sides by carrying the bands or slips through perforations in the boards.

3. (*Nautical.*) The rope used to confine the heads of sails to their gaffs or yards.

Lac'quer. Primarily, a varnish composed of shellac dissolved in alcohol and colored by means of gamboge, saffron, annotto, and various other coloring matters. It is applied to wood, to papier-maché, and to metals to protect them from rust and improve their color. The term is also applied to compositions containing none of the above ingredients, they being replaced by turpentine, resin, etc.

The proportions of the shellac and alcohol vary. Two gallons of alcohol to one pound of shellac is probably the most common proportion.

Besides the coloring matters above referred to, turmeric, dragon's blood, gum sandarach, and red saunders are frequently employed in red and gold colored lacquers, the articles and their relative proportions being varied according to the tint desired. In the military service the following lacquers are used: —

For Small-Arms, or Water-Proof Paper.

Beeswax	13 pounds.
Spirits turpentine	13 gallons.
Boiled linseed-oil	1 gallon.

All the ingredients should be pure and of the best quality. Heat them together in a copper or earthen vessel over a gentle fire, in a water-bath, until they are well mixed.

For Bright Iron Work.

Linseed-oil, boiled	80.5
Litharge	5.5
White-lead, in oil	11.25
Resin, pulverized	2.75

Add the litharge to the oil; let it simmer over a slow fire three hours; strain it, and add the resin and white-lead; keep it gently warmed, and stir it until the resin is dissolved. For ordnance, shot, or shells, or other iron work not designed to be kept bright, coal tar thinned with spirits of turpentine forms a very cheap and permanent lacquer.

Lac-tom'e-ter. Called also galactomer. A species of hydrometer, graduated to show the comparative specific gravity and consequent value of different specimens of milk.

The instrument is a good evidence of the specific gravity of milk, and the specific gravity is a probable, but not positive, evidence of quality. Taken in connection with the per-cent glass, which measures the per cent of cream that rises, it is nearly a positive indicator of pure and watered milk.

One form of the *lactometer* for ascertaining the amount of cream in milk consists of a tube with a funnel mouth for convenience in charging it, and having the upper portion graduated. The tube is about a foot in length, and being filled the cream is allowed to rise, when its richness is determined by the number of graduated spaces occupied by the cream.

The hydrometer alone is not adapted to determine the amount of cream in milk, which can only readily be determined by test. Dr. Ure suggests it may be applied to the skimmed milk to determine the proportions of curds and whey.

Lac'to-scope. An instrument invented by Donne of Paris, for assisting in determining the quality of milk by ascertaining its relative opacity.

The "three times skimmed sky blue" of Bloomfield is the bottom of the scale, unless the pump-water milk for urban distribution is considered as zero.

Dingler's "Polytechnisches Journal" describes a simple apparatus for determining the richness of milk, as measured by its transparency. Two polished plates of glass are adjusted by means of a screw to stand at different distances from each other. The milk is placed between them, and the distance of the plates from each other when the flame of a stearine candle is rendered invisible, is the measure alike of the transparency and comparative richness of the milk.

Lac-var'nish. One made from shellac dissolved in alcohol. Colored by red, orange, or yellow matters. Lac is obtained from the *Ficus indica*, and the product is *stick lac*, *seed-lac*, *shellac*, and *lac-lake.*

Lad'der. 1. A frame — usually movable — having a series of steps attached to side-bars or ropes. The varieties are distinguished by their purposes, position, or by some feature of construction.

A *ladder* differs from a *stairs* in that the latter has *treads* and risers, being thus boxed in below. The *ladder* has merely *steps.*

Of the *nautical* ladders, we have, —

Accommodation-ladder.
Companion-ladder.
Forecastle-ladder.
Hold-ladder.
Jacob's-ladder.
Quarter-ladder.
Side-ladder.
Stern-ladder.

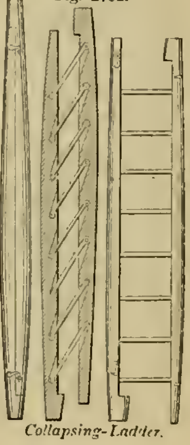
As to purpose, we have, —

Fire-escape.
Fire-ladder.
Fruit-ladder.
Garden-ladder.
Scaling-ladder.

The names denoting construction are, —

Chain-ladder.
Extension-ladder.
Rope-ladder.
Rule-joint ladder.
Step-ladder.

Fig. 2784.



Collapsing-Ladder.

The *collapsing-ladder* (Fig. 2784) has rounds pivoted to the side-rails, recesses in which receive them when the ladder is folded. When the side-pieces are drawn apart, the rounds assume a horizontal position.

A movable ladder is sometimes used in ascending and descending shafts. Two poles ascend and descend alternately, and have stages on to or from which the person steps from or to the corresponding step on the other pole, at the moment when they become stationary. See MAN-ENGINE.

Scaling-ladders are shown in the triumphal monuments of Rameses II., the great Sesostris, 1355 B. C.

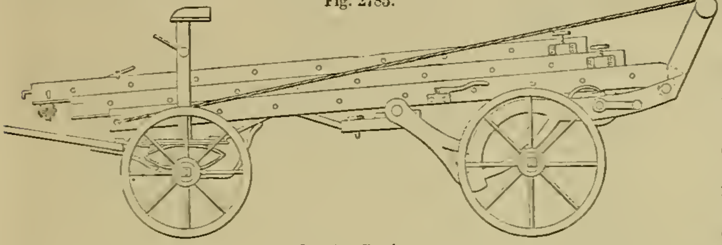
The first ladder of record was that seen by Jacob in his dream, and it is the longest and best of which we have any account. It is the only one mentioned in the Bible.

2. (*Nautical.*) The *accommodation*-ladder is a stairs slung at the gangway. The *forecastle* and *hold* ladders are at these respective places. The *Jacob's*-ladder abaft the top-gallant masts, where there are no ratlines at the shrouds. The *quarter* and *stern* ladders are for reaching or leaving the boats moored astern.

3. A notched cleat or stick in a bookcase, for supporting shelves.

Lad'der-car'riage. One for conveying fire-ladders. In the example, the bed-frame serves as a connection in coupling the wagon, and braces the ladder when raised. The windlass, having its bearings at the foot of the frame, extends the sliding sections of the ladder. The basket, attached by a rope to the pulley at the top of the ladder, forms a fire-escape.

Fig. 2785.



Ladder-Carriage.

Lad'der-way. 1. (*Mining.*) Or foot-way shaft. The shaft of a mine, by which the workmen ascend and descend.

2. (*Nautical.*) A *companion*-way or *scuttle*-way on board ship.

La'dies. (*Skating.*) A size of skates; 15 × 18 inches.

La'ding. (*Glass.*) The transference in cisterns of molten glass from the pot to the table, in plate-glass making.

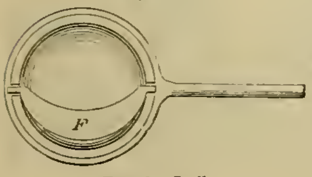
La'ding-hole. (*Glass.*) An aperture in the side of a furnace for plate-glass, at which the *curette* for carrying the metal is introduced or is filled. See page 669.

La'dle. 1. (*Founding.*) A pan with a handle to hold molten metal.

On a small scale, the *bullet-ladle* is a familiar instance.

The large ladle used in the foundry is called a SHANKS (which see).

Fig. 2786.



Foundry-Ladle.

Ladles are protected by a thin coat or layer of loam, and every time, before being used, they are brushed over with black wash and carefully dried.

The example has a lunate-shaped plate *F* pivoted to the rim, and serving to keep back impurities floating on the metal.

2. (*Ordnance.*) An implement used for removing the shot when it is not wished to fire the gun. It is a semi-cylinder of copper, beveled at the end, and attached to a staff. For use, the muzzle of the gun is slightly depressed and the ladle passed in so as to run under the shot, which is received in it; when the ladle is withdrawn, it brings the shot out with it.

b. A cylindrical scoop of copper for loading loose powder into a cannon.

3. (*Pyrotechnics.*) A copper scoop for filling rockets.

4. (*Glass.*) A vessel in which molten glass is carried. *A curette.*

5. (*Domestic.*) A large dipping spoon.

6. (*Hydraulics.*) The float-board of a mill-wheel.

La'dle-board. A mill-wheel float.

Lag. 1. One of the boards or staves forming the covering of a large band-drum, or the upper casing of a carding-machine, or the covering of a steam-boiler or cylinder.

The *lags* of the drum are fastened by *lag-screws* to the frame of the wheel.

The *lags* of the carding-machine are *clothed* with *cards* on the under sides, and are separately removable.

The *lags* of the boiler or cylinder are wooden staves, hooped, and enclosing a body of non-conducting material. Otherwise called *cleading.*

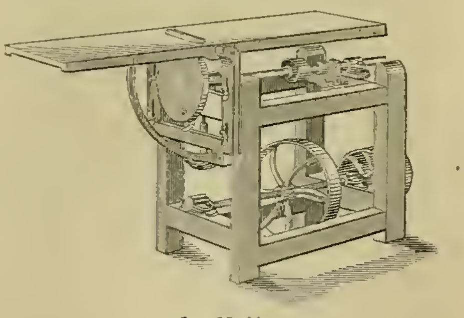
2. (*Steam-engine.*) The retardation of the valve.

Lag'ging. 1. (*Steam-engine.*) The non-conducting jacket or clothing of a steam-boiler or cylinder, to prevent radiation of heat. *Cleading, deading, sheathing, clothing.*

2. (*Carpentry.*) Narrow planks extending from one rib to another in the centering of arches and forming the board covering upon which the courses of voussoirs are laid.

Lag-ma-chine'. (*Wood-working.*) A machine for hollowing out the insides of *lags* or covering for wooden rolls or drums; or the *cleading* for jacketing cylinders or steam-pipes.

Fig 2787.



Lag-Machine.

Lag-screw. A flat-headed screw used to attach lags to band-drums.

Laid. (*Paper.*) Paper having the marks made by the wires of the *deckle*.

The choice of coloring matter occasions the names *cream-laid, blue-laid*, etc.

Laid-on. (*Joinery.*) A term applied to moldings which are got out in strips and nailed on to the surface of the object.

Laid-pa'per. Paper made with a ribbed surface like that formerly made in the hand-frame.

Lam'bre-quin. 1. A curtain on the helmet to protect from the rays of the sun, like the cap with a valance named from the East Indian hero "Havelock."

2. A festooned drapery, forming an ornament at the upper part of a window, and covering the curtain rings and bar.

Lamb's Tongue. A plane with a deep, narrow bit for making quirks.

Lam'e-ro. A walled receiver, where the *slimes* (mud charged with auriferous or argentiferous particles, or both) are deposited from the arrastra, to part with a portion of their water, and accumulate till sufficient to form a *torta*, in which the amalgamation is performed. See AMALGAMATOR.

Lam'i-na-ted Arch. A timber arch made of successive thicknesses of planking bent on to a centering and secured together by tree-nails. See ARCHED BEAM.

The Ouseburn Viaduct of the Newcastle and Tynemouth Railroad, England, was erected on this principle. It is 108 feet high, and consists of 5 arches, each 116 feet span, and two stone arches at each end, 45 feet span.

Another bridge has 7 arches of 120 feet each.

Each arch has 3 segmental ribs, each of which has 30 deck deals, 3 inches wide, being 2 deals in width and 15 in height. The deals vary from 20 to 45 feet in length, and are laid so as to break joint. They are connected by oak treenails, each of which passes through 3 thicknesses. A layer of brown paper dipped in boiling tar is laid between thicknesses. The ends of the ribs are let into cast-iron shoes, which are fixed to the imposts of the masonry piers. The ribs are connected by diagonal braces and iron ties. The spandrels are strongly framed. All the wood-work was *kyanized*.

Lam'i-na-ted Pipe. Water, sewer, or gas pipe made of thicknesses of veneer or scale board successively wrapped to obtain thickness and strength. Each layer is thoroughly saturated with asphalt, and the grain of alternate layers passes in transverse directions, so as to secure an intimate bond and a line of resistance to disruption in any direction, lengthwise, oblique, or across the pipe circumference. The veneer is sometimes made to alternate with fabric or an adhesive composition.

Lam'i-na-ted Rib. An arched beam made of planks bent, laid flatwise in layers, and secured by bolts. See ARCHED BEAM.

Lam'i-nat-ing-ma-chine'. A gold-beater's rolling-mill for reducing the *ingot* of gold to such a thickness that a square inch will weigh 6½ grains. The ingot weighs 2 ounces, and is ¾ inch broad. The rollers are of hard steel, and extend the ingot to a *ribbon*. The gold is frequently annealed during the process.

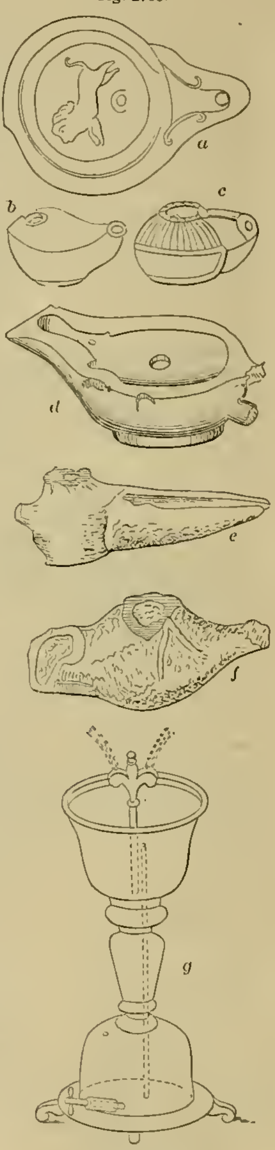
Lam'i-nat-ing-roll'er. (*Metal-working.*) One of a set by which a fagot or bloom is drawn out into a bar or sheet.

Lamp. A device in which an artificial light is produced by the burning of a wick saturated in oil or liquid fat.

Lamps were used before candles. The oil was conducted to the flame by means of a wick, before man learned to use the suet which hardened upon a wick and made a rigid rod of grease.

"The invention of artificial light has extended the available term of human life, by giving the night to his use; it has, by the social intercourse it encourages, polished his manners and refined his tastes, perhaps, as much as anything else, has aided his intellectual progress." — DRAPER.

Fig. 2788.



Ancient Lamps.

Lamps were used in early ages in all the ancient civilized countries, China, India, Egypt, Greece, and Rome. Many beautiful forms from these countries are to be found in collections: especially from the excavations of Pompeii. Sepulchral lamps were commonly placed in tombs, and have thus been preserved in many cases.

Homer makes no mention of them, though they had been long in use in Egypt, and it is understood that he had seen the Thebes he portrayed. The upper three figures, *a b c*, are representations of Egyptian lamps found in the tombs. The constellation Leo, shown upon the largest lamp, was *the* favorite sign in Egypt, for then Osiris (the Nile) came forth and embraced all the fertile land of Egypt even unto the desert, and retiring left the fertile deposit, from which sprung all the productions of the country.

d e f are ancient European lamps.

The Egyptians, according to Clemens Alexandrinus, were the first who used lamps in their temples. Green porcelain lamps were found in the great pyramids of Ghizeh and Sakkarah. The festival of Isis at Busiris was called the Feast of Lamps. The lamps had wicks floating in oil which rested on salt-water. They were used in the tabernacle and in the temple of the Jews.

In Hero's "Spiritalia," 150 B. C., is a description of a lamp (*g*) in which a supply of oil from a reservoir below is driven up by means of air introduced into the base by an air-pump. In another form of Hero's lamp, the oil is raised by water, introduced below the oil by means of a pipe.

"Al-mansúr first caused wax to be burnt in the interior [of the mosque of Cordova] in addition to oil, thus combining the effect of both lights." — Makkari's (Arabic) "History of the Mohammedan Dynasties of Spain."

For varieties, see under the following heads: —

Annealing-lamp.
Aphlogistic-lamp.
Argand-lamp.
Astral-lamp.
Carcel-lamp.
Car-lantern.
Clock-work lamp.
Davy-lamp.
Dobereiner's lamp.
Electrical lamp.
Fountain-reservoir lamp.
Frost-lamp.
Hydrogen-lamp.
Hydrostatic lamp.
Lamp-stove.
Lantern.
Magnesium-lamp.
Mechanical lamp.
Miner's lamp.
Monochromatic lamp.
Petroleum-lamp.
Pump-lamp.
Safety-lamp.
Signal-lamp.
Singeing-lamp.
Sinumbra-lamp.
Solar-lamp.
Street-lamp.
Student's lamp.
Submarine lamp.
Sun-burner.
Switch-lantern.
Tar-lamp.
Vapor-burner.
Vapor-lamp.

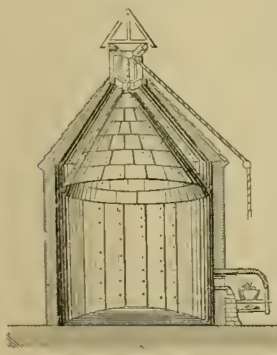
Lamp'black. A black pigment, consisting of pure charcoal, the particles of which are in a very fine state of division. It is principally prepared from refuse tar, resin, or turpentine, though it may be produced from a variety of other substances, animal and vegetable.

The tar, resin, etc., is burned in iron pots or a furnace, a quantity of air just sufficient to support combustion being admitted, in order to produce a dense smoke with little flame.

The smoke is let into cylindrical iron chambers, lined with sheepskin, woolen cloth, or canvas. Each chamber is provided with a roof fitting within it and suspended by a pulley and chain. This is lowered occasionally, scraping the lampblack from the sides of the cylinder, and depositing it on the bottom, whence it is removed through a small door by means of a hoe or scraper. A series of chambers may be used, communicating with each other by horizontal passages. In this case the roof of the last is partially open at top to permit a draft. The black deposited in this is the finest of all, but contains more or less resinous and oleaginous matter. This is removed by heating the black to a red heat in cast-iron boxes with close covers, and maintaining it at that temperature for two or three hours.

Ivory-black, largely used as a pigment, and bone-black, employed in refining sugars, are produced from animal bones. A bluish black, termed peach-black, is derived from the combustion of peach kernels.

Fig. 2789.



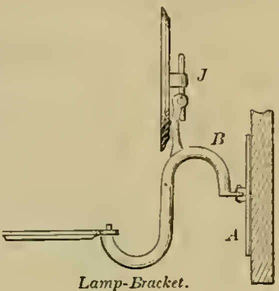
Lampblack-Furnace

Lamp'black-fur'nace. A cylindrical chamber lined with sheepskin or canvas, and having a conical top. The top is provided with a cowl through which the more volatile products of combustion escape, the carbon adhering to the lining of the chamber. At one side is a smaller communicating compartment provided with a grate, on which a vessel containing the hydrocarbon, resin, coal-tar, or similar substance, is placed, and heated by a fire beneath.

When a sufficient quantity of black has accumulated, a cone, having a small perforation at its summit, suspended within the main chamber, is lowered, scraping off the deposit accumulated on the lining, and causing it to fall to the bottom, whence it is removed by a suitable implement. In this state it contains resinous, bituminous, and other impurities, which are driven off by heating to redness in a close vessel, leaving nearly pure charcoal in an extremely comminuted state.

Lamp-brack'et. A branch extending from a wall or pillar, to hold a lamp. *C* is the ring for the lamp-bowl, *K* the reflector which slips on the pin *J* of the bracket *B*, which is hinged to the plate so as to swing horizontally.

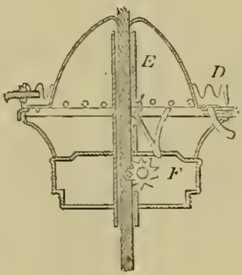
Fig. 2790.



Lamp-Bracket.

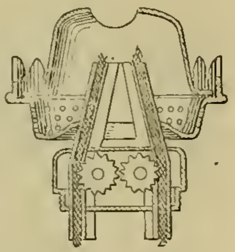
Lamp-burn'er. The portion of a lamp at which the wick is exposed and ignited. It has devices for adjusting the wick, and its crowning portion is usually such as to deflect a current of air upon the wick to insure a more perfect combustion. In the example, *F* is the wick-raising wheel, *E* the wick-tube, *D* the gallery for the flanged foot of the lamp-chimney.

Fig. 2791.



Lamp-Burner.

Fig 2792



Double-Wick Burner.

In Fig. 2792 the wicks in the two curved tubes are raised simultaneously by two serrated wheels, which mash together. The air passes upward both within and outside the wick-tubes.

Lamp-ce-ment'. A cement for brass mountings on glass, such as on lamps, is made by boiling resin 3 with caustic soda 1 in water 5, thus making a kind of soap, which is mixed with half its weight of plaster of paris, zinc-white, white-lead, or precipitated chalk. It is unaffected by petroleum or similar burning-fluids.

Lamp-chim'ney. The glass funnel which increases the draft and protects the flame of a lamp.

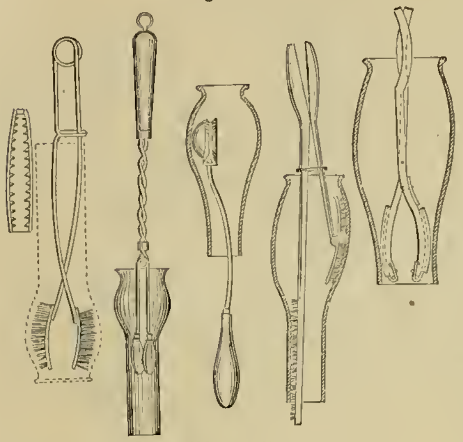
L'Ange invented the lamp-chimney. He added it to the tubular wick and central air-tube of Argand's lamp, and perfected the invention.

Lamp-chimneys are usually of glass, but have been made of mica, metal with mica windows, horn, and porcelain. Their forms are various, from the straight cylinder of the German student's lamp to the obese bulb of commoner varieties. They have also been made in various convoluted and spiral forms, designed to give greater liberty of expansion with changes of temperature. They have also been split longitudinally, spirally, and made with holes, the intention being in each case to make them less liable to fracture by heat or a blow.

Lamp-chim′ney Ad-just′er. A means for raising and lowering a glass lamp-chimney in order to modify the draft, or to allow the wick to be snuffed without lifting off the chimney.

Lamp-chim′ney Clean′er. (*Domestic.*) A pad or brush for cleaning the chimneys and glasses of lamps. It is usually made expanding, so as to bear upon opposite portions of the inside. A few of the many varieties are shown in Fig. 2793.

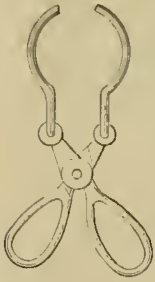
Fig. 2793.



Lamp-Chimney Cleaners.

Lamp-chim′ney Tongs. An implement for grasping a hot lamp-chimney and removing or replacing it.

Fig 2794.



Lamp-Chimney Tongs.

Lamp-cone. A dome-shaped or conical cap, with a slit for the flame, and placed over and around the wick and wick-tube of a lamp, to concentrate the current of air at throat of the cone. See LAMP-BURNER.

Lamp-el′e-va-tor. A means of adjusting the hight of a suspended lamp in a room. It usually has a telescopic tube, lazy-tongs, or pulleys and chains, with counterweights. See DROP-LIGHT.

Lamp-hang′er. A means of suspending a lamp, consisting of a ring and chains, or other device.

Lamp-post. A stand for a street-lamp, usually adapted for gas; the pipe rises inside the hollow post, with a burner on top surrounded by a glazed lantern.

Lamp-posts are made to subserve other purposes, such as holding basins for drinking-fountains, the water being conducted up the hollow of the post. Through the same may also pass the wires whereby the jet of gas is lighted by electric action.

Lam′pro-type. (*Photography.*) A polished collodion picture; from the Gr. *lampros*, beautiful.

Lamp-shade. A screen placed above the light to intercept or mellow it. It may have a dark exterior and reflecting interior surface. In the list below are some comparisons of transparent and partially opaque materials.

Loss of Light by Use of Shades and Colored Media.
(F. H. Storer and Allan Stevenson.)

Glass, etc.	Thickness. Inches.	Loss. Per cent.
American enameled . . .	$\frac{1}{16}$	51.23
Crown	$\frac{1}{8}$	13.08
Crystal plate	$\frac{1}{8}$	8.61
English plate	$\frac{1}{3}$	6.15
Porcelain transparency . . .	$\frac{1}{16}$	97.68
Parisian pink tinge . . .		57
Deep red		80
Window-glass	$\frac{1}{16}$	4.27
Window-glass (green) . . .	$\frac{1}{16}$	81.95
Window-glass (ground) . .	$\frac{1}{16}$	65.75

The shade is usually supported from the lamp-stem or around the base of the burner by means of a three-branched frame known as a *shade-holder.*

Lamp-stove. One in which the heat is obtained by the burning of oil in wicks beneath the kettle, oven, or what not.

Lamp-wick. The capillary or foraminous material which conducts oil or grease to the part where it is consumed in the flame.

Wicks are usually of woven fiber, — cotton, for instance, — but have been made of muslin, paper-pulp, asbestus, biscuit of fire-clay, etc.

The tubular lamp-wick was made for the Argand lamp, to admit air to the inside of the flame as well as the outside. Wicks are also made flat, to admit air to each side of a flat, comparatively thin flame.

The tubular wick for candles, in imitation of the wick of the Argand lamp, has been patented six times in England. Candle-wicks are also made flat; double, with space between, to bend out in burning; wick woven or wound spirally; plaited wire enclosed in longitudinal threads; woven with asbestus; parallel threads laid longitudinally; wicks coated with various materials, such as resin, stearic acid, silicate of soda, size, glue, oil, or in solution of alum, salts of bismuth, borax, chlorate and nitrate of potash, ammonia, sal ammoniac, acetates of lead or zinc; wicks which bend out of the flame in burning; stationary wicks to which candle is raised; double, triple, compound, and multiple wicks; flat wicks, made hollow by folding around a wire; candles with several small wicks.

Lamp-wick Trim′mer. A pair of scissors or nippers specially designed for cutting off the charred tops of wicks without dropping the snuff.

Lan′cas-ter Gun. A cannon with a twisting, slightly oval bore and conoidal projectile.

Lan′cas-ter Ri′fle. One with an elliptic rifling, the bore being slightly oval in section. The twist is one turn in 32 inches, which is the length of the barrel; bore, .498 inch; eccentricity, .01 in half an inch. The lateral expansion of the bullet causes it to fill the bore. Length of bullet, 2½ diameters with a windage of 4 thousandths, and has a paper patch, — the first of its kind. Named from the inventor.

Lance. 1. (*Weapon.*) A weapon consisting of a long shaft with a sharp point, much used, particularly before the invention of fire-arms. It was the principal weapon of the Macedonian phalanx, and the Roman infantry were armed with it as well as with the *pilum* or javelin.

In the Middle Ages it was held in the highest repute by knights and men-at-arms who formed the main strength of European armies; it was gradually superseded by the invention of gunpowder.

The lance used by knights of the Middle Ages was of a peculiar form. Near the lower end the shaft was very thick, with a deep opening in which the arm was placed when the lance was put in rest preparatory to a charge. Immediately in front of the opening, the shaft was from a foot to a foot and a half in diameter, and sloped off towards the upper end, which was from a half-inch to three quarters in diameter.

From this weapon the cavalry of the Middle Ages took their name. A *lance* denoted a man-at-arms (horseman completely armed) with four or five attendants. Among the French in the fifteenth century these attendants consisted of three archers, one *coutilier* (so named from the long broad dirk in his belt), and one page or varlet (mod., *valet*). The introduction of fire-arms gradually led to the disuse of the lance in Western Europe, though it continued in use among the Poles, Russians, and other Sclavonic tribes, as well as the Turks, Tartars, and kindred nations. Frederick the Great introduced lancers into the Prussian army, and was soon followed by the Austrians, who term them *Ulans*, and they have been since introduced into all or most of the armies of Europe.

The lances now in use among the European cavalry have a shaft of ash or beech-wood from 8 to 16 feet long, with a steel point 8 or 10 inches long, and to prevent this from being cut off by a saber stroke, the shaft is guarded by a strip of iron on each side from one and a half to two feet long. The other end has an iron cap to prevent splitting. The point has a small pennon, intended to frighten the enemy's horses. When not in use, the lance is carried in a leathern shoe by the right stirrup, dependent by a leathern thong on the right arm. In use, it is carried under the right arm. Their attempted introduction into the American service in the Army of the Potomac was not a success.

2. (*Pyrotechnics.*) Lances are small paper cases, filled with composition, and attached to light frames of wood or bamboo to mark the outlines of the figures in pyrotechnical devices. Various chemicals are used to give the desired color to the flame, viz. : —

For white : 26 niter, 9 sulphur, 5 mealed powder.

For yellow : 8 nitrate of soda, 2 sulphur, 2 mealed powder, 1 lampblack.

For red : 30 nitrate of strontia, 16 niter, 10 sulphur, 7½ mealed powder.

For blue : 4 niter, 1 sulphur, 2 sulphate of copper, ammoniated.

For green : 12 niter, 8 sulphur, 1 lampblack, 24 nitrate of baryta.

3. (*Carpentry.*) A pointed blade, usually employed to sever the grain on each side of the intended path of a *chipping-bit* or *router*.

It is used in *crozes*, *planes*, and *gages* of certain kinds.

Lance-buck'et. (*Cavalry.*) The shoe in which the butt of a lance is carried by the troopers of certain bodies of cavalry.

Lan'cet. 1. (*Surgical.*) An instrument for bleeding.

a, *gum* lancet with three blades of different shapes.

b, *vaccinating* lancet, spear-shaped.

c, needle-pointed vaccinating lancet.

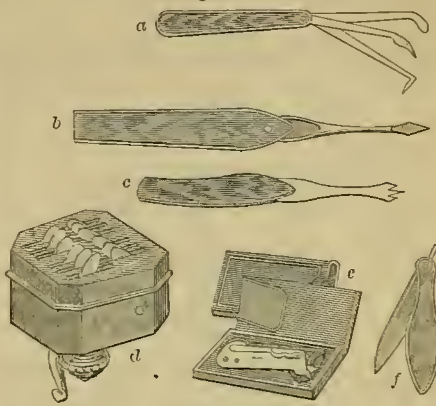
d, *scarificator* for lancing the skin preparatory to cupping.

e, *spring*-lancet for bleeding, consists of a spring, trigger, and blade. The spring is cocked, blade adjusted to the vein, and by pressing the trigger the blade operates instantly. Shown in its pocket-case.

f, *thumb*-lancet, so called from the manner of holding it.

The discovery of minute vessels, termed *lacteals*, which absorb a white liquid, the *chyle*, and pour it into the blood, was made by Aselli, in 1622. Their presence had been noticed by Eristratus in the time of Ptolemy, but their function was not understood. Aselli described them in his *De Venis Lacteis*, Milan, 1627. This work is remarkable as being the first anatomical work illustrated by colored plates. The arteries and veins in red, the lacteals in black.

Fig. 2795.



Lancets.

The smaller circulation of the blood, that from the heart through the lungs and return, was observed by Servetus. He was burnt October 27, 1553, at Geneva, by the order of the city council of Geneva, aided by one who had barely escaped the same fate, and knew better. The pulmonary circulation was distinctly described by Realdus Columbus in his *De Re Anatomica*, published in 1559, and by Andrew Cæsalpinus, who also noticed the refluent motion of the blood in the veins. Sylvius noticed the venal valves. Fabricius, of Acquapendente, noticed that they all opened *towards* the heart.

William Harvey, born in 1578, studied at Cambridge, and under Fabricius at Padua, and made the discovery of the nature of the arterial and venal circulations, and the complete double circulation, in 1616.

Lancets of copper were disinterred in Pompeii in 1819, in the house of a Roman surgeon in the Via Consularis. They were in company with a probe, bullet-hook, catheters, forceps of various kinds, needle, lever for raising depressed bones, cautery, spatulas, etc.

2. (*Metal-working.*) The tapping-bar of a metal furnace.

Lan'cet-arch. (*Masonry.*) An arch with a sharply pointed top. See Arch.

Lan'cet-win'dow. (*Architecture.*) A high, narrow window terminating in a very pointed arch. It is characteristic of the style of Gothic known as Early English.

Land. 1. (*Milling.*) That part of the face of a millstone which is not furrowed ; that which intervenes between the furrows.

2. (*Agriculture.*) The unplowed portion of a field as distinguished from the furrow and the plowed portion.

3. (*Fire-arms.*) That portion of the bore of a rifle which is not occupied by the grooves.

4. (*Steam-engine.*) The unperforated portion of the face-plate of a slide-valve.

5. (*Nautical.*) The lap of the strakes in a clincher-built boat. Also called *landing*.

Lan'dau. (*Vehicle.*) A carriage with a folding top, called from Landau in Germany, where they were originally made.

Lan-dau-let′. A chariot opening at top.

Land′ing. 1. A pier, wharf, or jetty, for disembarking passengers.

2. The platform of a railway station.

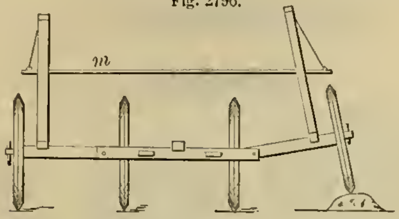
3. The platform of a furnace at the charging hight.

4. A level space at the top of a flight of stairs.

Land′ing-strake. (*Nautical.*) The upper strake but one, of a boat.

Land-mark′er. A machine for laying out rows for planting. In the example, the vehicle has four angular-tired wheels, which are at the required distance apart, say 44 to 48 inches, for planting corn, according to latitude and kind of corn. *m* is the driver's seat, supported on posts on the outer sections.

Fig. 2796.

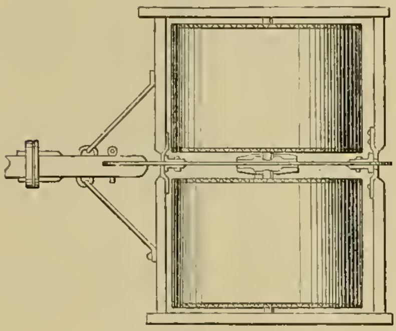


Land-Marker.

Land-par′ing Ma-chine′. A machine for cutting sods and turfs at a regulated distance beneath the surface. A form of plow.

Land-roll′er. One for leveling ground and mashing clods in getting land into tilth for crops.

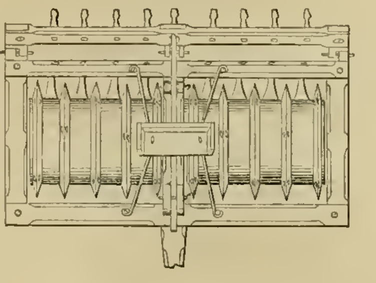
Fig. 2797.



Land-Roller.

In the example, the rollers are so coupled together that they may travel in different planes, and are left free to pass over obstructions independently. The roller in two parts is turned readily, as one may revolve in one direction and the other in the other direction in turning short at the end of a bout.

Fig. 2798.



Land-Roller with Seeder.

Fig. 2798 is a roller with circumferential ridges to break clods, and has a seeding device at the rear.

Land′side. (*Plow.*) The flat side of a plow, towards the land. The lower portion is a bar extending back from the share; and the upper portion is a plate attached to the sheth and the landside handle.

Land-tie. A rod securing a face-wall to a bank. See PILE.

Lan′gate. A linen roller used in dressing wounds.

Lan′grel. (*Weapon.*) A kind of missile formerly used to destroy the rigging of an enemy's vessel.

It was a cylindrical cage or bundle to fit the bore of the gun, and was filled with bolts, nails, and chunks of iron.

Lan-guet′; Lan-guette′. 1. (*Music.*) (Fr. *langue*, tongue.) The tongue of a metallic organ-pipe of the mouth or flute kind. It nearly closes the area of opening in the pipe at a point opposite to the slit, so as to compel the air entering at the lower end of the pipe from the bellows to pass towards the slit which forms the *mouth*. The issuing sheet of air impinges against the metal bounding the upper edge of the slit, so as to divide against the *lip*, and acquire a vibration which is communicated to the column of air in the tube, producing a musical note. See MOUTH-PIPE; PIPE.

2. A thin *tongue* of metal placed between the blades of a comb-cutter's saw, to preserve their distance.

3. A small piece of metal on a sword-hilt which overhangs the scabbard.

Lan′iard. (*Nautical.*) A cord or line for seizing objects on board ship. See LANYARD.

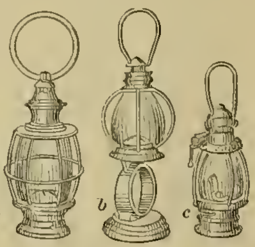
Lan′tern. 1. A case with transparent sides or panes for holding and protecting a luminous body.

The *hand*-lantern (*a*), *arm*-lantern (*b*), *breast*-lantern (*c*), are named from the modes of carrying them.

They are known on board ship by their position or duty; as, *poop*-lantern, *powder-room* lantern, etc.

Perhaps the original lantern is to be found in some varieties of fireflies, in which the phosphorescent light, like Alfred's lantern (A. D. 890), is protected by a horny covering. The ordinary American firefly and the glow-worm have integuments over their little bunches of brilliancy.

Fig. 2899.



Lanterns.

Some species of nocturnal moths sail through the dark oceans of night, carrying lanterns at their prows in the shape of eyes, which, black or brown by day, become glowing sparks in the gloom.

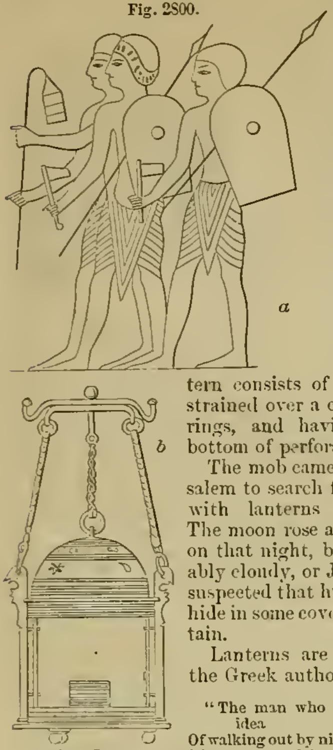
It may not be entirely out of place to class some of these natural lights among the "electric lights." Some of them are intermittent, and we suppose them to be urged into brilliancy by what we call a Voltaic impulse from the battery, the brain.

The *dark*-lantern is arranged to display or hide the light, as may be required. It is used by policemen and by burglars.

The *magic*-lantern is a mode of displaying pictures, which are made to slide between a light and a lens, their image being thrown upon a screen.

Perhaps the earliest example of a lantern is in a sculpture at Alabastron, Egypt (*a*, Fig. 2800), representing a patrol on its rounds, two soldiers being armed with spears, shields, and battle-axes, and a third one carrying a lantern a little in advance. The panes were probably of talc, the lapis specularius of the Romans.

Fig. 2800.



Ancient Lanterns.
a, Egyptian ; b, Roman.

The modern Egyptian lantern consists of a waxed cloth strained over a cylinder of wire rings, and having a top and bottom of perforated copper.

The mob came out from Jerusalem to search for the Saviour with lanterns and weapons. The moon rose at about 6 P. M. on that night, but it was probably cloudy, or Judas may have suspected that his master would hide in some covert on the mountain.

Lanterns are referred to by the Greek authors : —

> "The man who first invented the idea
> Of walking out by night with a lantern,
> Was very careful not to burn his fingers."
>
> ALEXIS.

> "So taking out the candle from his lantern."
>
> *Ibid.*

> "A well-lit horn lantern."
>
> EUMELUS : quoted by ATHENÆUS, A. D. 220.

The lanterns of Epictetus and Diogenes will not be soon forgotten. See also CANDLE.

Lanterns are referred to by the Roman authors Plautus, Martial, and Pliny ; have been disinterred at Herculaneum and Pompeii. In the latter place, one was found in the vestibule of a house alongside a skeleton ; the person was evidently trying to escape in the thick darkness of the descending ashes. We read of the use of lanterns in the games of the circus, the sacred games of Greece, in augury, and by the military. In the latter case, the Roman soldier carried the lantern on a pike, as did the Egyptian ten centuries previously, and how much anterior to that time we do not know.

The Roman lantern (*laterna*) was usually of bronze, with panes of bladder, horn, mica, parchment, oiled silk, or sometimes, under the emperors, of glass.

One is shown at *b*, Fig. 2800. It is cylindrical. The bottom plate has three balls for feet, and three posts for suspension. The metal is bronze. Within is a lamp of the same metal. The interior was reached by raising the hemispherical cover.

A great ship-lantern hanging by the poop of a vessel appears on Trajan's column.

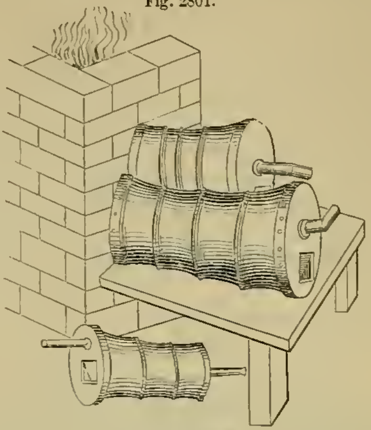
Alfred the Great had a horn lantern around the graduated candle which was his time-measurer.

2. The light-chamber on top of a lamp-post.

3. The upper member of a lighthouse containing the light.

4. (*Architecture.*) A small cupola or dome-topped structure on a roof or tower. A *tholus.* The tholus of the United States Capitol is illuminated by a cluster of burners lighted by electricity from the level of the rotunda floor, 264 feet below.

Fig. 2801.



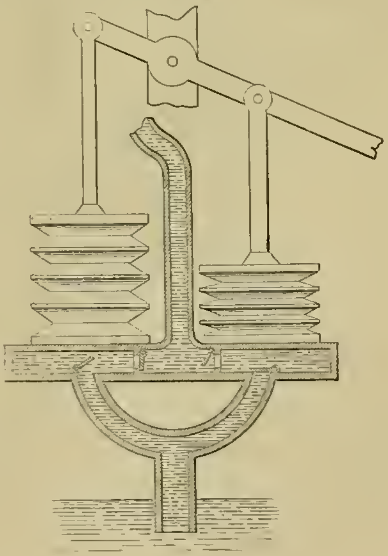
Lantern-Bellows.

5. A trundle-wheel. A *wallower.* See LANTERN-WHEEL.

6. (*Calico-printing.*) A certain description of apparatus by which steam is applied to cloths in order to fix the colors with which they have been printed. The colors consist of a mixture of dye-extracts and mordants. The lantern has a frame with tenter-hooks, from which the cloth is suspended in a zigzag manner ; and a penthouse, with a pyramidal roof encloses the frame and cloth, shutting in the steam around them.

7. (*Founding.*) A hollow, perforated core of large diameter relatively to its length.

Fig. 2802



Lantern-Pump

Lan'tern-bel'lows. So called from its resemblance to a paper lantern.

Air is admitted through an inwardly opening valve at the outer end of the bellows in the action of drawing it out, and expelled by pushing it in by means of the handles operated (in the example) by the right and left hands of the workman, their alternate action causing a continuous blast. They may be arranged to be operated by the feet. This apparatus is of great antiquity, and is still in general use in Asia and Egypt.

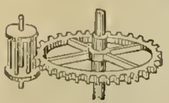
Lan'tern-pin'ion. A pinion of rundles between disks mashing into the cog-wheel of some kinds of horse-powers. See LANTERN-WHEEL.

Lan'tern-pump. One having a pair of disks at the ends of a flexible cylinder, like a Chinese lantern. See BAG-PUMP.

Lan'tern Stuff'ing-box. A long stuffing-box with tightening bolts, used in some marine-engines.

Lan'tern-wheel. This is allied to the cog-wheel, the bars or spindles which connect the parallel heads being so spaced and proportioned as to engage with the cogs of the spur-wheel. It is a cheap form of wheel, and is seldom used where facilities are at hand for making better. It bears the relation of a pinion to the spur-wheel. It is sometimes called a *wallower* or *trundle* wheel, from the *trundles* or rundles of which it is made.

Fig. 2803.



Lantern-Wheel.

Lan'yard; Lan'iard. (*Nautical.*) A cord, line, gasket, or sennit, for seizing or lashing objects on board ship; as, —

The rope which passes through the *dead-eyes*, *hearts*, or *thimbles*, used in setting up *shrouds* or *stays*.

The lanyards of the cat-hook; the *fish-tackle*.

The lanyards of the buoy; the *lashing*.

The lanyards of stoppers, etc.

A lashing for securing the gun-ports; fastening spars in their *beckets*; boats to the ring-bolts on deck; the *hatches* to the *coamings*; the binnacle in its place; suspending the hammocks from the hooks of the deck-beams.

(*Ordnance.*) A strong, double-twisted twine about 2 inches in diameter, 12 feet long, and having a hook at one end and a toggle at the other. It is used to pull the trigger of the gun-lock of a piece of ordnance, or to jerk the friction tube, according to the modern plan of firing cannon.

Lap. 1. (*Grinding and Polishing.*) A wheel, disk, or piece of soft metal used to hold a polishing powder, as in cutting and polishing gems. Hence the term "*lapidary's* art." It is usually a rotating wheel on a vertical or horizontal axis, with a working face or periphery respectively.

Laps are made of various metals and alloys, such as *brass*, *cast-iron*, *copper*, *lead*, and *pewter*.

Brass is used by opticians with emery and water, for smoothing lenses and speculums.

Cast-iron is used with sand or emery in many trades; by glass-grinders, opticians, etc. The cast-iron *lap* of the lapidary is called a *skive*, and is charged with diamond-powder.

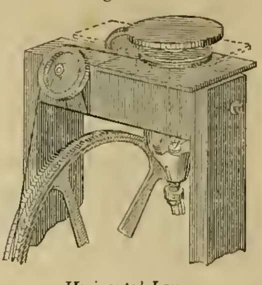
Copper is used by machinists, by lapidaries, glass-grinders, and glass-engravers. It is usually charged with emery.

Lead and its alloys are used by machinists, cutlers, lapidaries, jewelers, watchmakers, etc. It is charged with emery, rottenstone, crocus, etc.

Tin, *zinc*, and their alloys are also used.

The powder in either case is burnished into the metal, the latter merely forming a vehicle for the abradant or polishing-powder.

Fig. 2804.



Horizontal Lap.

Lead *laps* sometimes consist of a disk of metal, secured by a screw-nut against a shoulder on the spindle, but are better cast upon a perforated iron plate, which gives rigidity to the *lap*, while the soft lead or pewter allows the grinding-powder to be imbedded therein.

Some adopt a disk of wood with a leaden tire cast around it.

The cutler's *lap* is cylindrical, and has a wooden center made in several pieces, the grain of the wood presented outwardly, and the disks of which it is composed fastened by circular plates at the ends. The wooden center is turned to the required width, and has a groove in the middle of the face and chamfers at the edges to hold the metallic rim which is cast thereon. This is composed of tin 1, and lead 4 or 5 parts. The edge is then turned true, and is prepared for use by a dressing of emery and oil. Also known as a *glazer*.

This wheel may be used for grinding or polishing, by having regard to the kind of emery, the degree of pressure, and the mode of holding the article. See GRINDING-MATERIALS.

2. (*Steam-engine.*) *a.* Lap of the slide-valve on the steam side is the space which it advances beyond the opening of the steam-port after it has closed it, and is given for the purpose of causing the engine to work expansively, by cutting off the admission of steam before the end of the stroke. *Inside lap.*

b. Lap on the exhausting side of the piston causes the passage to the condenser to be closed before the end of the stroke, the piston being then said to be *cushioned* by the elasticity of the confined vapor upon which it descends. *Outside lap.*

3. A plate covering the line of junction of two iron plates which make a *flush-joint*, and to which they are both connected by solder or lines of rivets. See CARVEL-BUILD.

The usual lap of iron plates in ships is from 5 to 6 diameters at double-riveted joints, and about 3 diameters at single-riveted joints.

4. (*Roofing.*) The distance which the tail of a shingle or slate overlaps the head of the second course below. The overlap on the course immediately below is the *cover*. The exposed portion is the *margin*; the width of the *margin* is the *gage*. The *gage* with shingles is about one third of the length, so that two thirds is *cover*. The *gage* of slates is something under one half the length. The excess over twice the *gage* is the *lap* or *bond*.

5. (*Masonry.*) The overlay of a stone in a wall on its bedstone.

6. (*Fiber.*) A layer or continuous band of cotton fiber made into *batting*, and wound or lapped upon an axis or roller ready for carding.

The sheet of cotton as it enters the carding-machine. As it comes therefrom it is called the *fleece*.

Lap'ar-a-tome. An instrument for performing laporotomy, or cutting into the abdomen in the region of the loins.

Lap-board. (*Tailoring.*) A board resting on the lap and hollowed out on the side next the user. Employed by tailors and seamstresses to cut out work upon.

Lap-dove′tail. (*Joinery.*) A form of *secret* or concealed dovetailing, which shows the thickness of the lap only on the return edge, where it has the appearance of a thin board. See DOVETAIL.

Lap-frame. (*Flax-manufacture.*) A machine in which several slivers of carded tow from the *breaker*, or first carding-machine, are united in a lap and wound on a bobbin, from which they may be fed to the *finisher*-card.

Lap′i-da-ry-mill. The grinding and polishing apparatus of the lapidary. See LAPIDARY-WHEEL; LAP.

Lap′i-da-ry-wheel. The art of diamond-cutting was probably known in China and India at an early day, but the stone was little known among the ancients of Europe and Western Asia. Other varieties of stones were mounted and used in great numbers. Pliny refers to gem-cutting: "How many hands are worn down that one little joint of our finger may be ornamented." The Arabians brought the diamond into notice. The discovery of the Brazilian mines in 1730 made it more common. Berghen of Bruges furnished the lapidaries' wheel with diamond-dust, enabling him to cut diamonds, as other stones were cut by the emery previously used. Diamonds were previously set in the rough. They are now cut into *brilliants* or *rose-diamonds.* See BRILLIANT; DIAMOND.

The plano-convex lens of rock-crystal found at Nimroud by Layard showed the marks of the lapidary's wheel. The seals of this wonderful nation required the lap to reduce them to form. They were of various hard materials, such as amethyst, agate, etc., gems and semi-gems. See SEAL.

The wheels of the lapidary are of two kinds.

The *slicer*, which is a thin iron wheel touched with diamond-dust, and used like a circular saw.

The *lap* or horizontal wheel, called a *mill*, whose flat face is touched with materials of a hardness adapted to the subject and to the stage of the work.

The operations are called *cutting*, *grinding*, or *polishing*.

The *mills* are known as *slitting*, *roughing*, *smoothing*, or *polishing*.

The materials of the *mills* are *iron*, *lead*, *tin*, *willow*, *mahogany*, or of wood covered with *list* or *leather*.

The abrading materials are *diamond-dust*, *sapphire*, *ruby*, *corundum*, *emery*, *rottenstone*, etc.

Slicing by a circular saw or *splitting* in the lines of natural cleavage are resorted to when admissible.

The *slitting*-wheel is usually of *iron* touched with *diamond-dust.*

The *grinding*-wheel is usually of *lead* touched with *emery.*

The *polishing*-wheel of tin touched with rottenstone. See DIAMOND-CUTTING.

Fig. 2805 is a view of the lapidary's bench, showing the crank, the driving-wheel, the lap, and the *gim-peg*, which latter has holes in which rest the upper end of the *dopp*, on which the gem is cemented to be applied to the lap. The choice of holes determines the inclination of the *dopp*, and consequently the angle of the facet.

Carnelian, as an example, is first slit with the thin iron slicer, fed with diamond-dust, and moistened with brick oil; secondly, it is rough ground on the lead-mill with coarse emery and water; and, thirdly, it is smoothed either on the same lap rubbed down fine, or with a similar lap used with finer emery.

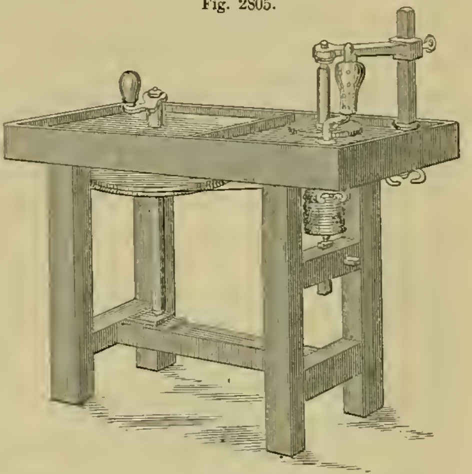
Carnelian, and stones of similar or superior hardness, which are not smaller than about one third of an inch in diameter, are polished on a lead-mill supplied with rottenstone and water. The face of the polishing-lap is *hacked* or *jarred*, to enable the powder to adhere. This *hacking* is done by holding a knife in a slanting position, so as to *chatter* upon the revolving lap and make small furrows therein, which hold the powder.

Smaller and harder stones are polished on a pewter lap, and still harder upon a copper lap.

Rounded stones, said to be cut *en cabochon*, are wrought by means of the *wooden-mill* with fine emery, the *list-mill* with pumice-stone, and *leather-lap* with putty-powder.

Faceted work on pastes and artificial stones, also carnelians, amber, jet, etc., are cut on lead-wheels with emery and polished on pewter with rottenstone. Gems of a somewhat harder kind use a pewter lap and fine emery for the cutting, and a copper lap with rottenstone for the polishing. For sapphires, the chrysoberyl, and some few other stones, a copper lap with diamond-powder is used for cutting the facets, and a copper lap with rottenstone for polishing them. Lastly, for the diamond, two stones are rubbed in a peculiar manner, the one against the other, to start the facets, and they are cut and polished by means of an *iron* lap or *skive* fed with diamond-powder, being cemented on a *dopp* and held upon the *lap* by means of a *gim-peg*, as above described. See also DIAMOND-CUTTING.

Fig. 2805.



Lapidary's Bench.

Substances treated by the lapidary like carnelian: agate, amethyst, aquamarine, beryl, blood-stone, Brazilian topaz, carbuncle, cat's-eye, chalcedony, chrysolite, chrysoprase, crystal, elvans, emerald, feldspar, flint, fluor-spar, garnet, granite, heliotrope, jade, jaspar, lapis-lazuli, marble, mina nova, onyx, opal, pastes, peridot, plasma, porphyry, quartz, sard, sardonyx, serpentine, topaz. See Feuchtwanger's "Popular Treatise on Gems."

La-pid′e-on. A musical instrument contrived by M. Baudry, made of flints and schist suspended from an iron frame, and struck with a flint hammer to produce the notes. The flints are about forty in number and elongated, but of various lengths and thicknesses. They are arranged in the order of their tone, and the labor and investigation of years were required before the complete scale was formed.

A correspondent of "Nature" writes that in roaming over the hills and rocks in the neighborhood of Kendal, near Lancaster, England, which are composed chiefly of limestone, he had often found what are called "musical stones." They are generally thin, flat, weather-beaten stones, of different sizes and peculiar shapes, which, when struck with a piece of iron or another stone, produce a musical tone instead of the dull, heavy, leaden sound of an ordinary stone. The sound of these stones is in general very much alike, but sets of eight stones have been collected which produce when struck a distinct octave. The new French scientific weekly, "La Nature," copies the communication from its English namesake, and brings forward some additional instances of the same phenomenon. It tells of a performer who played musical airs on rough flints suspended by silk threads, striking them with an iron rod. We are also informed of the accidental discovery of musical properties in a stone fountain at the French Institute. A distinguished musician, A. Elwart, having struck it with the palm of his hand, elicited "a musical sound corresponding with extreme precision to the perfect accord major of *fa* natural." The fountain in question is in the grand court of the Institute.

La′pis-laz′u-li. A rare ornamental stone of a deep blue spotted with a deeper blue, and intermixed with a few grains of gold.

Lap-joint. One layer overlapping the edge of another; as the *clincher*-build of boats. Illustrations are also found in *halving*, *scarfing*, and *caulking* of timbers (which see).

Lap-ma-chine′. (*Spinning.*) A *spreader*, *spreading-machine*, *blower and spreader*. See LAPPING-MACHINE.

Lap′ping. 1. Grinding or polishing on wheels whose metallic rims are provided with emery and oil.

Glazing is done on wooden wheels.

Polishing on leather-covered wheels.

Buffing on leather, with rouge.

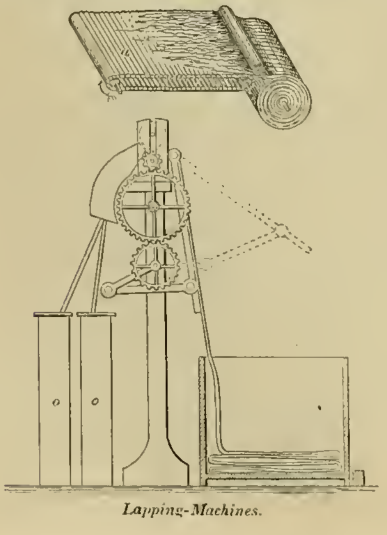
2. (*Spinning.*) Laying several fleeces or slivers together. See LAPPING-MACHINE.

3. (*Fabric.*) A machine blanket used by calico-printers.

4. (*Ordnance.*) Wearing away the land surface in a rifled gun to ease the entrance of the projectile.

Lap′ping-ma-chine′. (*Cotton Manufacture.*) *a.* A machine in which cotton is reduced to a downy condition, spread equally, subjected to a certain compacting pressure, and then wound in an even continuous wad (*wadding*) upon a roller, forming a *lap*.

Fig. 2806.



Lapping-Machines.

Prepared cotton may be spread upon the traveling apron *a*, in weighed quantities, covering a marked area, as between occasional black slats; or it may be formed into a *lap*, after a succession of scutching and blowing operations. See BATTING-MACHINE.

b. After cotton has undergone a preliminary carding in the *breaker*, from which it comes in the form of a thin fleece, several of these fleeces are joined to form one thickness.

In another form of *lapping-machine*, several cans *o o*, filled with a narrow fleece from the breaker-card, are placed in two rows, and the ends of the fleeces brought together between two rollers, the lower one driven by a wheel and pinion and the upper one pressed down upon the former by weights.

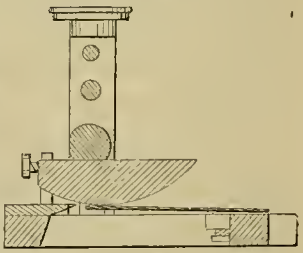
Lap-ring. An open ring in which the ends lap past each other without touching, so that it may form a connecting link for attaching the single-tree to the *clip* of the *double-tree*, or connecting the ends of a broken chain, etc. A *cotter* is a better device for the latter purpose, however. (See COTTER.) The *lap-ring* is somewhat like a *split-ring*, but the latter is elastic. The heavy material of the *lap-ring* precludes elasticity.

Lap-roll′er. (*Fiber.*) One in a lapping-machine, upon which the fleece or wadding is wound.

Lap-shav′er. A machine for shaving leather to a thickness by means of a knife set to a graduated distance from a roller or an edge over which the hide or piece of leather is passed. The term is derived from the old practice of shaving away inequalities by means of a knife while the leather laid upon a board in the lap.

Lap Skiv′ing-ma-chine′. A machine for scarfing off the thickness of leather towards the edge. In Fig. 2807, as the strap is drawn across the edge of the knife, the eccentric gage-block swings on its bearing and gradually descends, tapering the strap toward the end. Each part is adjustable to vary the operation within given limits.

Fig. 2807.



Skiving-Machine.

Lap-stone. A stone laid in the lap, and used as an anvil by a shoemaker in hammering his leather.

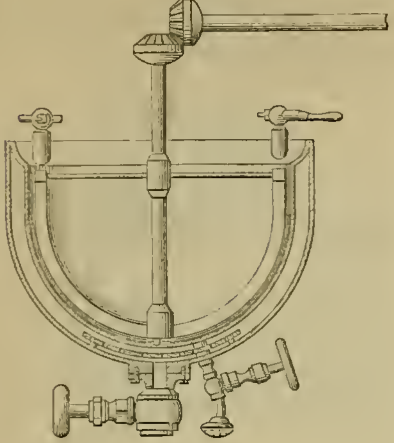
Lap-streak. A structure, usually in boats, in which each streak or plank *laps* over the one below it. *Clincher-built.*

Lap-weld. (*Forging.*) A weld in which the welding edges are thinned down, lapped, and welded.

Lar′board. (*Nautical.*) The left side of a vessel to a person standing on deck and facing toward the bow. From the Italian *quella borda*, that side; in contradistinction to *questa borda*, this side; abbreviated into *la borda* and *sta borda*. *Port* is now substituted for larboard, to give a greater difference in the sound of the word of command.

Lard-boil′er. A steam-heated pan in which the fat of hogs is boiled, to obtain the lard by the shrinkage and hardening of the membranes. In the example, the hemispherical boiler has double walls, with openings for the inlet of steam, the discharge of air and condensed water, and an exit opening, with a strainer for the lard. Stirrers revolve within the pan, and a perforated plate above the steam inlet distributes the steam upon the bottom of the pan. See also LARD-RENDERER; LARD-TANK.

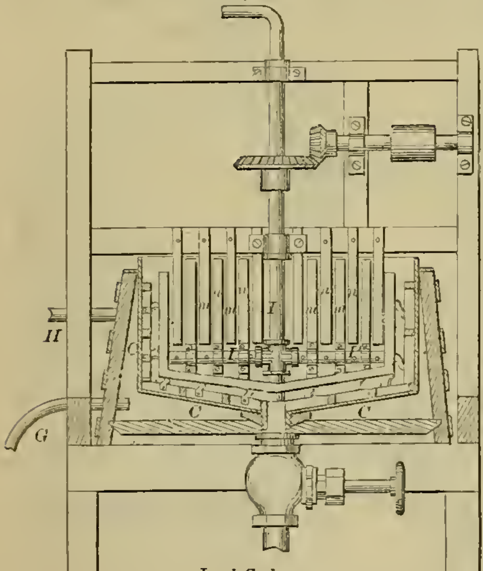
Fig. 2808.



Lard-Boiler.

Lard-cool'er. One in which rendered lard is artificially cooled. The inner vessel containing the lard is surrounded by a space *C* to be filled with cold water, passed in and out through pipes *H G*. Air is forced through a tubular shaft *I* into the inner vessel. Wooden scrapers prevent the cooled lard from accumulating on the sides of the vessel. Movable wooden slats *m* pass between fixed ones *n* to agitate the liquid contents of the inner vessel.

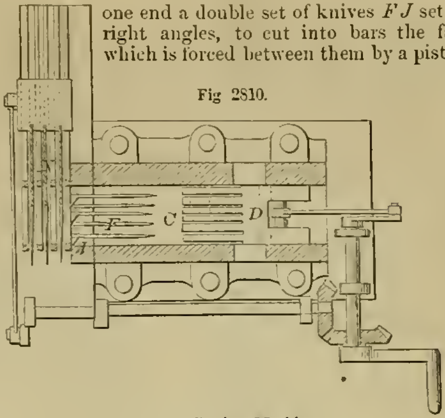
Fig. 2809.



Lard-Cooler.

Lard-cut'ter. One for cutting lard for rendering. This is usually performed by knives at a bench; but, in the example, a close trough *C* has at one end a double set of knives *F J* set at right angles, to cut into bars the fat, which is forced between them by a piston *D*. The bars are then cut into short pieces by knives *N* reciprocated transversely to the trough.

Fig 2810.



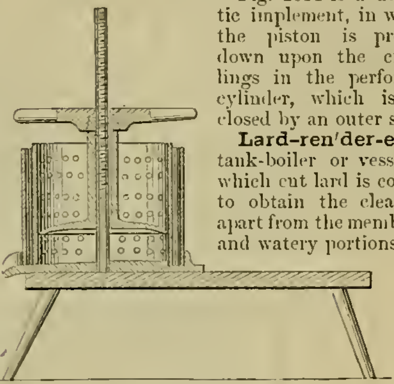
Lard-Cutting Machine.

Lard-press. A press in which cooked lard is pressed from the cracklings.

Fig. 2811 is a domestic implement, in which the piston is pressed down upon the cracklings in the perforated cylinder, which is inclosed by an outer shell.

Lard-ren'der-er. A tank-boiler or vessel in which cut lard is cooked to obtain the clear fat apart from the membrane and watery portions.

Fig 2811.



Domestic Lard-Press.

Lard-tank. A vat in which fats are cooked to obtain them free from watery matters and membrane.

Wilson's tank is a vertical cylinder with a charging hole at top; a steam-jacket and steam-coil for heating; try-cocks at different hights for examination of contents; discharge-cocks at different hights for drawing off the liquid oil and the water; discharge-hole, with cover at the bottom, to remove the solid matter from the bones and fibrine.

In Everett's apparatus (Fig. 2812) the digester, containing the fat, is surrounded by an outer shell constituting a hot-water and steam space, to which it is connected by stay-rods, which unite the water-space at bottom with the steam-space at top, and pass through the vertical flues *A B*. The vapors from the digester, charged with odors and organic matter, pass through a pipe at top of the apparatus into a super-heating coil over a furnace, into which they are finally discharged and consumed. A spiral flue surrounds the outer case of the boiler.

Broadnax's apparatus consists of an exterior casing of masonry in which the digester, which may be of the form shown either in the upper or lower figure, is placed. In the first it is stationary, and consists of an inner and outer shell, between which and through flues in the inner one *A A* the heat circulates. The rendered fat, in a fluid condition, descends from shelf to shelf, and is strained through the perforated bottom *C*, whence it is drawn off. The furnace has an inclined flue at each side, through which the products of combustion pass to and around the digester. Gases from the digester are delivered into the furnace. This may be effected, as shown in the first figure, by an air-pump *J* and condenser *K*, by which the gases withdrawn from the digester are compelled to pass through a cylinder, heated by a grate *P*, in which the watery particles are condensed by a series of plates *i j* and drawn off by a pipe; the dry vapor, ascending, passes through another pipe to assist in heating the furnace.

In the lower figure, the perforated digester *G* is mounted on trunnions and rotated by a crank; the oil exuding is strained through the diaphragm *E*, and the gases pass through the pipe *I* to the furnace. *H* is the charging manhole.

Large-face Lathe. (*Wood-working.*) A lathe for turning patterns of wheels, heavy moldings, and other large circular work. It has a hinged tool-rest on a bracket, which may be moved out of the way to allow the work to swing to the floor if necessary; or even larger work may be done by preparing a pit for the object to swing in.

Fig. 2813.

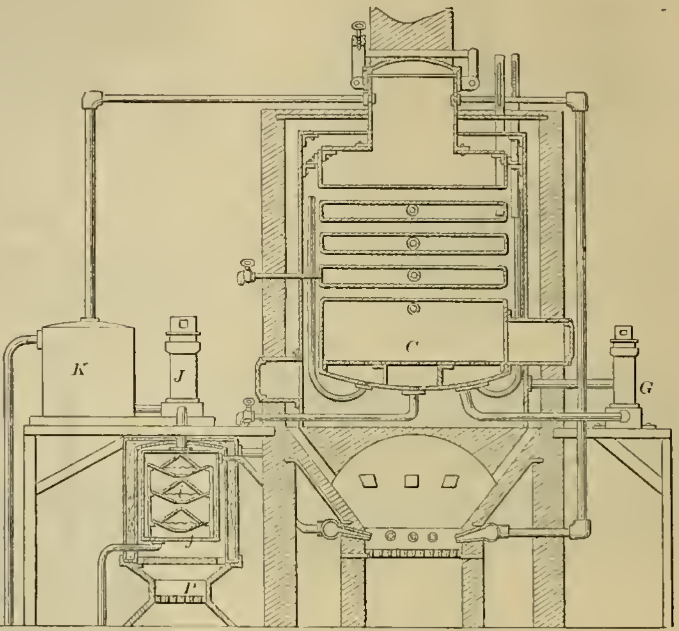
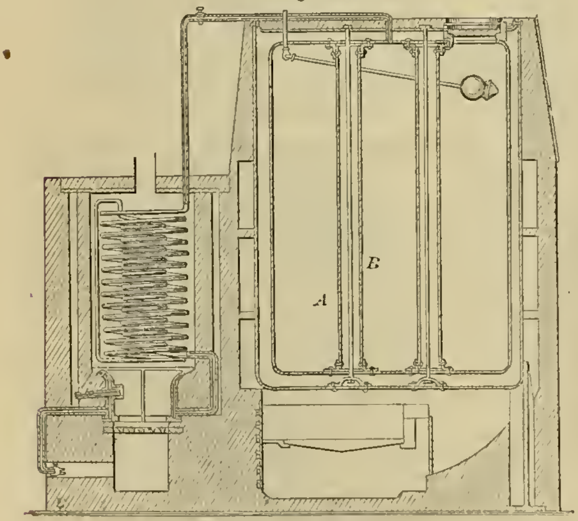
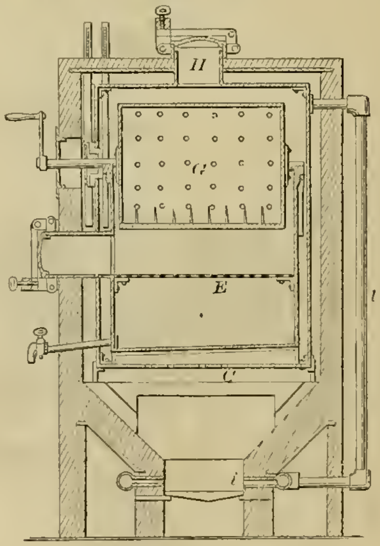


Fig. 2812.



Everett's Lard-Rendering Tank.



Broadnax's Lard-Tank.

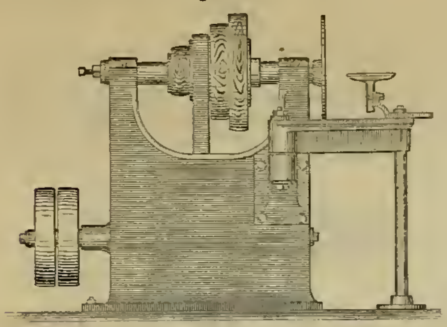
Lar'get. A piece of bar-iron, cut off to a length (and weighing say about 14 pounds for an average sheet), forming a blank to be heated and rolled into a sheet of iron. (English Spec. 14,244.) It is to the *sheet* what the *loop* is to the *bloom*, the *fagot* or *ball* to the *bar*.

Lar'i-at. A rope 1¼ inches in circumference and 30 feet long, used for picketing horses in camp. It is fastened to a ring on the picket-pin, which is driven into the ground, permitting the horse a limited circle to graze in.

Lar'mi-er. (*Architecture.*) The corona or dripstone of a doorway or window-way.

Lar'yn-ge'al E-cra'seur. (*Surgical.*) An instrument for extirpating abnormal growths of the larynx and epiglottis. It consists of a steel rod,

Fig. 2814



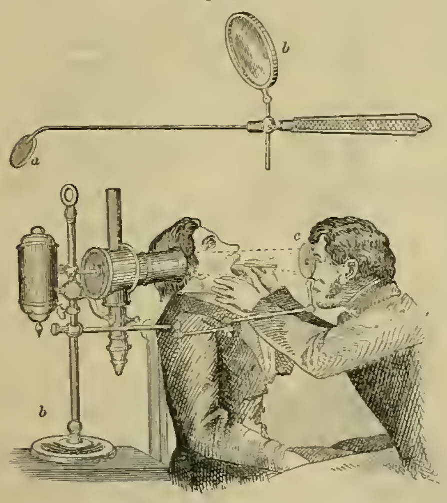
Large-Face Lathe.

about 8 inches long, curved, and fenestrated at one extremity. A wire loop is first passed around the object to be extirpated, is drawn through the fenestrum *slowly*, by means of either a screw or lever at the other end of the instrument, thus *crushing* it off.

By this method (ecrasion) the loss of blood is avoided.

La-ryn'go-scope. An instrument for obtaining a view of the larynx. It consists of a small plane mirror *a* on a long, slender stem, which is introduced to the back of the throat, and a *large* concave mirror *b* for reflecting light (solar or artificial). This last reflector may be either fixed to a stand or suspended from the forehead of the operator. An *inverted* image is seen in the *small* mirror. The upper figure is Elsberg's laryngoscope. When artificial light is employed, the patient should sit so that it is a little back of him and on his right side, as in Tieman's instrument (the lower figure). In this case, the light is reflected by a concave mirror *c* to the smaller mirror, which is held by the observer at the posterior part of the mouth, the uvula resting upon its back. By its means, the vocal chords of the interior of the larynx are exhibited, and have been photographed. One constructed by Dr. Turck in 1857 was modified and improved by Dr. Czermack of Pesth, 1856, who exhibited it in action in 1862, in London. Mr. John Avery of London is said to have constructed a similar apparatus in 1846.

Fig. 2815.



Elsberg's and Tieman's Laryngoscopes.

La-ryn'go-tome. Laryngotomy, or the opening of the larynx, was practiced by the ancients in quinsey. It was recommended by the Greek and Arabian physicians, by Galen and Asclepiades decidedly.

Lash. 1. (*Weaving.*) A thong formed of the combined ends of the cords by which a certain set of yarns are raised in the process of weaving Brussels carpet. Each yarn (termed an *end*) passes through an eye (the *mail*), to which is attached a cord passing over a pulley above the frame of the loom. The cords required to raise to the surface a certain set of yarns, required for one row in the pattern, are bound together into a lash, so as to be operated by a single pull. See Brussels Carpet.

2. The thong or braided cord of a whip.

Lash'er. (*Nautical.*) The rope which binds a gun to the rings at the cheek of the port.

Lash'ing. (*Nautical.*) A rope or gasket, by which anything is secured on board ship, by wrapping around it.

As the *lashing* of a studding-sail boom.

The lashing of the parts of a ponton-bridge.

The lashing at the head of a *shears*.

The lashing of a tail-block.

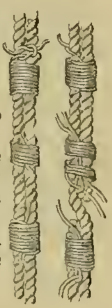
Also the act of binding one thing to another.

Las'ket. (*Nautical.*) One of the rings of cord on the head of a *bonnet* or *drabbler* to secure it to the foot of the sail above, by a lacing cord. A *latch*.

Lasque. (*Diamond-cutting.*) A kind of table diamond. See "Jeffries on the Diamond."

Las'so. A rope with a running noose, used in Spanish America and Texas for catching cattle, etc.

Fig. 2816.



Lashing.

In the British cavalry, 10 men per troop are furnished with a *lasso*, not as a weapon, but that they may aid in drawing a load on emergencies.

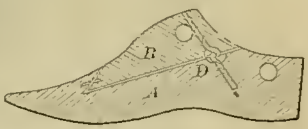
The lasso was used in war by the ancient Egyptians, as we see by the paintings at Thebes.

The Sagartians, a cavalry contingent of the army of Xerxes, used "lassoes which end in a noose." — Herodotus, VII. 85.

The lasso is seen in the sculptures upon the palace of Asshur-bani-pal, a son of Esarhaddon, which are now in the British Museum. Pausanias states that the Sarmatians used it; Suidas, that it was used by the Parthians. To this list may be added the Huns, the Alani, and among moderns the Pampas Indians of South America.

Last. A foot-shaped block *A B* placed inside a shoe, to give shape to the upper and hold the parts, which are tacked thereto previous to pegging.

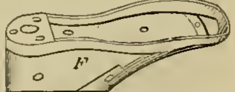
Fig 2817.



Shoe-Last.

F is a last, shown side up, to expose the sole, which has a metallic rim around the edge to hold a wooden sole, which may be replaced when worn out.

Fig 2818.



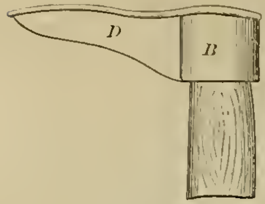
Movable Sole-Last.

D B is a metallic foot-shaped anvil for holding boots and shoes while clinching nails.

Lasts are mentioned by

the Greek authors. Right and left lasts were introduced in England about 1785.

Fig. 2819.



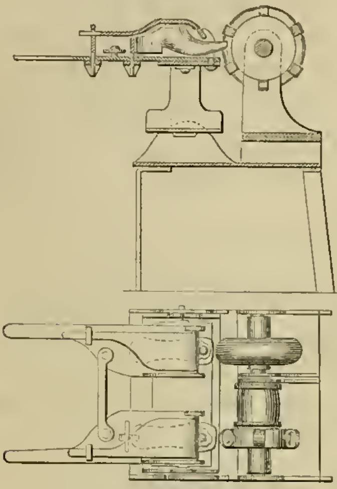
Last-shaped Anvil.

Last'age. (*Nautical.*) Ballast or lading in a ship.

Last'er. A tool for stretching the upper leather over a last. See Lasting-tool.

Last-fin'ish-ing Ma-chine'. A machine in which the ends of lasts, which are held in the chucks of a last-turning machine, are dressed up and finished.

Fig. 2820.



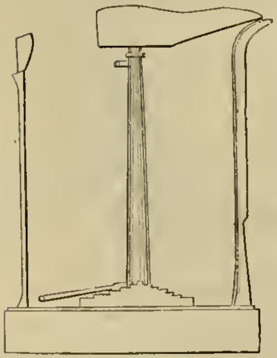
Last-Finishing Machine.

Fig. 2820 shows a lathe having a revolving cutter to operate upon the last at the same time and in the same direction that the guide-wheel presses upon the pattern. The supporting frame is on the pantograph principle, and any change in the position or form of the model is reproduced in the last.

Last-hold'er. (*Shoemaking.*) A standard for the last while lasting, pegging, sewing, soleing, etc.

The last is placed upon a standard rotated by a lever, to bring the toe of the boot against the rest-standard at either end of the base. One standard gives an upward support for pegging, and the other a side support for sewing. The lever is held by a ratchet.

Fig. 2821.



Last-Holder.

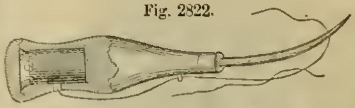
Last'ing. 1. (*Fabric.*) *a.* A five-leaf twill stuff; a stiff woolen fabric in which horsehair was formerly interwoven to form a stiffening for stocks or dresses.

b. A woolen fabric used in making women's shoes.

2. (*Shoemaking.*) The process of drawing the upper leather smoothly over the last.

Last'ing-awl. A sewing awl for shoe-closers. The example shows one carrying a bobbin in the handle of the awl, leading the thread out through a hole in the handle, and passing it through an eye in the point of the awl. In use, the awl, being passed through the leather, carries with it the thread; then being slightly drawn back, it forms a loop through which a second thread is passed. The entire withdrawal of the awl then makes a lock-stitch, similar to that made on some sewing-machines.

Fig. 2822.



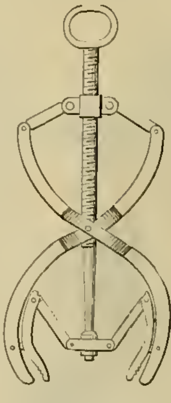
Eye-Pointed Lasting-Awl.

Last'ing-jack. An implement to hold the last while straining and securing the upper thereon; and for centering or adjusting the insole and outsole for the subsequent action of the pegging or sewing-machine. Sometimes used in hand-pegging.

Last'ing-ma-chine'. (*Shoemaking.*) A device for drawing the upper leather of a boot or shoe smoothly over the last, turning the projecting edges down upon the insole, and holding them until they are properly secured by tacks or other fastenings.

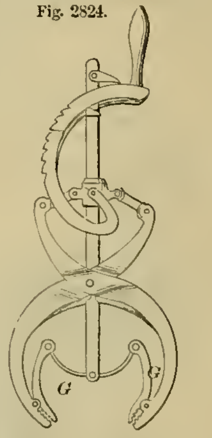
Last'ing-pinch'ers. (*Shoemaking.*) A tool to grip the edges of the upper leather of a boot and draw it over the last. The two jaws are gripped simultaneously upon the edges of the leather, by the motion of the nut *C* upon the screw, and the same movement brings the jaws toward each other and stretches the leather around the last.

Fig. 2823.



Lasting-Pinchers.

Fig. 2824.



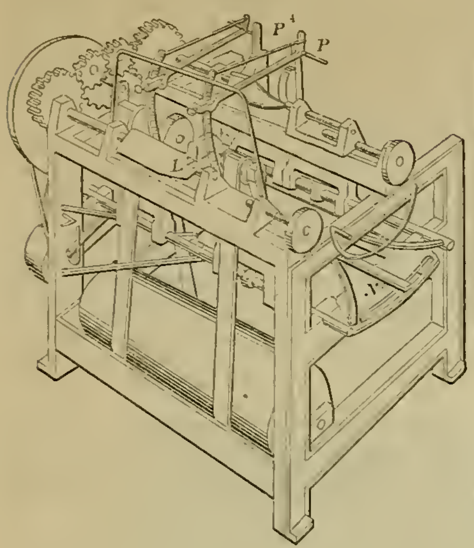
Tool for lasting Boots and Shoes.

Last'ing-tool. (*Shoemaking.*) A tool for gripping the edges of an upper leather and straining it over a last. In the example, the two pairs of jaws *G G* engage the sides of the leather, being drawn thereupon and inward simultaneously, by the action of the cam lever.

Last-mak'ing Ma-chine'. (*Wood-working.*) A machine for cutting lasts from the block or blank. The work is usually done in a Lathe for turning Irregular Forms (which see).

Such is also the machine (Fig. 2825) in which, by a train of gearing, the block L^5, from which the last

Fig. 2825.



Frohock Last-Lathe.

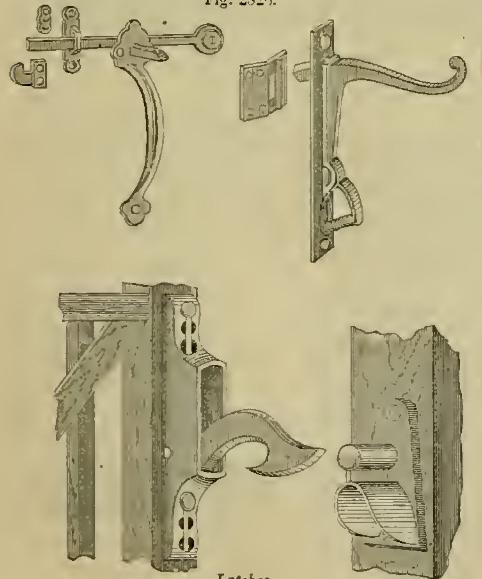
is to be cut, is made to present a face to the cutters precisely corresponding to the face of the model against guides on rods $P\ P^1$. By moving links on these rods up or down on their graduated scales, the last may be enlarged or reduced in its relative proportions to the model. A similar variation of the bar N''' on the sector at the end of the machine will vary the work in relation to its length as compared with the model.

Last-turn′ing Ma-chine′. See LATHE FOR TURNING IRREGULAR FORMS.

Latch. 1. (*Hardware.*) A door-fastening, consisting of hinge-bolt and catch. A latch may be opened from either side of the door or gate.

Latches are known by purpose, or peculiarity of construction, as —

Fig. 2826.



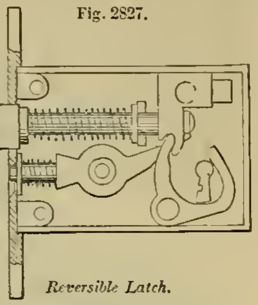
Latches.

Rim, night, sliding-door, gate, thumb latches.

The upper examples in Fig. 2826 are a *thumb*-latch and *gate*-latch respectively. The lower is a *gravitating* gate-latch, the catch and its keeper being shown detached.

A reversible latch is one in which the bevel of the bolt can be set in either direction, so as to make the latch answer for a right or a left hand door. The bolt is simply pulled out, turned half round, and then released, the spring bringing it back to place.

Fig. 2827.



Reversible Latch.

2. (*Knitting-machine.*) The piece hinged to the needle, which closes over the engaged loop to hold it in position in the needle while the latter is penetrating another loop. The latch is subsequently opened by the latch-lifter to allow the loop to be pushed back upon the needle, and is then closed by the latch-closer to enable the *knock-off* to disengage the formed loop or stitch. The *latch* is sometimes called the *fly*.

3. (*Nautical.*) *a.* A cord clamp which holds the in-board end of a mackerel-line. A *mackerel-latch.*

b. A loop on the head-rope of a bonnet-sail. A *lasket.*

Latch-clos′er. (*Knitting-machine.*) The piece which closes the latches, to enable the *knock-off* to slip the formed loops off the needles.

Latch-key. A private key for a street-door latch.

Latch′ing; Las′ket; Latch. (*Nautical.*) A loop formed on the head rope of a *bonnet-sail*, by which it is connected to the foot of the sail to which it forms an appendage.

Latch-lift′er. (*Knitting-machine.*) The rod or finger which lifts and reverses the latches to enable the loops or stitches to be pushed back along the needles.

La-teen′-sail. (*Nautical.*) A triangular sail, having its upper edge fastened to a long yard which is inclined at an angle of about 45°. The yard is slung at a point three quarters of its length from the peak end. It is used principally in the Mediterranean, upon *xebecs*, *galleys*, and *feluccas*, which have three, two, and one mast, respectively.

Lateen-sails of papyrus were used by the ancient Egyptians on the Nile.

La-teen′-yard. (*Nautical.*) One used in extending a *lateen*-sail. It is slung at a point one quarter of the length from the tack of the yard.

Lat′er. A brick or tile.

Lath. 1. (*Carpentry.*) One of the strips of wood nailed to the rafters to support the roof-covering.

2. (*Plastering.*) One of the narrow strips nailed to the studs of partitions to support plastering.

Strips of metal are sometimes used for this purpose in fire-proof structures. Such lath have means for securing to the studding or wall, and also affording a *key* to the mortar which is laid thereon.

Slips of wood, used in plastering, are noticed by Pliny.

Lath floated and set fair. Three-coated plasterers' work. The first is called "*pricking-up*"; the second, "*floated*"; the third, "*finishing.*"

Lath laid and set. Two-coated plasterers' work.

The first is called *laying*; the second, *finishing*.

Metallic lath for wooden or iron partitions has been made in various forms, of which the annexed instances may be given : —

a has a corrugated plate and transverse rods, behind which latter the plaster makes its lock.

b has plates with dovetail holes in which the plaster fastens.

c has corrugated plates which catch upon hooks on the studding.

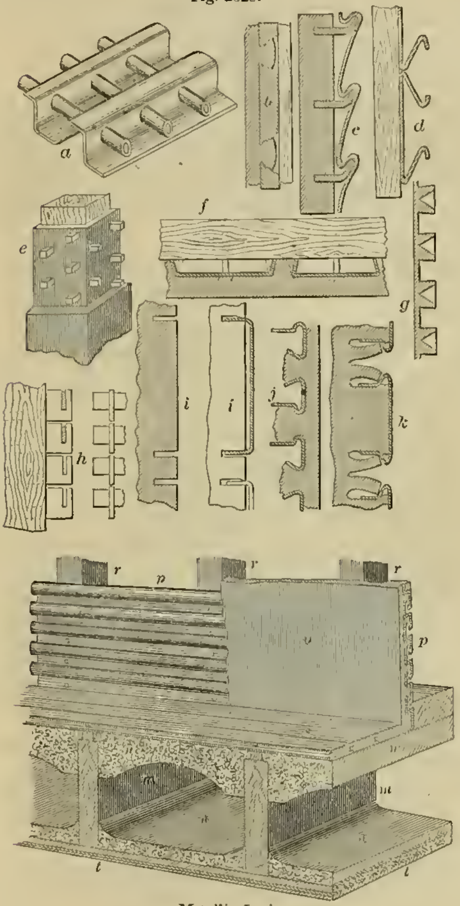
d has plates which present bent prongs.

e has metallic plates with frustums presenting their bases outwardly.

f has strips with flanged corrugated edges.

g has sheets with projecting studs of frustal form.

Fig. 2828.



Metallic Lath.

h has iron slats which are held by slotted iron plates driven into the studding.

i i show a form in which the edges of bent slips enter slots in the studding.

j has bent strips which occupy depressions in the studding.

k has means for pinching the edges of the lath.

The lower figure represents a portion of a structure in which the wooden joists and studding are so isolated from each other and protected externally that the wood cannot be readily fired by exposure to flame.

m m are the wooden joists ; *n n* protecting bodies of concrete ; *t* the corrugated lath whose trough-like shape enables it to form a key for the plaster, to protect the joist from the effects of fire in the room below, the portion of the plaster in the trough acting as a clinch for the outer portion of the plaster which forms the ceiling surface.

The same may be said in regard to the wall plastering *o*, which is spread upon similar metallic lathing *p* on the studding *r*. The upper body of concrete *n* extends above the joists, so as to isolate the flooring *s* therefrom.

This plan is a compromise, and retains the usual wooden portions of a floor or partition, excepting the wooden lath, for which corrugated sheet-iron laths are substituted. The laths are perforated for attachment by nails in the usual manner.

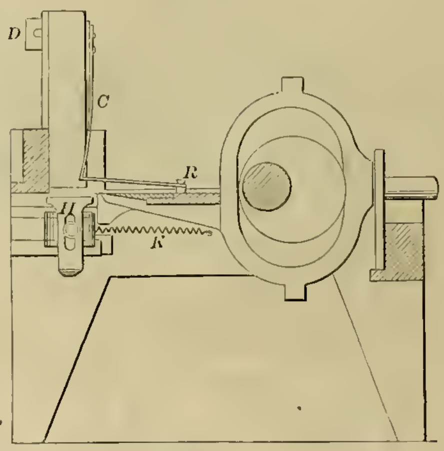
3. A bedstead slat for supporting the mattress. See Bed-bottom.

Lath-brick. A long brick, 22 × 6 inches, used for oast or grain-kiln floors.

Lath-cut′ter. One for cutting lath from a board or balk.

The example is one of the former, in which the lath is cut by a reciprocating knife from a board which is fed thereto by its gravity. A flexible adjustable guide *C* preserves the perpendicularity of the board and releases it after the cut. The rests *H* reciprocate in dovetail slides and are operated by the bumper on the knife-frame *R* and the recoil spring *K*. The knife is reciprocated by a cam and yoke.

Fig. 2829



Lath-Cutter.

Lathe. 1. A machine in which the object revolves while it is shaped by a cutting-tool applied to it.

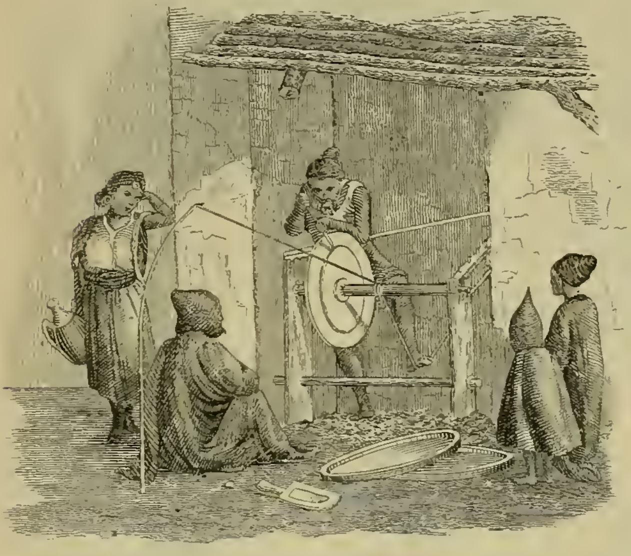
Turning, as an art, is believed to have originated with the potter's-wheel, which consisted of a simple disk or table rotating in a horizontal plane, upon a vertical shaft. This wheel was used only with plastic material formed by the hand, and is as ancient as the oldest Egyptian monuments, in which the god Ptah is represented in the act of molding man upon the throwing wheel.

The turning-lathe proper (*tornos*), having its work suspended on horizontal centers, appears to have been unknown in Egypt, but was mentioned by the Greek writers some centuries before our era, and was employed on wood. Its use for metal is of comparatively recent origin.

The credit of the invention is given by Diodorus Siculus to Talus, the grandson of Dædalus, about 1240 B. C., and by Pliny to Theodorus of Samos. The initial mode is probably the *pole-lathe*, in which the stick of wood is suspended on two centers and rotated by power applied directly to it, while a cutting-tool is supported on a rest and brought into contact with the rotating wood. An advanced form would be to apply the power to a mandrel whose end formed one of the centers and upon which the wood was chucked.

Fig. 2830 shows the foot-lathe of the Kabyles, an African people. The turner is shown making a wooden bowl. The motion is reciprocating; as the man presses with his foot in the bight of the cord the bowl is rotated towards him, and he applies the chisel or other cutting-tool. He then lifts his foot, and the elasticity of the spring-bar, which has been bent over, rotates the bowl in the other direction and lifts the bight of the rope, ready for another effective stroke.

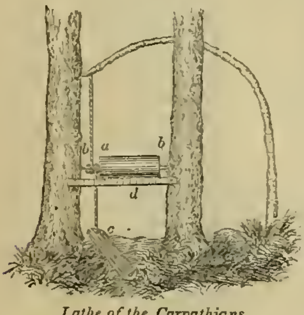
Fig. 2830.



Pole-Lathe (Africa).

The lathe of the native East-Indian consists of two upright pieces of wood driven into the ground at the requisite distance for holding the work, with spikes projecting horizontally. The work is held between these spikes and made to rotate backward and forward by a bow held in the left hand, and the string of which is passed once round the wood. Fig. 2831 shows a pole and treadle lathe used by people of the Carpathian Mountains. The work *a* is suspended on centers *b b*, and rotated by the cord which connects the end of the spring-pole with the treadle *c*. The chisel rests upon the bar.

Fig. 2831.



Lathe of the Carpathians.

The earliest screw-lathe known is one described in the work of Jaques Besson (see Plate 9 of that work) published at Lyons, France, in the year 1578. This curious lathe, which is also illustrated and described on page 616, Vol. II., Holtzapffel's "Turning and Mechanical Manipulation," has its tool traversed alongside the work by means of a guide-screw, which is moved simultaneously with the work to be operated upon, by an arrangement of pulleys and cords clearly shown in the engraving. Besson's machine was capable of cutting screws of any pitch by the use of pulleys of different diameters, and could be made to cut right-hand or left-hand screws at pleasure, by crossing or uncrossing the cord. The inventor also describes its application to elliptical, conical, or other solids.

A metal-turning lathe, in its most essential details, is found described on page 214 of "Mechanick Exercises, or the Doctrine of Handy Works," by Joseph Moxon, hydrographer to King Charles II., printed in London, 1694. This is cited, however, rather as one of the earliest intelligible and illustrated descriptions which have come down to us, than as fixing the actual date, — for evidence exists of its much earlier origin; for example, a bronze drinking-vessel, five inches in diameter, and *evidently turned*, was exhumed from an ancient tomb in Thebes, Egypt. This vessel may be seen in the Abbott collection, museum of the Historical Society at the corner of Second Avenue and Eighth Street, New York.

In the earlier construction of the lathe, the *slide-rest* was the first great step toward the principle of the *slide-lathe*, and no doubt led to that invention, which was considered impracticable before planing-machines were made of sufficient magnitude to plane a lathe-bed of even small dimension. A few slide-lathes had indeed been made, the beds of which were composed of a timber framing, covered with iron plates on the upper side to preserve the surface, similar to those which were previously used for the ordinary hand-lathes, with the exception that the outer edges of the iron plates were made of suitable shape to form the Vs for the carriage to slide upon. It was not, however, until some time after the introduction of the planing-machine that slide-lathes came into general use, and their utility was fully acknowledged.

The application of a *screw* to the *slide-lathe*, so as to render it capable of both *sliding* and *screw-cutting*, was the next important improvement; and a great amount of time, perseverance, and capital was expended by a few persons in endeavoring to perfect this portion of the lathe. A short screw was first made, as accurately as possible with the rude means then possessed, from which one was cut double the length, by changing the turned bar end for end in the lathe after cutting one half. Subsequently, by following out this principle, screws were made of any length required.

After this, the *surfacing motion* was introduced, and also the use of a shaft at the back of the lathe, in addition to the regular screw, for driving the sliding motion by rack and pinion, instead of both the motions of sliding and screw-cutting being worked by the screw alone; for it was found that the threads of that portion of the screw nearest the fast head-stock, being most in use, were worn thinner than the other parts; and, in consequence, the lathe did not cut a long screw with the degree of accuracy which it otherwise would have done.

Thus, step by step, improvements were gradually brought forward; the fore-jaw and universal chucks and other important appliances were added, so as to render the lathe applicable to a great variety of work, even cutting spiral grooves in shafts, scrolls in a face-plate, skew-wheels, and also turning articles of oval, spherical, or other forms. The duplex lathe, with one tool acting in front and the other behind the work, is also found to be a very useful arrangement for turning long shafts, cast-iron rollers, cylinders, and a great variety of work, where a quantity of the same kind and dimensions has to be turned. See Duplex-lathe.

The *slide-rest* is the invention of General Sir Samuel Bentham, and is the precursor and original of the planing-machine for metal. General Bentham is the inventor of the planing-machine for wood, patented in England in 1791. It seems to have been a reciprocating machine, acting after the manner of a hand-planer. He afterward invented the planing-machine with circular cutters. See Planing-machine.

Since the beginning of the century, numerous improvements in the lathe, some of them valuable, have been made the subjects of letters-patent in this country and in England; so numerous, indeed, are they that a bare recitation of their titles would fill considerable space. The more important improvements will be found described in the book called "The Lathe and its Uses; or, Instruction in the Art of turning Wood and Metal," copiously illustrated, published by Wiley & Co., New York; and in "Turning and Mechanical Manipulation," by Joseph Holtzapffel, an English work not republished in the United States.

Lathes are known by various names, according to construction, mode of driving, etc.

The *bar-lathe* has a single beam or shear, generally of a triangular shape. On this the heads or puppets slip.

The *bed-lathe* is the usual form, and has two parallel shears.

The *center-lathe* has head and tail stocks, which afford centers for each end of the work turned.

The *chuck-lathe* supports the work being turned, by means of a grasping tool or socket on the mandrel of the head-stock.

The *foot-lathe* is driven by a treadle.

The *geometric lathe* is an instrument for producing wavy or eccentric patterns with a general concentric arrangement. See Geometric Lathe.

The *hand-lathe* is driven by a crank or bow, and is of small size, for the bench or table.

The watchmaker's lathe is a small bench-lathe, sometimes having pivot centers, on which the work is turned by a bow, and sometimes a *hand-lathe* or a foot-lathe of small proportions.

The *last*-lathe is a Lathe for turning Irregular Forms (which see).

The *mandrel-lathe* supports the work on a spindle, which is attached to the axle of the head-stock, or on the head and tail centers, according to circumstances.

The *pivot*-lathe is a small bench-lathe whose centers are the ends of rods clamped in the heads and not partaking of the revolution.

The *pole-lathe* supports the work on puppets, and the cord passes from the treadle two or three times round the work, and then upward to a spring-bar. See Figs. 2830, 2831.

The *power-lathe* is driven by horse-power, water, or steam.

The *rose-engine* lathe is a form of the geometric.

The *spindle-lathe* has a rotating axis in the head-stock, to which the work is attached.

The *spoke-lathe* is a Lathe for turning Irregular Forms (which see).

The *turn-bench* is a small portable lathe for the work-bench or desk.

The parts of a lathe are, —

The *bed*, *sheers*, *cheeks*, *sides*, on which the puppets slide. The *puppets*, which form the *head-stock* and *tail-stock*. The *mandrel*, or live spindle of the live head, and on which is the speed-pulley. The centers on the *live* or *front spindle*, and the *dead* or *back spindle*, respectively, on which the work is turned.

The *fly-wheel* (of a foot-lathe), on which is the cord passing to the *speed-pulley* of the head-stock.

The *treadle*, or *foot-board*, to which the power is applied.

The *collar-plate*, *cone-plate*, *face-plate*, *chuck*, or other means of connecting the work.

The *rest* for the tool.

See under the following list of lathes and appliances: —

Axle-lathe.
Back-poppet.
Ball-turning lathe.
Bar-lathe.
Beaded-work lathe.
Bead-tool.
Bearer.
Bed.
Bed-lathe.
Belt-shifter.
Belt-tightener
Bench-lathe.
Bevel-tool.
Blanchard lathe.
Boring collar.
Bottom-tool.
Branch-chuck.
Broad.
Button-lathe.
Carrier.
Car-wheel lathe.
Center-chuck.
Centering-tool.
Centers.
Chaser.
Chasing-lathe.
Chuck.
Chuck for wood lathes.
Collar-plate.
Comb.
Compound-rest.
Cone-plate.
Cranked tool.
Crank-hook.
Cutter-head.
Cycloidal engine.
Dead-head.
Dog.
Dog and driver chuck.
Dog for wood-lathes.
Dog-lathe.
Driver.
Duplex-lathe.
Eccentric chuck.
Elliptic chuck.
Engine-lathe.
Face-plate.
Flat-tool.
Fluting-lathe.
Foot-lathe
Foot-wheel lathe.
Fork-chuck.
Founder's lathe.
Gage-lathe.
Geometric chuck.
Geometric lathe.
Hand-lathe.
Hand-wheel lathe.
Hanging-tool.
Heading-tool.
Head-stock.
Heel-tool.
Hollow-mandrel lathe.
Hook-tool.
Inside-tool.
Ironing-lathe.
Last-lathe.
Lathe-chuck.
Lathe-dog.
Lathe for irregular forms.
Leading-screw.
Mandrel-lathe.
Nulled-work lathe.
Oval chuck.
Oval lathe.
Overhead motion.
Pail-lathe.
Parting-tool.
Pivot-lathe.
Planisher.
Point-tool.
Pole-lather.
Poppet-head.
Potter's lathe.
Power-lathe.
Puppet.
Quarter-hollow tool.
Quarter-round tool.
Rest.
Rigger.
Ring-chuck.
Rose-engine lathe.
Round tool.
Screw-cutting chuck.
Screw-cutting lathe.
Screw tool
Scroll-chuck.
Seal engraver's lathe.
Shafting.
Shafting-lathe.
Shears.
Side-tool.
Skew-chisel
Slide-lathe
Slide-rest.
Spherical lathe
Spindle-lathe.
Spoke-lathe
Straight-line chuck.
Surface-chuck.
Tail-piece.
Throw-lathe.
Tool-holder.
Tool-post.
Tool-rest.
Transferring-lathe.

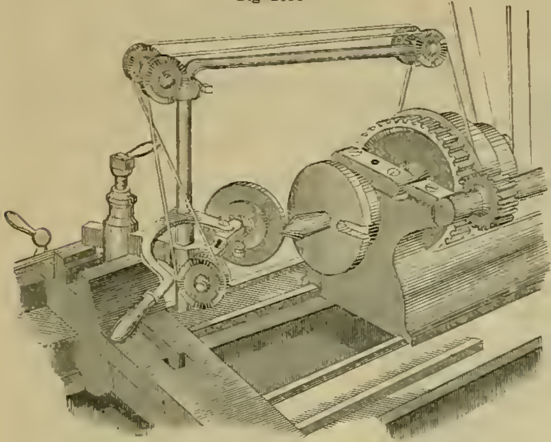
Treadle.
Turn-bench.
Turning-lathe.
Universal chuck.
Watchmaker's lathe.
Wheel-lathe.
Whirling-table.
Whisket.
Wood-turning lathe.
Wrist-pin turner.

2. (*Weaving.*) The wooden frame beam which forces up the weft. The *lay* or *batten.*

It may consist of these parts: —

The *swords;* two upright laths at the ends of the race.

Fig 2832.



Lathe-Center Grinder.

The *lay-cap* or *pull-to;* the top bar by which it is handled.

The *reed, sley,* or *slay,* which has parallel slips of metal or cane which separate the warp-threads and batter against the weft.

The *race,* or shuttle-track.

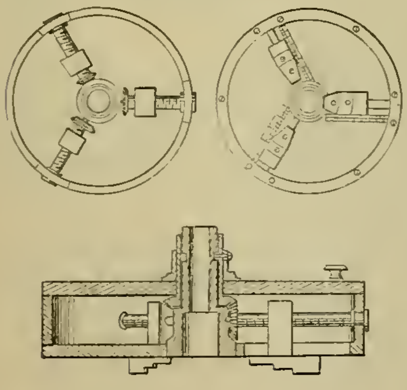
The *shuttle-boxes,* at the ends of the race.

The *picker, pecker,* or *driver,* which strikes the *fly-shuttle* and drives it along the *race* through the *shed,* which is formed by the decussation of the warp.

The *picker-cord,* which jerks the *picker.*

Lath-cen'ter Grind'er. An attachment to a lathe for truing the hardened live center *in situ,* by means of an emery-wheel rotated by a band conducted over idlers from the lathe-pulley.

Fig. 2833.



Lathe-Chuck.

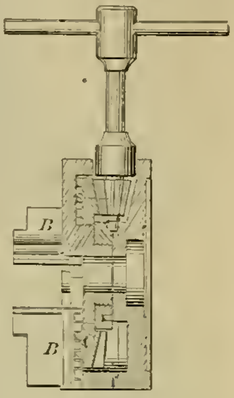
Lathe-chuck. One for holding work to the live mandrel, or a mandrel between centers of a lathe.

Fig. 2833 shows a universal chuck, in which the gear is placed at the center of the chuck, and pinions are arranged at or near the inner end of the driving-screws. The gear-hub is retained in place by a set-screw made to play in a groove in the gear-hub. Scales on the face-plate serve as guides in setting an eccentric, and also in adjusting the jaws at the right point.

The right-hand view is on an enlarged scale, and shows the dogs, the screws, and the back-plate, carrying the bevel-gear which mashes with the pinions on the dog-screws.

In Fig. 2834, the dogs *B B* are advanced or receded by the action of a wheel *C* with a spiral worm on its face and a bevel-gear on its back, actuated by the bevel-pinion which is turned by the key. See also CHUCK.

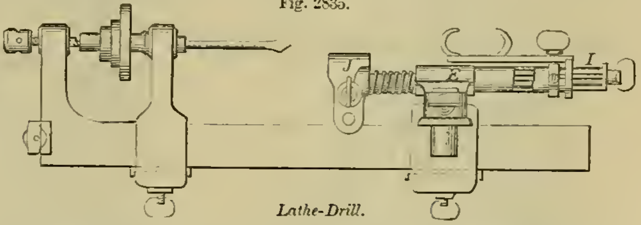
Fig. 2834.



Lathe-Chuck.

Lathe-dog. A piece on a mandrel or on work in a lathe, which, by contact with a pin on the face-plate of the live head, is caused to turn the work. See DOG.

Fig. 2835.



Lathe-Drill.

Lathe-drill. A bar-lathe arranged as a horizontal drilling-machine. The work is grasped by the vise *J,* and fed to the tool by the slipping of the piece *I* in the tube *E.*

Lathe for turn'ing Ir-reg'u-lar Forms. Previous to the present century, we read in the works of Condamine, De la Hire, and Plumier of lathes adapted to turn irregular forms.

De la Hire shows how all sorts of polygons may be made by the lathe, and Condamine shows how a lathe may be made to turn all sorts of irregular figures by means of tracers moved over the surface of models and sculptures, medals, etc.

Plumier's work enters extensively into the art of turning. Among other machines, he describes the slide-rest in combination with a planing-machine. This he calls an English invention.

In addition to the citation of these authors, we may refer to a number of elaborate machines made by Sir Samuel Bentham, 1793, and Joseph Bramah, 1802.

The machine invented by Brunel for making the groove around ship's blocks for the insertion of the ropes by which they are attached to the rigging has a revolving disk of brass with two cutters. It traverses around one side of the block, receiving its direction from a shaper placed parallel thereto, making the groove deeper at the ends than at the central part, where the sheave-pin is inserted.

The parent of all recent machines of this kind is, however, the lathe invented by Thomas Blanchard of Philadelphia, and patented by him September 6, 1819.

This lathe for turning irregular forms contains the generic idea of all machines for duplicating shapes by using a model in conjunction with a blank, the outline of the model guiding the cutting-tool to produce a duplicate from the blank.

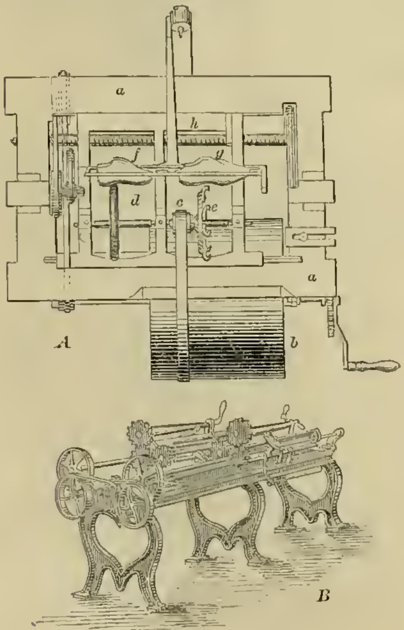
This ingenious device may be said to have wrought a complete revolution in that branch of wood-working to which it appertains. Originally applied to turning lasts, it has since been employed to shape the most difficult forms, gun-stocks for example, which it was formerly imagined could only be produced, and in a far less finished manner, by the drawing-knife, the gouge, and the chisel.

Fig. 2836, *A* shows a plan of the machine as originally patented. *a* is the frame, *b* a drum driving the pulley *c*, whose shaft serves as a common axis to the rapidly rotating pattern-wheel *d* and cutter *c*. These are maintained respectively in contact with the pattern *f* and the roughed-out block *g*, which is to be turned, so that as the former moves transversely back and forth the latter follows its motions.

The common axis of the wheel and cutter is caused to recede or advance, as projections or depressions of the model are brought in contact with the pattern-wheel, by means of a spring. A screw *h* produces a longitudinal movement.

It is obvious, as stated by the inventor in his specification, that various alterations in the positions of the working parts, with relation to each other, may be made without interfering with the general principle.

Fig. 2836.



Lathe for turning Irregular Forms.

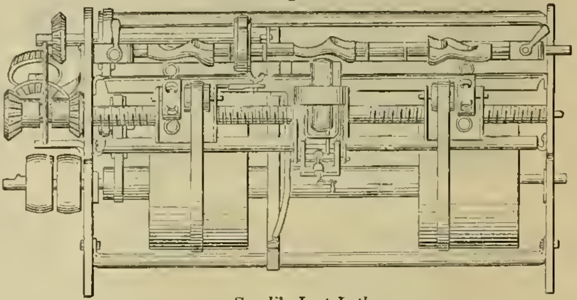
B, Fig. 2836, is a recent form of lathe of this description, all the parts of which are of iron.

In Spenli's lathe, a right and left last are turned at the same time in the same lathe, and from a single pattern, which may be larger or smaller than the last produced. The cutter-heads are traversed by the right and left hand screws of the single spindle, so as to simultaneously advance or recede from the central wheel, which is actuated by the pattern-last. By shifting the bolt in the slotted lever, the motion of the pattern-wheel head can be accelerated or retarded to make the lasts respectively smaller or larger than the pattern, while preserving the relative proportion of the parts of each last.

There are several forms of the machine :—

1. The slowly revolving model and work ; a rapidly rotating cutter acting on the work, and regulated as to proximity to the axis of the work by a tracer which rests against the rotating model.

Fig. 2837.



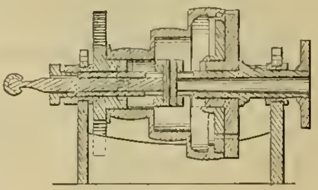
Spenli's Last-Lathe.

2. Rapidly rotating work and a rapidly rotating cutter, whose proximity to the work is regulated by a templet.

3. Rapidly rotating work and a cutter actuated by a templet.

Lathe-head. The poppet-head which contains the mandrel, on which is a cone-pulley for the belt and a means for attaching a face-plate or chuck for the work.

Fig. 2838.



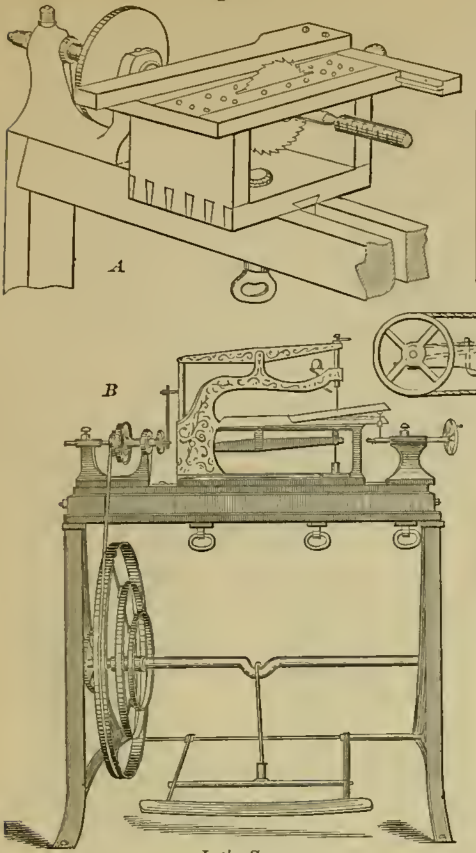
Lathe-Head.

Lathe-saw. For some of the smaller uses of circular saws they may be retained on the mandrel, supported on the lathe centers, as shown at *A*, Fig. 2839, while a bench is arranged upon the shears of the lathe. The wooden box is secured by a screw-clamp beneath the shears, and the platform is hinged to the back of the box, the saw projecting through a slot in the platform.

A *fence* can be arranged on the platform to act as a gage and guide in slitting a number of pieces to a size. A guide against which the work may be held, so as to present it at any angle to the saw, is a convenient adjunct.

B (Fig. 2839) shows a small fret-saw mounted on an ordinary lathe. The table is adjustable in hight, so that, being half an inch above the lathe-center, the saw will have an inch stroke, or a quarter of an

Fig. 2839.

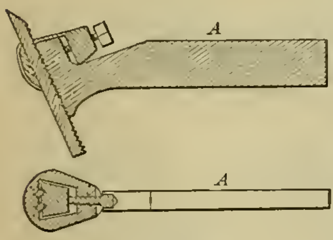


Lathe-Saw.

inch will give a half-inch stroke, and so on. The post uniting the back ends of the levers is connected to a wrist on the face-plate of the lathe-mandrel.

Lathe-tool Hold'er. A socket or holder for a lathe-tool, having a shank *A* which is held by the set-screw on the post of the slide-rest.

Fig. 2840.



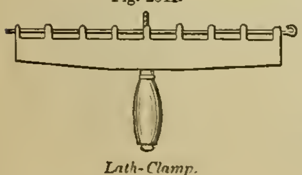
Lathe-Tool Holder.

Lath'ing-clamp. A clamp to hold a set of spaced laths while nailing to the studding.

Lath'ing-hammer. A hatchet, whose *bit* and *poll* present a straight line, so that the bit does not interfere with nailing up laths in corners of rooms.

The bit is used for cutting lath to a length, and it has a notch for withdrawing nails.

Fig. 2841.

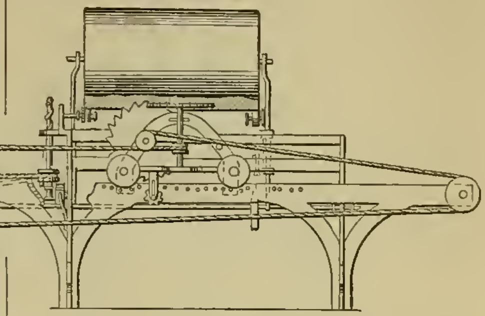


Lath-Clamp.

Lath-nail. A small cut nail (about 4 *d.*), for fastening laths to studding.

Lath-saw'ing Ma-chine'. One for sawing lath from the board or the bolt. The cylindrical log is mounted on journals upon gravitating guide-bars, and supported and rotated by rollers. The laths are sawn from its periphery by saws cutting rectangularly to each other.

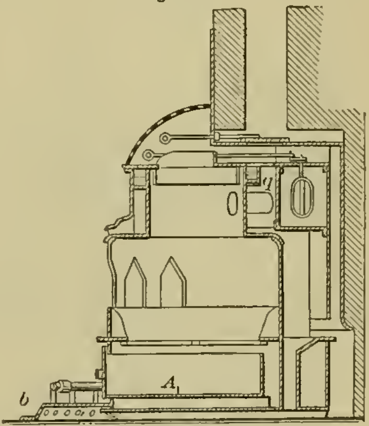
Fig. 2842.



Lath-sawing-Machine.

La-trobe'. A form of stove which sets into the fireplace of a room, has a projecting ornamental front, and is arranged for heating floors above. In the example, the furnace portion has a means of direct access to the flue in kindling fire or urging a strong draft, the lower damper shown in the cut, which moves the butterfly-valve in the partition between the downcast flue and the upward or reverting flue, which conducts the smoke to the chimney. The upper damper governs the opening by which the air heated by the stove is conducted to the hot-air flue and led upward to the registers of the rooms on the upper floors. The lower plate *A* is elevated above the floor, and the air heated beneath it is also conducted to the room at the passages leading to the upper rooms. The air is admitted through a perforated extension-plate *b* of the base-plate. *q* is a vessel for water, which is evaporated and mingles with the hot air which passes to the room or rooms.

Fig. 2843.



Latrobe.

Lat'ten. Thin metal. Metal in sheets.

In the Middle Ages, a thin plate of brass or bronze, used for cutting into crosses, bending into candlesticks, etc.

Black-latten is brass in milled sheets, used by braziers and for drawing into wire.

Shaven latten is a thinner article.

Roll-latten is polished on both sides, ready for use.

Latten-wire is wire made from latten-plate. It was thus made before the invention of wire-*drawing*.

Lat′ten-wire. Wire made from strips of latten.

Lat′ter-kin. (*Plumbing.*) A pointed piece of hard wood, used for clearing out the grooves of the *cames* in *fret-work* glazing.

Lat′tice. A structure of crossing laths or bars, as a *lattice-window*, *lattice-girder*, etc.

Lat′tice-bridge. A bridge supported by a girder whose web consists of diagonal crossing-pieces. See Iron Bridge.

Lat′tice-gird′er. A girder consisting of two horizontal bars united by diagonal crossing-bars. See Iron Bridge.

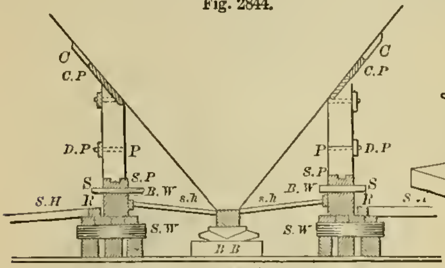
Lat′tice-truss. One having horizontal chords and inclined intersecting braces.

Lat′tice-win′dow. A window formed of leaden frames, called *cames*. The panes are usually diamond-shaped, and are set with an acute point upward.

Launch. 1. (*Shipbuilding.*) A term comprehending the apparatus for launching a ship.

S W, the *slip-ways* or *sliding-ways*. The structure above them, giving temporary support to the ship, is the *cradle*. The *slip-ways* are parallel, inclined platforms of timber, firmly founded on the floor of the slip, and kept steady in their positions by shores *S H*. Their slope varies from 1 in 12 for small vessels to 1 in 24 for the largest. The breadth is from three to four feet. The distance apart of the *slip-ways*, from center to center is about one third of the width of the vessel.

Fig. 2844.



Launch.

R R are ribbands to act as guides.

B W are the sill-pieces of the cradle-frame, and are termed *bilge-ways*. Their length for wooden ships is about five eighths of the length of the ship.

P, the *poppets*, are posts rising from the sole-pieces *S P*, which rest on the *bilge-ways*.

S, the *slices*, are wedges by which the *cradle* and ship are lifted clear of the *building-blocks B B*, to prepare for launching.

The upper ends of the poppets *P* rest against planks *C P*, which are prevented from slipping by means of the *cleats C*, bolted to the side of the vessel.

D P, the *dagger-planks*, are longitudinal ties by which the *poppets* are stayed.

S H, *s h*, are outer and inner shores, by which the *bilge-ways* are held to their places on the *sliding-ways*.

2. (*Nautical.*) The largest boat belonging to a ship of war. It is only used for service which cannot be performed by the smaller boats, being hoisted in board and kept on deck just abaft the foremast, where it serves as a receptacle for lumber and stores. In large men-of-war the launch is sometimes decked over, and is capable of mounting several light guns. The corresponding boat of merchant vessels is called the *long-boat*.

The launch is from 30 to 40 feet long, having a beam from .29 to .25 of its length. It has 10 or 12 oars, and is carvel-built.

Steam-launches are now used in the navy, and as despatch and revenue boats.

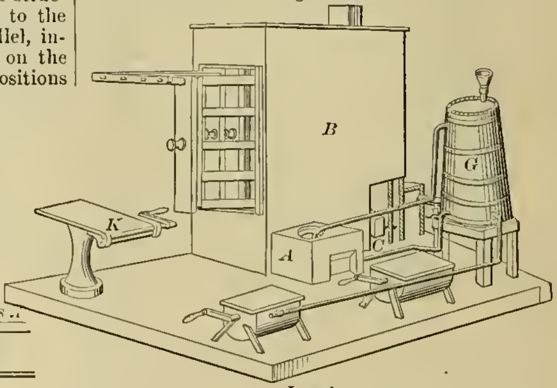
Launch-en′gine. Launch-engines generally consist of a boiler with engines attached thereto, and are used for propelling the launches of large ocean steamers in shallow harbors, etc. Such launches are used for general service, the transportation of men and stores, and as despatch-boats.

Laun′der. (*Mining.*) A wood water-gutter or pipe. A trough for conveying water to a stamp-mill or other hydraulic apparatus for comminuting or sorting ore.

Or a trough or box to receive the slimes from the stamps.

Laun′dry. An apartment arranged for washing, drying, starching, mangling, and ironing clothes, as in the example, which has a boiler *A*, drying-closet *B*, water-reservoir *G*, mangle *K*, and washing-machines.

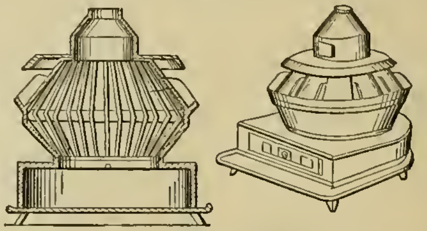
Fig. 2845.



Laundry.

Laun′dry-heat′er. A stove adapted to the uses of a laundry, especially for heating smoothing-irons, having an inclined heating-surface with a shelf.

Fig. 2846.



Heater for Smoothing-Irons.

Law-bind′ing. (*Bookbinding.*) A plain style of binding in leather of the natural tan-color ; calf or sheep.

Lawn. 1. (*Fabric.*) A very fine white goods, cotton or linen, finer than *cambric ;* of an open texture, plain or printed.

White lawn is part of the flowing dress of a bishop. It has the odor of ecclesiastical preferment, and, according to Pope, of sanctity also, which is not always the same thing.

> "A saint in *crape* is twice a saint in *lawn*."

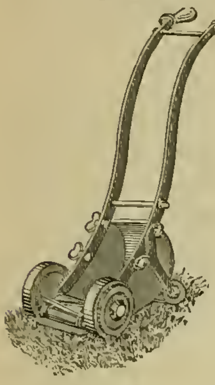
A certain Right Reverend Lieutenant-General was felled a few years since by a round shot. His three-starred coat hid the lawn.

2. (*Porcelain.*) A fine sieve of silk, 300 threads to the inch, through which *slip* for porcelain is strained, to insure an impalpable, creamy fluid. See SLIP.

3. A smooth, grassy surface in the vicinity of a house.

Lawn-mow'er. A machine for cutting sward. One form of lawn-mower has a revolving cylinder, armed with spiral knives, which rotate in contact with the rectilinear edge of a stationary knife, placed tangentially thereto. The cylinder is rotated by gear connection to the supporting and driving wheels. The blades of grass are nipped between the edges of the spiral and straight knives, are cut off and delivered into a trough behind the cylinder. The machine is made of different sizes, to cut a swath of from 18 to 36 inches, and is pushed before him by the gardener.

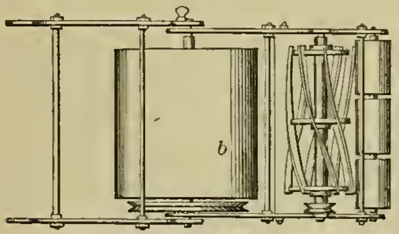
Fig. 2847.



Lawn-Mower.

Fig. 2848 has a roller *b* and a set of spiral knives, which cut against a straight edge, near the supporting rollers, which support the hinged portion when the mower is brought into action. The mower may be thrown up and over the handle end when the machine is to be used for rolling only.

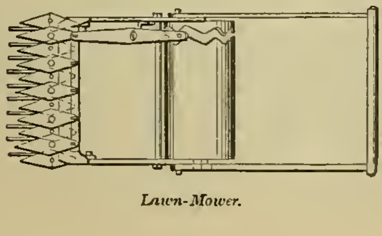
Fig. 2848.



Lawn Roller and Mower.

In Fig. 2849, a row of knives are vibrated by the arm which is oscillated by the zigzag on the roller.

Fig. 2849.



Lawn-Mower.

Lay. 1. (*Rope.*) The direction in which the respective *yarns*, *strands*, etc., are wound in forming them into a *rope*, *hawser*, *cable*, etc.

Hemp is *laid-up right-handed* into *yarns*.

Yarns are *laid-up left-handed* into *strands*.

3-*strands* are *laid-up right-handed* to form a *hawser*.

3-*hawsers* are *laid-up left-handed* to form a *cable*.

The terms signifying the respective forms are, *single-laid*, *hawser-laid*, *cable-laid*.

2. (*Cotton-manufacture.*) *a.* 120 yards of yarn. The yarn is wound on a reel 4½ feet in circumference, 80 revolutions of which make a *lay*, and 7 lays make a *hank* of 840 yards. This is the length of a *hank* of any grade of cotton yarn. The yarn is rated by the number of banks which go to make up a pound. Nos. 40 to 50 are ordinary *throstle* weaving; Nos. 300 to 400, ordinary mule weaving. By the mule much higher numbers have been reached. No. 700 being exhibited in 1853. See YARN; HANK.

The *lay* is also called a *rap* or *ley*.

3. (*Flax-manufacture.*) 300 yards of linen yarn. See LEA.

4. (*Wool-manufacture.*) A quantity of wool or other fiber in a *willow* or carding-machine.

5. (*Weaving.*) The *batten* or *lathe* of a loom, by which the weft-threads are beaten up in the shed to compact them against their predecessors. See LATHE, 2.

Lay-cap. (*Weaving.*) A slat which lies on top of the *reed*, and which is grasped by the hand in working the *lathe* or *batten*.

Lay'er. 1. (*Tanning.*) A pit containing a strong solution of tannin; used for hides near the conclusion of the tanning process. A *bloomer*.

The pits containing the weaker solution, used in the earlier portions of the process, are termed *handlers*.

2. (*Leather-manufacture.*) A welt or strengthening strip.

3. (*Husbandry.*) A limb laid a part of its length beneath the surface-ground, that it may strike root.

4. *a.* A course of stone or brick.

b. A thickness or bed of puddled clay in a canal.

c. A bed of mortar or cement.

Lay-fig'ure. An artist's model. A jointed figure to clothe in imitation of the human body.

Lay'ing. 1. (*Rope-making.*) The twisting of three (or more) yarns into a *strand*, or of three strands into a *rope*. The rotating hooks by which the *strands* are made are rotated in a direction contrary to the twist of the separate *yarns*. The *rope* again receives a *twist* the opposite of the *strands*. See LAY; ROPE.

2. (*Plastering.*) The first coat of plastering in two-coat work. The surface is made rough by a broom to form a key for the next coat.

The first coat of *three-coat work* is called the *rendering*.

Lay'ing-hook. (*Rope-making.*) One of the iron hooks on the poles of a ropewalk in which the strands are laid as twisted.

Lay'ing-ma-chine'. A machine for laying up yarns into rope. See ROPE-MAKING MACHINE.

Lay'ing-on Tool. (*Bookbinding.*) The tool wherewith the gold-leaf is laid on to the cover or the edge.

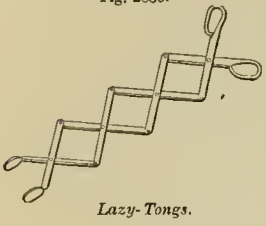
Lay'ing-top. (*Rope-making.*) A conical piece of wood placed between the strands, and gradually receded as the lay progresses, in order to keep the twist well to the point at which the strands diverge, and not let it degenerate into a slack twist throughout the length of the strands in the walk.

Lay-race. (*Weaving.*) The shuttle-path on the lay of a loom. The *shuttle-race.*

La'zy-back. (*Vehicles.*) A high back-bar to a carriage-seat. It is sometimes made shifting, so as to be removed at will.

La'zy-jack. A lifting-device of compounded levers on the principle of the *lazy-tongs.*

Fig. 2850.



Lazy-Tongs.

La'zy-tongs. A system of levers, moved by the impulse communicated to the first pair. It is called the lazy-tongs, inasmuch as the grippers are advanced at the same time they are closed together, reaching and grasping simultaneously. The motion is used in many appliances and machines. Gates, guards between platforms of cars, elevators for fire-ladders, drop-lights, and extension gasaliers, and others which will appear occasionally in this work under their respective heads.

Lea. 1. (*Flax-manufacture.*) A measure of 300 yards of linen yarn.

Table.

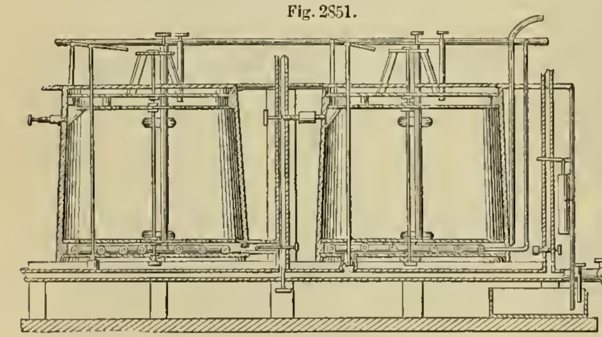
300 yards, 1 *lea.*
10 *leas,* 1 *hank.*
20 *hanks,* 1 *bundle* = 60,000 yards.

Also called a *lay, ley, rap,* or *cut.*

2. (*Cotton.*) 120 yards of yarn.

3. (*Weaving.*) *Leas.* One of the alternate sets of threads into which a warp is divided. The whole series is divided into alternate sets, which are to be placed in the loops of the respective *heddles,* so as to be raised and depressed alternately to form the shed in which the shuttle traverses. See WARPING-MILL.

Fig. 2851.

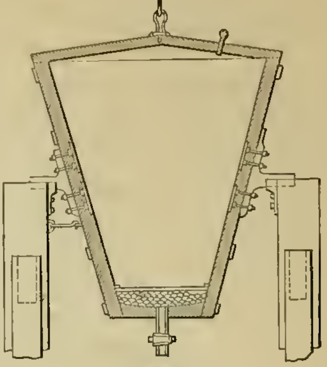


Bark-Leach.

Leach. A vat or chamber in which a body is placed, in order that its soluble portions may be removed by soaking and infiltration. It is a filtering operation in which the liquid removes the soluble matter from the material through which it flows. A familiar instance is the ash-leach.

In the bark-leach, the bark is contained between two perforated horizontal partitions in the leach, the lower one having a coiled steam-pipe for heating the contents. The menstruum may be forced through the bark in either direction by means of pipes furnished with valves to determine the said current.

Fig. 2852.



Leaching-Vat.

Leach'ing-vat. A vessel in which a material containing a soluble portion is exposed to the action of a solvent, say water, which dissolves and carries away the said portion.

The example shows the form for leaching-vat used in the process of chlorinating gold. This is made of two-inch plank and painted inside with pitch. Leaden discharge-cocks are placed at the bottom, and pieces of quartz laid loosely under the perforated earthenware false bottom, which is arranged so that it will remain in the vat when the latter is overturned. The vat is closed air-tight by means of a thick lid pressing upon a rubber band on the rim. A pipe inserted into the lid leads the chlorine gas from one vat to another, so that it passes consecutively from one to another in the row until it is exhausted. The vat is charged with auriferous slimes, the lid fastened, gas admitted. After the gold is dissolved, water is admitted, carrying off the chloride of gold to a vat. When the ore is thoroughly leached, it is discharged into a car by overturning the vat, and is then driven off and dumped outside the works.

Lead. 1. A soft, bluish-gray, fusible, ductile, heavy metal. Volatile above red heat. Equivalent, 103.5; symbol, Pb.; specific gravity, 11.44; fusing point, 612° F.

It usually occurs as *galena* (sulphide of lead), and is easily reduced. This is, —

Picked; to remove trash.

Broken and washed; to separate earthy and siliceous matters.

Roasted; a portion is moderately heated to convert it into the sulphate, and then mixed with an unroasted portion. The two are then well roasted to eliminate the sulphur. See LEAD-FURNACE.

The protoxide of lead is litharge, a yellow powder much used in the arts, and as a glaze for pottery and a component in flint-glass.

A compound oxide, red lead, is used as a pigment and a flux.

The white-lead of commerce is a carbonate of lead, and a valuable white paint. See WHITE-LEAD.

The uses of lead are manifold.

Its tractability, softness, fusibility, weight, and cheapness render it particularly suitable for bullets, shot, packing of projectiles, etc.; lining of cisterns, boxes, gutters, and numerous other articles; and it is specially useful in type metal, in all solders and fusible alloys (see ALLOYS), as well as in the composition of various articles of use and ornament, domestic and mechanical.

The lead of commerce is divided into: —

Pig-lead.
Sheet or *milled* lead.
Lead pipe.
Shot.

White-lead.
Litharge.
Chromate of lead.
Red-lead.

Lead was known in old times. "They sank as lead in the mighty waters," is a part of the triumphal song of Miriam, 1491 B. C. Job refers to its use for writing-tablets, "An iron pen and lead." A work of Hesiod was preserved for many centuries scratched on leaden tablets. "Iron, tin, and lead" were enumerated by Ezekiel as among the commercial objects of the Tyrian trips to Tarshish. The mines of the Cassiterides, that gave the tin to alloy with copper for the vessels of the temple at Jerusalem, gave also lead to the brave merchants of Phœnicia. The Romans used sheet-lead largely for water-pipes.

2. (*Sounding.*) An ordinary *hand-lead* is a mass of lead, weighing from 7 to 11 pounds, attached to a line of 20 fathoms length. The line is marked at 2, 3, 5, 7, 10, 13, 15, 17, and 20 fathoms; the numbers between the *marks* are called *deeps*. Thus, "by the *mark twain*," "quarter less 5," "and a half 7," "by the *deep* 9," indicate those depths respectively.

The *deep-sea lead* weighs 25 to 30 pounds, with a much larger line marked at every 10 fathoms. See SOUNDING.

3. (*Printing.*) A thin plate of type-metal, less than type-hight, and used to separate lines in printing.

Spaces separate the letters or words.

4. (*Knitting-machine.*) *a.* Solder in which various members are imbedded, and by which they are attached.

b. The tin socket which forms a haft for the knitting-needle.

5. The graphite for filling the grooved cedar staff to form a lead-pencil. See PENCIL.

6. (*Plumbing.*) *a.* A roof covered with sheet-lead.

b. The *came* of the diamond-paned casement.

Lēad. 1. (*Sawing.*) The overhang of a saw, to extend the cut throughout the length of the saw and to carry the saw back in the *kerf* during the return stroke.

2. (*Mining.*) A lode or vein of ore.

3. (*Engineering.*) The distance from an earth-cutting to an embankment.

4. (*Steam-engine.*) *a.* An arrangement of the ports of a steam-valve by which steam is admitted in front of the piston a little before the end of the piston-stroke. Also an arrangement of the ports to provide for the escape of the steam from behind the piston before the completion of the stroke.

When on the *steam* side, it is called *outside* lead. When on the *exhaust*, it is *inside* lead. It tends to check the velocity of the piston at the end of the stroke, and allows of the valve being open and ready to admit a larger supply of steam the instant the motion of the piston is reversed.

b. (*Lead of the crank.*) The setting of the crank of one engine a little in advance of the right angle to the other; namely, at 100° or 110° in place of 90°. This assists in rendering the motion of the piston more uniform, by moderating its velocity at the end of the stroke.

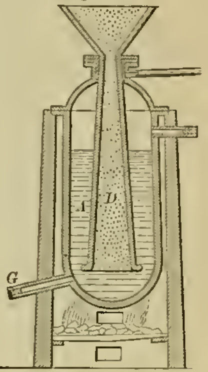
Lead-bath. A process for the extraction of gold or silver from comminuted ore by exposing it mechanically to molten lead, with which it forms an alloy. The subsequent separation is by cupellation or, with silver, by Pattinson's process. See *infra.*

In reducing silver ores, the ancient Peruvians mixed them with galena or lead in portable ovens. It is still practiced in that country. Quicksilver was well known in Peru among the Incas, but was used to make the pigment vermilion, not to amalgamate the precious metals. Hawks writes, A. D. 1572, that the process of amalgamating silver ores with mercury is being substituted for melted lead. See AMALGAMATOR.

In Bursile's English patent, February 12, 1853, the ore is treated with an amalgam formed by the union of quicksilver in a readily fusible alloy of lead and bismuth, or lead, bismuth, and tin.

In Fuller's apparatus, the comminuted ore occupying the central shaft *D* is discharged in a diffused condition beneath the column of lead *A*, which is kept in a molten condition by the furnace beneath. The heavier portion of the alloy is drawn off at times at the pipe *G*. The ore rises through the lead, bringing the particles of gold or silver in contact with the lead, with which they unite. The flow of ore is encouraged by withdrawing air from above the lead by an air-pump. *H* is the discharge-pipe for tailings.

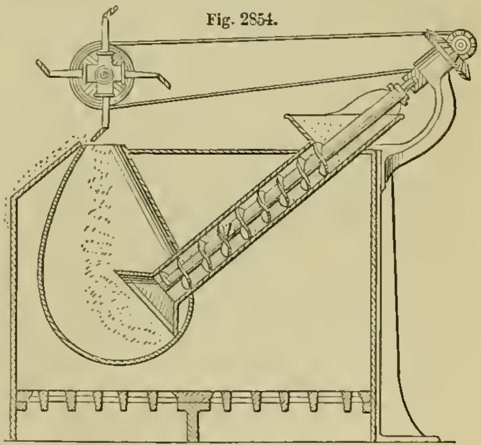
Fig. 2853.



Lead-Bath for Precious Ores.

In Fig. 2854, the vessel is suspended in a furnace through which extends an inclined tube, which discharges its contents near the bottom. The tube has a propelling screw having a shoulder and elastic collar at its bearing, and a grinding plate at its lower end, which works against a grinding surface attached to the lower end of the tube. Above the mouth of the vessel is a wheel which removes the waste ore as it rises to the surface of the molten lead.

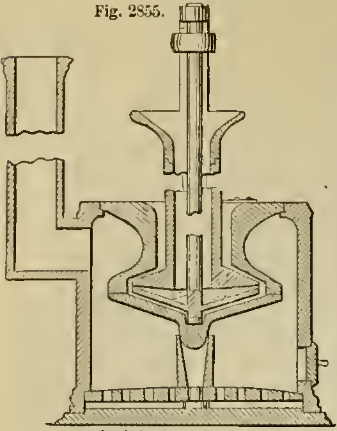
Fig. 2854.



Rose's Lead-Bath.

In Crosby's apparatus the bulbous vessel contains a lead-bath, and is supported in the furnace. The tubular conductor has a disk on its lower end, against which rotates a grinding-plate attached to the vertical axial-shaft. The ore passes down the tube, is associated with lead which flows through openings in the side of the ladle, and the combined mineral and metal are triturated together between the grinding-surfaces, the precious metals becoming amalgamated with the lead while the refuse mineral rises to the top and is skimmed off.

Fig. 2855.



Crosby's Lead-Bath.

Lead-cut'ter. (*Printing.*) A knife for cutting leads which are held in a tray the while.

Lead'er. 1. (*Pyrotechnics.*) A long paper tube of small diameter, enclosing a strand of quickmatch, used for communicating fire rapidly from one point to another. Quickmatch thus enclosed burns much more rapidly than in the open air.

2. (*Nautical.*) A thimble for conducting or guiding a rope which passes therethrough. A *fair-leader.*

3. (*Machinery.*) A *master* wheel or principal wheel in a piece of machinery.

4. (*Printing.*) A row of dots on a line, to lead the eye across the page or column, are called leaders, as: —

Anchor..◆..............................page 94.

5. (*Mining.*) A small vein of ore; indicating proximity of a larger lode, usually leading thereto.

6. (*Surveying.*) The forward one of the two chain-carriers.

7. (*Plumbing.*) A rain-water pipe to conduct to the ground the water collected by the spouting.

Lead'er-hook. A hold-fast hook clasping a *leader* or rain-water pipe, and having its tang driven into the wall of the house.

Lead'ers. Dotted signs for leading the eye across a space. See Leader.

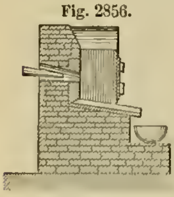
Lead-flat. A level roof consisting of sheet-lead laid on boarding and joists.

Lead-fur'nace. The furnace by which the ores of lead are reduced to the metallic state. The sulphuret, commonly known as galena, is the principal source from which the pure metal is derived.

The ore having been picked is broken and washed to separate earthy and siliceous matters.

It is then roasted until about half the charge is converted into sulphate of lead, when this and the portion which remains intact are thoroughly mixed together, and the heat rapidly increased, by which means sulphurous-acid gas is driven off and pure metallic lead remains.

Fig. 2856.



Lead-Furnace.

The furnace (Fig. 2856) is used in the north of England, and is known as the Scotch furnace. It has a rectangular cavity of masonry, lined with cast-iron. The inclined sole-plate is also of cast-iron, and has an upright ledge at its back and sides, shelving towards the interior, where it passes through the *work-stone* leading towards a pot which receives the molten lead. The tuyere is introduced through the *back-stone*, and the charge is introduced above. The chimney *d* communicates with flues leading to condensing-chambers. Quicklime and powdered charcoal are introduced during the process of reduction, in order to decompose the oxide of lead formed during the operation, and to render the slag less fusible, that it may be the more readily removed. The lead is said to be purer than that obtained by the smelting-furnace, as the heat is lower, and the silver and lead are *sweated out* without reducing the other metals.

In Carpenter's furnace, steam is used in conjunction with air, the two being introduced either separately or together into the space above the ore.

Lead-glance. Galena. Sulphuret of lead.

Lead-har'ness. That appertaining to the *leading*-horses of a team; in contradistinction to that for *wheel*-horses, which have breeching to enable them to hold back the vehicle.

Lead'ing-ax'le. An axle ahead of the driving-wheels in British locomotives.

Lead'ing-block. (*Nautical.*) One for guiding the direction of a purchase or rope.

Lead'ing-buoy. (*Nautical.*) A buoy placed as a guide in sailing.

Lead'ing-light. (*Nautical.*) One character of light as displayed for the benefit of seamen on a coast. Two lights are exhibited from two towers; one may be higher than the other, so as to confer a special characteristic. Certain bearings as to channel are indicated when the lights are seen in one line, the opening of the lights on either side of their conjunction indicating when to tack. Other indications may be given by the conjunction, according to the nature of the case.

Lead'ing-part. (*Nautical.*) The portion of the tackle between the fall and the standing part. It is that portion which passes over the sheaves. The fall is that which, in pulling or easing, does not reach the sheaves.

Lead'ing-rod. One used in draw-boring and polishing the bores of rifle-barrels.

Lead'ing-screw. (*Lathe.*) The longitudinal screw between the *shears* of a lathe, by which the *slide-rest* is moved longitudinally of the lathe-bed. *Lead-screw.*

Lead'ing-springs. The springs fixed upon the leading axle-box of a locomotive-engine, bearing the weight above. (*English practice.*)

Lead'ing-wheel. A wheel of a locomotive-engine, placed before the driving-wheels.

Lead-lights. A form of casement window in which small panes are fixed in leaden *cames*, which are attached to cross-bars called *saddle-bars.*

Lead-line. (*Nautical.*) A sounding-line.

Lead-mill. A circular disk of lead with an abradant powder, and used by the lapidary for roughing and grinding. See Lapidary-mill.

Lead-nail. 1. A small, round-headed, copper-alloy nail, used for fastening on lead-sheets on roofs.

2. (*Nautical.*) A scupper-nail.

Lead-pot. (*Metallurgy.*) A crucible or pot for melting lead.

Lead from Sil'ver sep'a-rat-ing. Pattinson's method (English) of separating lead from silver is an economical substitute for cupellation. It is founded upon the property which pure lead has of crystalizing out of a solution of silver in lead. The argentiferous lead being fused is allowed to cool slowly, solid crystals of nearly pure lead are first formed, and are separated by an iron strainer from time to time, the melted remainder becoming still richer in silver. At Beaumont's works, Allenheads, Northumberland, the process is conducted in hemispherical, cast-iron pans, each holding about 3 tons of metal and heated by a fire beneath. The process is several times repeated, and the remaining metal is treated by cupellation.

Argentiferous lead ores containing only 3 ounces of silver to the ton can be profitably worked for the silver by this means, while 20 ounces of silver to the ton scarcely paid when treated by the process of cupellation. See also CUPELLATION; PATTINSON'S POTS; LEAD-BATH.

Lead-pen'cil. A marking and drawing instrument, made by enclosing a slip of graphite (commonly called *plumbago* or *black-lead*) in a casing of wood. This is generally round or hexagonal, but large pencils for the use of carpenters and others are sometimes made oval in section.

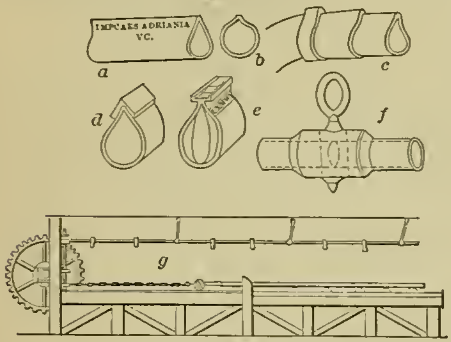
Graphite is generally ranked as a native carburet of iron, but the proportion of the latter metal is so small that it may be considered nearly a pure carbon. It is found in veins, often forming considerable masses. The mines of Cumberland, England, were long the principal source of supply, but are now nearly exhausted. By the old practice, the graphite is first calcined in close vessels at a bright red heat, and is then sawn in slips of the required size, which are inserted in a longitudinal groove in the case, which is formed in two similar parts and grooved by appropriate machinery. The two parts are afterward glued together.

Pencils of the second and inferior qualities are prepared from the dust and other refuse, ground fine and mixed with a kind of fine clay and water, into a paste which is placed in a receiver having an orifice at bottom, of the size and shape of the core. This is cut into proper lengths, straightened, dried at a moderate heat, and afterward baked in close crucibles, when they are ready for insertion into the cases. See GRAPHITE.

America now makes its own pencils. See description of the method pursued at the Dixon Pencil Works, Jersey City, under PENCIL.

Lead-pipe. The use of lead-pipes for conducting water is very ancient. Those of the Romans, used in their aqueducts, were made out of sheets 10 feet long, and a width proportioned to the diameter required, and averaging about 15 pounds to the square foot. The lead was brought from Britain, and beaten into sheets by heavy hammers: — PLINY.

Fig. 2857.



Lead-Pipe Making.

A sheet 100 inches wide made a pipe weighing 120 pounds to the foot; and would be about 30 inches diameter, allowing for a little lap, were it cylindrical.

The sheets of lead were soldered by the assistance of tin and rosin, the sides being brought flatly together, exposing both edges outside and giving a *pear*-form to the section. Over the joint was soldered a capping ridge, and the whole was hooped around with straps of lead. *a b c d e* show the forms of pipe found at Lyons. Metallic cocks like the modern were used, as seen at *f*.

"Abderahman Ben Alhakem (d. A. D. 852) constructed the Rusafa or embankment along the edge of the river at Cordova, caused water to be brought from the mountains in tubes of lead, and gave orders for the building and erection of numerous fountains in different quarters of the city, with baths of marble." — CONDÉ.

Leaden pipes were used in England as early as A. D. 1236, and Henry III., about 1270, granted the citizens of London the liberty to convey water from the town of Tyburn to the city, by pipes made of lead. A leaden cistern, built round with stone, was erected in 1285. The length of lead-pipe then laid down, from Paddington to the Cross in Cheapside, was 1,096 rods. Cisterns and supply-pipes of lead were numerous in the fifteenth century. The art of casting them was invented by Rev. Robert Brooke, 1539.

In 1582, the water-works of London Bridge were established by Peter Morice, and the water distributed by lead-pipes to certain parts of the city.

In 1613, the New River, an open aqueduct 40 miles long, and having a fall of 3 inches to the mile, was finished by Sir Hugh Middleton, and the water was distributed by wooden mains and leaden branches. In 1804, cast-iron pipes were substituted for the wooden mains.

Lead-pipe is made by *casting*, *drawing*, *pressing*, and *rolling*.

It may be cast in lengths in an ordinary *core-mold*, or consecutive lengths may be cast together by pulling out the core, opening the mold, shifting the pipe along *nearly* its length, replacing mold and core, and then pouring again.

In *drawing* lead-pipe, —

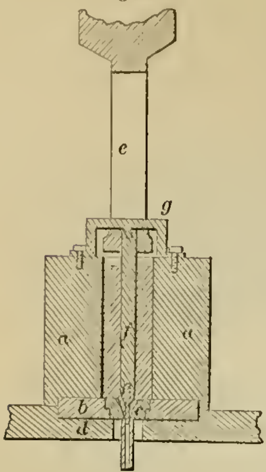
The lead is cast in an iron mold upon a rod of the intended bore, leaving the metal four or five times the thickness it is intended to be eventually. The pipe, with a triblet or mandrel inserted, is then drawn through openings in steel plates of gradually decreasing diameter, which reduce it to the thickness required. When power is applied, the chain winds upon the drum and hauls a little carriage which runs on ways, and has a double claw to engage the head of the mandrel. The perforated steel plate or *whirtle* is held in a cross-bearer above the bench. This mode is shown at *g*, Fig. 2857, and is described in Wilkinson's specification, English patent, 1790.

Instead of the plate, a series of rolls may be employed, gradually diminishing in size, successively reducing the diameter of its exterior, while the mandrel maintains the uniformity of its bore.

The first machine for *pressing* lead-pipe was patented in England by Hague, in 1822. The melted lead was forced through a circular throat whose axis was occupied by a mandrel. The lead was driven through at such a rate that it solidified by exposure to cold surfaces. By another plan, the lead is cast into a short heavy cylinder, and the ingot is forced through a throat at the lower end by the exertion of considerable force upon the piston which fits in the cylinder. This would make a round bar, but occupying an axial position in the middle of the throat is a mandrel, which forms the inside of the tube. This mandrel is supported by a bridge-piece in the cylinder, the lead opening to pass it and closing again before reaching the throat; or the mandrel is supported by the piston, which prevents the cleavage and obviates the necessity for rejunction of the metal. A large number of patents have been granted for machinery for making lead-pipe.

Fig. 2858 illustrates the operation. *c* is the triblet in the holder *b*, which rests on the bed *d*. *f* is a core suspended from the bridge *g*. *e* is the ram,

Fig. 2858.



Lead-Pipe Press.

which descends upon the cylinder of lead in the box *a*. The bridge traverses a slot in the descending ram.

Lead pipes of great length are formed by pressing the molten metal, contained in a cylinder having a tightly fitting piston connected with the ram of a hydraulic press, which forces the metal between a tube and a solid mandrel; after which it may be coiled on to reels.

Titus's mode of making lead-pipe is by the pressure of a vertical column of melted lead, of sufficient hight to force the metal past a forming die and mandrel.

Weight of Lead and Tin Pipe per Foot.

From ⅜ to 5 Inches in Diameter.

Internal Diam.	Thickn's.	Weight.	Internal Diam.	Thickn's.	Weight.	Internal Diam.	Thickn's.	Weight.
Ins.	Ins.	Lbs.	Ins.	Ins.	Lbs.	Ins.	Ins.	Lbs.
⅜	.06	.0424	1	.10	1.5	2	.22	7
⅜	.08	.625	1	.11	2	2	.27	9
⅜	.12	1	1	.14	2.5	2½	3/16	8
⅜	.16	1.25	1	.17	3.25	2½	¼	11
⅜	.19	1.5	1	.21	4	2½	5/16	14
½	.07	.0545	1	.24	4.75	2½	⅜	17
½	.09	.75	1¼	.10	2	3	3/16	9
½	.11	1	1¼	.12	2.5	3	¼	12
½	.13	1.25	1¼	.14	3	3	5/16	16
½	.16	1.75	1¼	.16	3.75	3	⅜	20
½	.19	2	1¼	.19	4.75	3½	3/16	12.5
⅝	.08	.0727	1¼	.25	6	3½	¼	15
⅝	.09	1	1½	.14	3.5	3½	5/16	18.5
⅝	.13	1.5	1½	.17	4.25	3½	⅜	22
⅝	.16	2	1½	.19	5	4	3/16	12
⅝	.20	2.5	1½	.23	6.5	4	¼	16
⅝	.22	2.75	1½	.27	8	4	5/16	21
¾	.08	.0969	1¾	.13	4	4	⅜	25
¾	.10	1.25	1¾	.17	5	4½	3/16	14
¾	.12	1.75	1¾	.21	6.5	4½	¼	18
¾	.16	2.25	1¾	.27	8.5	5	¼	20
¾	.20	3	2	.15	4.75	5	⅜	31
¾	.23	3.5	2	.18	6			

Lead-pipe Tin′ning. The first attempts in this direction were by Alderson in England, who patented his invention in 1804, which consisted in putting an interior casing of tin pipe within the leaden one.

Dobbs, in 1820, gave a coating of resin to the lead pipe, and then placed it in a mold, a core being also placed in the center, or axial position. Tin was then cast upon it and within it, the two becoming perfectly united. It is then ready for drawing or rolling, whichever may be preferred.

Warner treats the lead pipe with resin, so as to encourage the junction of the tin, and the pipe is then submerged in a bath of melted tin. The pipe may be bent, and thus drawn continuously through the bath, receiving its coat as it passes. If any part, say the outside, is not required to be tinned, such part is covered with lampblack and size. The film of tin may be very thin and does not detract from the flexibility. Tin melts at about 440° Fah. and lead at 612°, but at the point of junction an alloy is formed which melts at a lower temperature and forms a solder.

The purer the water the greater the liability to contract impurity from the lead. Waters containing chlorides, sulphates, or carbonates, throw down insoluble salts of lead. The oxide of lead formed on the pipe protects the metal. Pure waters dissolve the oxide slowly, and the gradual decomposition and removal eat away the pipe.

Owing to galvanic action, the lead is more liable to corrosion in spots not covered by the tin, and therefore an imperfectly tinned pipe is worse than one of lead. To insure the continuity of the coating, Naylor of New York City has patented a process of drawing a sponge saturated with a flux that protects the lead and assists in the adherence of the molten tin.

M. J. Grand's process consists in forming an ingot of tin and lead, the latter metal being on the exterior. A single crucible suffices for melting both metals simultaneously, the tin being uppermost and separated from the lead by an iron diaphragm. The lead is run first into a rapidly revolving mold having a gate in its axis, and while still liquid the tin is let on. The two metals thus become firmly cemented together, the pipe is drawn out in the usual way.

Leads. 1. (*Printing.*) Thin metallic slips used for spacing lines, etc. Invented by Schœffer about 1465.

2. A flat roof covered with sheet-lead.

Lead-shav′ing Ma-chine′. A machine for cutting lead into shavings, to be used in the manufacture of white-lead.

A series of rotary knives are, by means of a weight and pulleys, brought into contact with the lower surface of a cylindrical ingot of lead, from which they remove shavings proportionate in thickness to the projection of their edges beyond the box in which they are contained.

Lead, Sheet. Sheet-lead was formerly made by melting pig-lead and pouring the metal on a table having a ledge supporting a roller, which passed over the metal and reduced it to an even thickness. The ledge was all around the table, and determined the thickness of the sheet. The modern process is to reduce an ingot of lead by repeated rollings to the required thickness. This is called in England *milled lead.*

The thin sheet-lead which lines tea-chests is said to be made by pouring a quantity of molten lead upon a flat stone; and upon this, while the lead is yet in a fluid state, a corresponding flat stone is suddenly dashed, the superfluous portion, which is squeezed out around the edges, being afterward trimmed off.

Lead-shot. See Shot.

Lead-sink′er. (*Knitting-machine.*) One of the devices which alternate with the *jack-sinkers* in the depression of the loops between the needles. The lead-sinkers are all attached to one bar, called the sinker-bar, and are raised or lowered all together. See Knitting-machine.

Leaf. 1. A relatively thin and wide object having a flat surface: as, —

a. The leaf of a book, having a page on each of its opposite sides.

b. A valve or hinged member of a bridge, table, door, shutter, hinge, or screen.

c. One member of a pair of lock-gates.

d. A hinged platform for a ferry or wharf boat.

e. A tooth of a pinion.

f. One section of a fan.

g. A thin sheet of hammered gold.

h. One of the elevating flaps of a rifle-sight.

2. (*Weaving.*) The heddles which are connected to the same shaft, and moved at the same time. (See Draft.) The *leaf* is connected with a treadle by a cord. The *number* of leaves is according to the requirements of the pattern, and forms the *set of the draft;* beginning at the back, the *setter* works forward to the front leaf, after which they are again moved in the former succession. Hence we read of a *five-leaf* pattern, an *eight-leaf* pattern. The set of warps which are drawn up by one leaf form the upper part of the *shed* or *shuttle-way.* All the other warps are down for that time, and form the *way* on which the shuttle travels.

Leaf-bridge. A form of drawbridge in which the rising leaf or leaves swing vertically on hinges. One form of *bascule* comes under this description.

Leaf-met′al. 1. Gold-leaf; hammered gold. See Gold-beating.

2. Bronze leaf, or Dutch leaf. The qualities are known as, —

a. Common; soft, reddish color, composed of zinc 1, copper 3.

b. French; harder, less ductile, yellow, larger proportion of zinc.

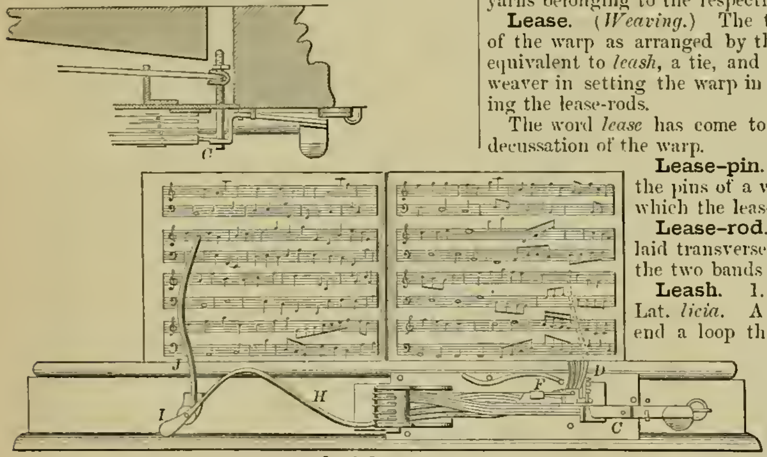
c. Florence; greenish-gold color, still larger proportion of zinc.

d. White leaf; Tin-foil (which see).

Leaf-sight. One on the breech of a fire-arm, having a hinged elevating piece (one or more) as a guide for elevation in firing. A *back-sight.*

Leaf-turn′er. A device for turning sheets of music or leaves in a printed book. The fingers *D* are inserted between the leaves, and by pressing a key *C* are successively released as required from a catch *F*, allowing a spring to act, carrying the finger from the right to the left hand side of the book, and turning the sheet with it. A free arm *H*, with finger-piece and finger *I J*, serves to keep down the leaves on the left-hand side and to turn back the whole series when a piece of music is finished. The fingers *D* may be pressed downward and held in horizontal position by a catch, so that the leaves may pass freely above them when required.

Fig. 2859.



Leaf-Turner.

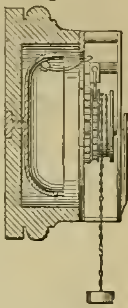
Leaf-valve. (*Pumping-engine.*) A clack-valve. One hinged or pivoted on one side. A *flap-valve; clack-valve.*

Leak-a′larm. An arrangement by which the accumulation of water in the hold of a vessel is made to sound an alarm to call attention to the leak. It is a regular part of duty on shipboard to sound the pumps, but it is a duty sometimes overlooked. Even when the amount is not dangerous, the accumulation of bilge-water may injure the cargo. See Bilge-water Alarm.

In the example, the water rising in the hold elevates the float, permitting the spring drum to revolve and wind up the chain. This rings the alarm-bell, and moves the index which signifies the depth. As the water falls, the float rewinds the spring.

In another case the staff of a rising float trips an escapement and releases a clapper-alarm.

Fig. 2860.



Leak-Alarm.

Leak-In′di-ca-tor. See Leak-alarm.

Leak-sig′nal. (*Nautical.*) A device to notify the watch of the rising of water in the hold. See Leak-alarm.

Leam. A ditch in a marshy district.

Lean-face. (*Printing.*) Type with unusually thin face-lines.

Lean-to. A shed built against the wall of another structure. A *shed-roof.*

Leap. 1. (*Mining.*) The shifting of a vein. A *fault.*

2. (*Hydraulic.*) A wicker fish-net. A *leap-weel.*

Leap′er. A hollow cylinder with a hook at one end, employed in untwisting old ropes. *Loper.*

Lea-rod. (*Weaving.*) One of the rods placed athwart the warp-threads and separating the *leas*, or yarns belonging to the respective *heddles.*

Lease. (*Weaving.*) The tie around each band of the warp as arranged by the *heck.* The word is equivalent to *leash*, a tie, and forms a guide for the weaver in setting the warp in the loom, and inserting the lease-rods.

The word *lease* has come to signify the plane of decussation of the warp.

Lease-pin. (*Weaving.*) One of the pins of a warping-mill, between which the lease is formed.

Lease-rod. (*Weaving.*) A slat laid transversely across and between the two bands of the warp.

Leash. 1. (*Weaving.*) From Lat. *licia.* A thread having at one end a loop through which a thread of the warp is passed, the other end being fastened to a rod or lever, to which all the other leashes of the same set are also attached. A *heddle.*

2. A leathern thong to hold dogs in couples, to be slipped simultaneously after game.

Leat. An artificial water-course. A mill-race.

Leath′er. The *tanned* or *tawed* skin of an animal.

Tanning was practiced in early ages in some localities, but the references to it are comparatively unfrequent. The Bible has but two notices of it, the girdles wherewith the prophets Elijah and John the Baptist were girded about their loins, — type and antitype.

It is not easy to distinguish in the early mentions of leather what was raw-hide and what was really dressed; even of dressed leather there are many kinds, such as the soft dressing with brains and fat, the tawing with alum and salt, the tanning with bark extract. The latter is the more complicated process.

Leathern dresses and fringes of thongs have long been common in Africa, being described by Herodotus: "The Libyan women wear goat-skins stript of the hair, fringed at their edges and covered with vermilion; and from these goat-skins the Greeks get their word *Ægis*" (goat harness). IV. 189.

It is believed that tanning and dyeing of leather was first practiced in Libya, and thence carried to Egypt, from whence it was carried across the sea to Greece. Leather was stained and embossed in Egypt. The "*rams' skins dyed red*," mentioned in the Mosaic account of the tabernacle, were of African manufacture. The Africans yet excel in this art. Yellow, red, and black *morocco* yet attest it.

The old national dress of the Persians was a close-fitting tunic and trousers of leather. Leathern helmets, cuirasses, belts, shirts, and buskins were common among the nations in the motley army of Xerxes.

The Libyans wore dresses of leather.

The Paphlagonians leathern buskins and helmets.

The Gordian knot was of leathern thongs, and was summarily cut about 330 B. C.

Alum was used in *tawing* leather by the Saracens.

We do not recollect any account of human hide leather, but as raw-hide or parchment it has been utilized. The doors of Rochester (England) Cathedral were formerly covered with the skins of Danish pirates. The same is reported of the doors of the churches of Hadstock and Copford, Essex, England. In the case of the Hadstock church, the microscope has determined the truth of the tradition, for a portion having been removed and tested, it proved to be the skin of a fair-haired person. Upon the north doors of the cathedral at Worcester was formerly nailed the skin of a person who had sacrilegiously robbed the high altar. The doors date from the end of the fourteenth century, and have been long ago removed, but were lately still to be seen in the crypt.

The use of the human hide as a drum-head is mentioned by Byron, who celebrates the desire of Ziska for a posthumous place at the head of the army of Bohemians who attacked the Emperor Sigismond and defeated him, in retaliation for the treachery of the latter in leaving John Huss to the cruelty of his Romish persecutors. Ziska died of the plague A. D. 1425, and left orders that his skin should be made into a drum-head, "to beat the advance," as Byron says.

The varieties of tanned leather are classed as *hides*, *kips*, and *skins*.

Hides include the skins of the larger animals, as those of cattle and horses. The parts of hides are known as *butts*, *backs*, *flanks*, etc., and form grades of thickness and quality.

Kips are the skins of small and yearling cattle, beyond the size of calf-skins.

Skins include those of calves, deer, pigs, sheep, seals, and some kinds of fur-bearing animals. The latter are usually called pelts or peltry, and of course preserve their hair.

Cattle-skins are the chief source of supply, and it is needless to cite the purposes to which they are applied. The former uses for armor, shields, and boats have decayed, but modern demands far more extensive have arisen. Calf leather is principally used for boot and shoe uppers and for bookbinding.

Sheep-skins are used for a commoner description of bookbinding, bellows, whips, aprons, bags, women's shoes, cushions, and seat-covers, carriage-tops, gloves, leggings, trunks, and many other purposes. Tanned in oil they form a substitute for real chamois leather.

Goat and *kid skins* form the best material for gloves, morocco leather, and ladies' shoes.

Deer and *antelope skins* are dressed in oil (see BUCKSKIN), and are used for gloves and other purposes. Their former use for breeches has become out of date. They afford material for making what now sells as *chamois* leather.

Horse-hides are used as a substitute for those of cattle in some cases, and probably unsuspected by those who buy articles made of this material. Split horse-leather is made up into shoes. Horse-hides are useful for making horse-collars.

Dog-skin is thin, tough, and valuable. It is good in gloves and for *whang*.

Seal-skin is much used as a fur, and, deprived of its hair, forms a good leather.

Hog-skin is yet to be found on saddles, for which it is better adapted than any other leather, being soft and pliable.

Porpoise-skins yield a soft, strong, durable leather, capable of a high finish.

Hippopotamus-hide makes a leather of great thickness, resembling a board when tanned. It is used in the construction of implements used for beetling in bleaching and washing cotton and linen goods.

Alligator-skins are now largely used.

Buffalo, *elephant*, *shark*, and *rhinoceros* skins also find their way to the tan-vat and a market.

1. *Morocco leather* is made from *goat* and *kid* skins, a peculiar grain being given to the surface.

2. *Chamois*, *shammy*, *shamoy*, or *shamois* leather was originally prepared from the skin of the *chamois*, but the skins of other goats, and even of sheep, are now dressed in the soft manner, and furnish skins for polishing, for gloves, and other purposes.

3. *Buff-leather* is so named from the *buffe* or wild bull of Poland and Hungary. It was used for armor, and tanned soft and white. It is yet used for cartridge-boxes and saber-belts in Europe.

4. *Whang* is tough leather made from skins of calves, dogs, ground-hogs, etc. It is used for bag-strings, whip-crackers, belt-lacing, and other occasional purposes.

5. *Russet* is leather finished except the coloring and polishing. In this condition tanned hides are stored, so as to be completed in any desired manner as the demand may suggest.

6. *Roan;* a leather made from sheep-skins in imitation of morocco, except the grain, and used for bookbinding.

7. *Skiver;* a thin split of leather used for hat-linings, etc.

8. *Wash-leather* is a soft-dressed skin suitable for polishing, for specie-bags, and for cleaning metals, plate, and highly polished articles.

9. *Tawed leather* is tanned with alum and salt, soaked in bran-water, dressed with flour of yolk of eggs, softened by rubbing and stretching.

10. *Fair leather* is finished in the natural color imparted by the bark, and not specifically colored.

11. *Russia-leather* is prepared by a careful and prolonged process, and is said to owe its peculiar smell to oil of birch.

12. *Shagreen* is an Oriental production, and resembles parchment. The hides of horses, asses, and camels are used. These are not tanned, but are indented by a covering of seeds and pressure. The dried skins are then sheared. They are then steeped to raise bulbs where the indentations existed.

13. *Enameled leather.* Leather split to the required thickness, and then subjected to two operations; one to make it impermeable to the varnish, and the other to coat it with varnish.

14. *Split leather.* Leather which has been split, the grain from the flesh side, in a machine for that purpose. It is sometimes done to lighten a leather, sometimes to make two thicknesses, both of which are utilized.

15. *Cordovan.* A Spanish leather supposed to be made of goat-skins, tanned and dressed, but often made of split horse-skins.

16. *Oil-leather* is curried in oil. Fish-oil, with or without potassa, is employed in alternation with drying. Fulling, graining, and pummeling are employed, followed by coloring, stretching, and surfacing.

17. *White-leather*, the same as *tawed leather.* The process leaves the leather *white*, differing thus from that tanned by ooze.

18. *Alum-leather.* The skins are tanned white by a solution of alum and salt. This process is adopted in making wash-leathers. See TAWING.

19. *Bazil.* Sheep-skins dyed with bark and used for making slippers.

20. *Jucten.* A name by which Russia leather is known. See RUSSIA LEATHER.

21. *Hungarian leather.* Made by a peculiar process, allied to *tawing.* See page 1142.

22. *Patent leather.* Made by a process of enameling.

23. *Saffian.* A kind of leather prepared in Asiatic Russia from goat skins.

24. *Maroquin leather.* Same as *saffian.*

Japanned, *patent*, *varnished* leather. See ENAMELED LEATHER, *supra.*

See the above under their alphabetical arrangement in the body of the work.

In connection with this subject it may be stated that sales of hides in the American market are made according to the following classification : —

Green hides are those which are sent in just as they come from the animal, never having been salted.

Part cured are those that have been salted, but not long enough to be thoroughly cured.

Green salted are those that have been salted and are thoroughly cured.

Dry flint is a thoroughly dry hide that has not been salted.

Dry salted is a thoroughly dry hide, having been salted while green.

In *green-salted* hides and skins, those weighing less than 8 pounds are called *deacons ;* 8 to 14 pounds, *calf ;* and 14 to 25 pounds, if plump, *kip*, but if thin and poor are called *runners* or *murrains*, and are sold at two thirds the price of good kip ; all above 25 pounds are called hides.

A green-salted hide is understood to be thoroughly cured, free from salt, dirt, meat, water, horns, tail-bones, and sinews, and before being weighed all such substances are removed, or a proper reduction is made from the weight.

All stag, tainted, and badly scored, grubby, or murrain hides are called damaged, and go at two thirds price, unless they are badly damaged, when they are classed as *glue stock*, and sell at a much lower figure. A deduction of about 10 per cent is made on all branded hides. In dry hides there are other kinds of damaged, such as moth-eaten, sunburned, or weather-beaten.

For varieties of leather and leather-working tools, see under the list in the next column, *et seq.*

Leather is formed by the combination of the substance of the skin with any other compound which has the property of rendering it imputrescible and elastic. — MUSPRATT.

Tannin is the substance generally employed, and has the effect of solidifying the gelatino-fibrous membranes, so that they are no longer putrescible under the joint influence of warmth, air, and moisture.

The *copperas* process, which impregnates the fiber with an insoluble sub-sulphate of peroxide of iron, is effective in the same way.

The *alum process* is one in which the alumina combines with the tissue. See TAWING.

The supposed reaction is the decomposition of the alum by the salt, producing sub-chloride of aluminium, which unites with the fiber. See TANNING.

Tanned skins are *curried* by soaking, rubbing, and paring (see CURRYING), smeared with *dubbing*, which penetrates the leather as the moisture evaporates ; *waxed*, by rubbing on the flesh side with oil and lampblack ; *black*-sized with a brush or sponge ; *tallowed ; slicked* on the flesh-side with a glass-*slicker.*

Leather curried on the *hair* or *grain* side, termed *black on the grain*, is blackened with *iron-liquor* and rubbed with an iron slicker before applying the grease.

The *grain* is raised by a *pommel* or *graining-board.*

The varieties of leather commercially considered are, —

Alum-leather.
American leather.
Backs.
Band-leather.
Bazil.
Belt-leather
Bridle-leather.
Bronze-leather.
Buckskin-leather.
Buffalo.
Buff-leather.
Butts.
Calf-skin.
Chamois-leather.
Cordovan-leather.
Curried leather.
Deer-skin.
Dog-skin.
Dyed leather.
Embossed leather.
Enameled leather.
Fair-leather.
Flint-leather.
Goat-skin.
Green-hides.
Harness-leather.
Hides.
Hog-skin.
Hungarian leather.
Jucten.
Kid.
Kip.
Lamb-skin.
Line-leather.
Linings.
Maroquin.
Oil-leather.
Pad-leather.
Patent-leather.
Roan.
Rough-tanned leather.
Russet-leather.
Russia-leather.
Saddle-leather.
Saffian.
Salted hides.
Seal-skin.
Shagreen.
Sheep-skin
Shoe and boot leather.
Sides.
Skins.
Skirting.
Sole-leather.
Split-leather.
Stamped leather.
Striped leather.
Tawed leather.
Toppings.
Wash-leather.
Waxed leather.
Welt-leather.
Whang.
White leather.

Leather, tools, machines, and appliances for working, excepting harness, for which see SADDLERY.

Alum-leather.
American leather.
Awl.
Bark-pit.
Basane.
Basil.
Bating.
Bawsin.
Beam
Beaming-machine.
Beam-knife.
Belt.
Belt-clasp
Belt-coupling machine.
Belt-cutter.
Belt-fastener.
Belt-lacing.
Belt-punch.
Belt-splicing.
Belt-tightener.
Bend-leather.
Blocking.
Bloomer-pit.
Boarding.
Boarding-machine.
Boot.
Boot-channeling machine.
Boot-clamp.
Boot-crimp.
Boot-edge trimmer.
Boot-grooving machine.
Boot-heel cutter.
Boot-holder.
Boot-hook.
Boot-machine.
Boot-seam rubber.
Boot-shank machine.
Boot-stretcher.
Boot-tree.
Boot-ventilator.
Bruising
Buff-leather.
Burnishing-machine.
Calk.
Chamfering-tool.
Chamois-leather.
Channeling-machine.
Channeling-tool.
Cheveril.
Cleaner.
Clearing-stone.
Clog.
Collar-awl.
Collish.
Cordovan
Crap-leather.

Creaser.
Crimper.
Crimping-clamp.
Crippler.
Currier's knife.
Curry-card.
Currying.
Cutting-board.
Dicing-leather.
Dubbing.
Edge-plane.
Edge-tool.
Enameled leather.
Fair-leather.
Fell.
Flank.
Fleshing.
Float.
Flounder.
Forel.
Fore-part iron.
Frizzing.
Fudge wheel.
Fulling-stock.
Gaiter.
Galoche.
Gang-punch.
Grain.
Graining.
Grain-leather.
Grains.
Gullet-hook.
Hair-side.
Handler.
Hand-pegger.
Hand-punch.
Harness.
Heading-knife.
Heel-blank.
Heel-breasting machine
Heel-burnishing machine.
Heel-calk.
Heel-cutter.
Heel-face dresser.
Heel-iron.
Heel-machine.
Heel-polisher.
Heel-polishing machine.
Heel-seat cutter.
Heel-shave.
Heel-tap.
Heel-trimmer.
Herse.
Hide-handler.
Hide-rope.
Hide-scraper.
Hide-shaving machine.
Hide-stretcher.
Hide-worker
Hollow punch.
Horse.
Hose.
Hose-making machine.
Huffling
Hungarian leather.
Ice-creeper.
Ice-sandal.
Insole.
Instep-stretcher.
Jappanned leather.
Jigger.
Jucten.
Kip.
Lap-shaper.
Lap-skiving machine.
Lap-stone.
Last.
Laster.
Last holder.
Lasting-awl.
Lasting-jack.
Lasting-machine.
Lasting-pinchers.
Lasting-tool.
Layer.
Leach.
Leather.
Leather. Artificial
Leather-awl
Leather-boarding machine.
Leather-buffing
Leather-chamfering machine.
Leather-cloth
Leather-corrugating machine.
Leather-creasing machine.
Leather-cutting machine.
Leather-dicing machine.
Leather-dressing machine.
Leather-edging machine.
Leather-embossing machine.
Leather-finishing machine.
Leather-fleshing machine.
Leather-fluting machine.
Leather-glassing machine.
Leather-glueing.
Leather-gouge.
Leather-graining machine.
Leather-grinder.
Leather-hammering machine.
Leathering-jack.
Leather-knife.
Leather-paper.
Leather-pebbling machine.
Leather-piercing machine.
Leather-polisher.
Leather-pressing machine.
Leather-punch.
Leather-punching machine.
Leather-quilting machine.
Leather-raising machine.
Leather-reducing machine.
Leather-roller.
Leather-rolling machine.
Leather-rounding machine.
Leather-scalloping machine.
Leather-scarifying machine.
Leather-scouring machine.
Leather-skiving machine.
Leather-slitting machine
Leather-softener.
Leather-sorting machine
Leather-splitter.
Leather-stamping.
Leather-stretcher.
Leather-striping.
Leather-stripping machine.
Leather-stuffer.
Leather-tapering machine.
Leather-washer.
Lift.
Lining.
Lining-apparatus.
Losh-hide.
Mace.
Maroquin leather.
Moccasin.
Moon-knife.
Morocco-leather.
Nailing-machine.
Oil-leather.
Overshoe.
Packing-awl.
Pannuscorium.
Parchment.
Patent-leather.
Pebbling.
Pebbling-machine.
Peg.
Peg-cutter.
Peg-float.
Pegging-awl.
Pegging-jack.
Pegging-machine.
Pep-strip.
Pelt.
Plate-leather.
Pommel.
Pooler.
Pricker.
Pricking-wheel.
Pure.
Raising.
Raising-board.
Rand.
Randing-machine.
Raw-hide.
Roan-leather.
Round knife.
Rounding-tool.
Russet-leather.
Russia-leather.
Saddlery.
Saddler's pinchers.
Saffian.
Sandal.
Scalloping-tool.
Screw wire-fastener.
Scribing-compass.
Seal-skin.
Seam-roller.
Seam-set.
Secreting.
Setting-punch.
Sewing-clamp.
Sewing-horse.
Shagreen.
Shammy.
Shank.
Shank-cutter.
Shank-iron.
Shank-laster.
Shank-wheel.
Shoe.
Shoe-clasp.
Shoe-distender.
Shoe-fastener.
Shoe-horn.
Shoe-jack.
Shoe-key.
Shoe-knife.
Shoemaker's pinchers.
Shoe-making machine.
Shoe-nailing machine.
Shoe-peg.
Shoe-shave.
Shoe-stretcher.
Skin-stretcher.
Skiver.
Skiving-machine.
Slicker.
Slicking-gage.
Slicking-machine.
Slippers.
Sole-finishing tool.
Sole-rounding machine.
Sole-shaper.
Soles. Machine for cutting
Sorting-machine.
Split-leather.
Splitting-knife.
Splitting-machine.
Steel.
Stitching-clamp.
Stitching-horse.
Stitch-wheel.
Stock-stone.
Straining-fork.
Straining-reel.
Stretcher.
Stretching-iron.
Striking-knife.
Stuffing.
Tack-claw.
Tag-cutting machine.
Tanning.
Tanning-vat.
Tawing.
Tip.
Trestle.
Trimming-machine.
Turning-machine.
Unhairing.
Unhairing-knife.
Unhairing-machine.
Uppers. Machine for cutting
Vamp.
Vellum.
Wash-leather.
Water-proofing machine.
Waxed ends. Machine for making
Waxing.
Waxing thread. Machine for
Welt.
Welt-guide.
Welt-knife.
Welt-machine.
Welt-trimmer.
Whang.
White-leather.
Whitening.
Wrinkling-machine.
Yufts.

Leath'er, Ar-ti-fi'cial. Cloth treated with oils, pigments, and gums, to give it a shining, water-proof surface.

The materials used are: —

Linseed and resin oil.

Glue, glycerine, boiled linseed-oil, caoutchouc, coloring matter; impressed with a design while hot, to imitate morocco, afterwards treated with a solution of chrome alum or copperas.

Turpentine and naphtha.

Lampblack.

Caoutchouc and gutta-percha.

Stearine, gelatine, leather parings.

Bark infusions, alum.

In various combinations and proportions.

Gunby's artificial leather, 1824 (English), cotton, linen, woolen, or felt cloth is coated with the following composition: —

Common glue-size, 8 parts; boiled linseed-oil, 4 parts; lampblack, 1 part; white-lead, 2 parts; pipe-clay, 2 parts.

This is to be melted and well mixed. The cloth is stretched and the composition spread by a palette-knife. Dry by a stove; repeat the composition and dry. Four or five coats may be thus applied. Varnish to give a gloss.

Hancock's artificial leather (English). A card or wide sliver of flax or cotton fibers is condensed so as to resemble a felted material. This is treated with liquid caoutchouc laid on by a spatula. It is then rolled, coated with resin, and rerolled.

Bonneville's artificial leather is made from leather cuttings, shavings, and parings, by reducing while in a dry state to powder. This powder is next mixed with a solution of india-rubber, with or without a solution of gum-lac, or of marine glue, to a suitable consistence. When partially dried, which process is effected by straining on wire-cloth or perforated metal, the sheets or slabs of artificial leather are pressed between rollers, and, if required, are ornamented in any suitable way.

In general terms, artificial leather may be stated to be any kind of cloth or paper immersed in a solution of the following ingredients, or any of them in combination : Gelatine, glue, soap, oil, glycerine, saccharine matter, water, clay, aluminous earth, plaster, ground slate or stone, cement, any oxide of metal, or pigment.

Or any kind of fabric or paper in a composition embracing any of the gums or resins, — dextrine, caseine, albumen, gluten, or starch.

The following ingredients are also used : tannic-acid, cutchin, gallic acid, boracic acid, alum, borax, chrome alum. See also LEATHER-PAPER.

Leath′er-awl. 1. A shoemaker's piercing-tool for stitching or lasting. See AWL.

2. A tool for lacing belts. In one case it has a broad point, which fades away into two cutting edges on a conical scoop-shaped blade, which make a clean, circular cut of the desired size within the capacity of the blade.

Or it has an eye-point to carry the lacing through.

Leath′er-board. (*Leather.*) A composition of leather scraps and paper material, ground together and rolled out into sheets.

Leath′er-board′ing Ma-chine′. A machine in which tanned leather may be pressed and rubbed to supple and soften it, so as to fit it for the subsequent operations, which are generally comprised under the term *finishing*. See BOARDING-MACHINE, Figs. 740, 741.

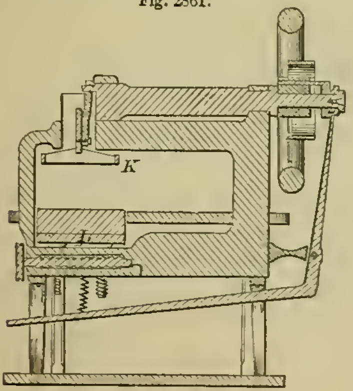
Leath′er-buff′ing Ma-chine′. A machine in which the surface of leather is reduced to a smooth but not polished surface, the face being left with a slight nap, velvety, like buff leather.

Leath′er-cham′fer-ing Ma-chine′. A machine for beveling the edges of straps or strips of leather, giving a feather or thinned edge thereto. It is a skiving process, and is usually performed on a *skiving* or *shaving* machine.

Leath′er-cloth. (*Fabric.*) A fabric covered with a water-proof composition, usually having a polished surface. It generally consists of a paint or a varnish, sometimes the former with a covering coat of the latter. The changes in menstruums, resins, pigments, and coarse and cheap materials, which are added for quantity, are so various that room cannot be afforded for stating them at length. See ENAMELED CLOTH ; LEATHER, ARTIFICIAL.

Leath′er-cor′ru-gat′ing Ma-chine′. A machine in which leather is crimped, corrugated, or fluted for certain purposes in manufactures. It is usually done by passing between a fluted and a plain roller and drying while the indentations are preserved ; or it may be done by passing the leather while damp between plates or dies of the requisite form.

Fig. 2861.



Sole-Cutting Machine.

Leath′er-creas′ing Ma-chine′. A machine for ornamenting the edges of leather straps by passing between rollers indented with the required patterns in intaglio and cameo.

Leath′er-cut′ting Ma-chine′. A machine for cutting leather into shapes for shoe-stock or other purposes ; sole-leather into soles and lifts, for instance. The sole-leather is placed on the adjustable table *L* beneath the platen *K*, and a die which is of the shape of the piece to be cut is placed upon the leather. Pressure on the treadle throws the friction-clutch into operation, and the cam-shaft is rotated, depressing the platen upon the die and cutting a sole from the leather.

Leath′er-dic′ing. Another name for *leather dressing* or *finishing* or *polishing*. Also known as *glassing*, the tool for the purpose being usually a slip of glass set in the grooved edge of a wooden strip which forms the handle.

Leath′er-dress′ing Ma-chine′. A machine in which tanned and curried leather undergoes the finishing operations which improve its texture and surface. The term is somewhat indefinite, as *boarding* or *graining*, *scouring*, *coloring*, and *glassing* or *polishing* are or may be all performed upon the leather in course. See under those heads.

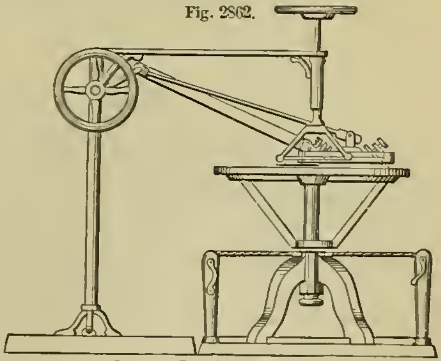
Leath′er-em-boss′ing Ma-chine′. A press or roller having an engraved pattern or one otherwise procured by casting or electro-plating, and which is impressed upon leather in a damp state. Schroth's English patent, 1839, describes dies of type-metal or a fusible alloy containing bismuth ; the leather is beaten soft in water, wrung, pressed, rolled, and fulled, until it becomes quite supple. It is then laid on the die and driven in by a bone tool or by a press. It is allowed to dry *in situ*. See also LEATHER-PEBBLING MACHINE.

Leath′er Feath′er-edg′ing Ma-chine′. One for skiving off the edge of a piece or strip of leather, gradually thinning it toward the edge, which is left comparatively sharp. See LEATHER-SKIVING MACHINE.

Leath′er-fin′ish-ing Ma-chine′. A machine in which tanned and curried leather is dressed to give it the required texture and surface finish.

In the example, the leather is placed on the table, which has horizontal and rotary movement beneath the reciprocating "plane stock," which carries two slickers and a circular knife, which act upon the surface of the leather. The term is somewhat indefinite, and may include boarding, graining, glassing, polishing, etc.

Fig. 2862.

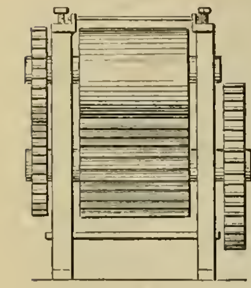


Leather-Finishing Machine.

Leath′er-flesh′ing Ma-chine′. A machine for reducing the thickness of leather by shaving off a portion of the flesh side.

Leath′er-flut′ing Ma-chine′. A machine for corrugating leather, as in the example, in which the leather when damp is run between a fluted and a plain roller, and afterward dried between heated plates of similar conformation. Sole-leather so prepared is used for work of a cellular character.

Fig. 2863.



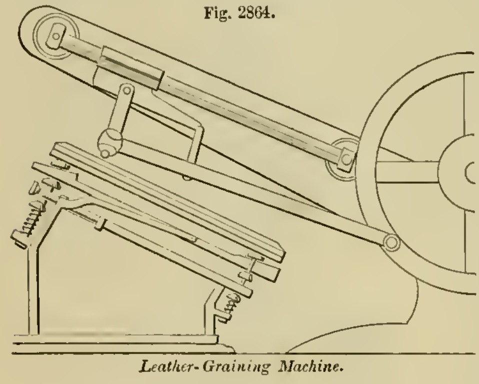
Fluting-Machine.

Leath′er-glass′ing Ma-chine′. One in which the leather is dressed or polished in a machine which has a "glassing-tool" attached to a suspended arm, which is vibrated by crank and pitman over the leather, which rests on a yielding bed below, curved to the arc of the swinging tool. The glassing-tool has an elastic bearing at its pivot to enable it to yield to inequalities. See LEATHER-POLISHING MACHINE.

Leath′er-glu′ing Ma-chine′. A machine for holding firmly together the scarfed ends of united sections of leather belting. See GLUING-PRESS, in which the contiguous, beveled, cemented ends of the leather strips are clamped between the bed-piece and the face of the pivoted platen.

In Fig. 2864, the leather is laid upon an inclined table, vertically adjustable by inclines and supported by springs which give a certain elasticity to the bed.

Fig. 2864.



Leather-Graining Machine.

The graining-tool is reciprocated above the leather, a crank acting upon a pitman and arm, the latter depending from the sliding carriage.

Leath′er-gouge. (*Saddlery.*) A tool used to cut channels in leather for receiving the thread of a line of stitches.

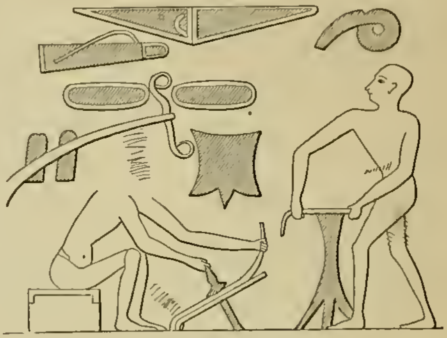
Leath′er-grain′ing Ma-chine′. A machine in which tanned hides may be boarded, grained, or softened, to render them flexible, that they may be in the supple and absorbent condition fit for the other finishing processes. See BOARDING-MACHINE, Figs. 740, 741, *ante.*

Leath′er-grind′er. A machine for reducing scraps of leather to shreds, in order that the material may be made into washers, in-soles, and heels for shoes. The machine has a feeding-box, a follower or piston, by which the shreds are kept in a compact mass while being acted upon by a set of revolving tearing teeth. A set of revolving clearers act to clear out the tearing teeth, and a contrivance is used for throwing streams of water upon the teeth.

Leath′er-ham′mer-ing Ma-chine′. A machine of the nature of a drop-hammer or *oliver*, for compacting leather for shoe-soles.

Leath′er-knife. The leather-cutter's knife with a curved blade seems to have undergone no special change for three thousand years. The figure in the accompanying cut is from a group on a building at Thebes; it represents men cutting out harness.

Fig. 2865.



Leather-Cutting (Thebes).

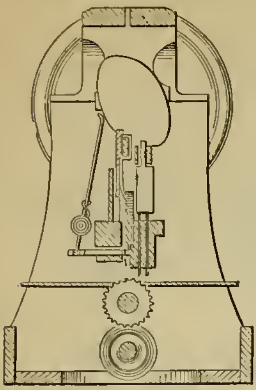
Leath′er-pa′per. A mode of preparing paper, in which it is made to assume the appearance of leather. The Japanese process is about as follows: Sheets are damped and laid in pairs between sheets of varnished paper, which have a crinkled grain running in one direction. They are then wound upon a roller, the grain of the pattern of the paper derived from the crinkled sheets between which it was laid running around the roller. The roller being slipped out, the roll of paper is slipped into a cylinder and subjected to endwise pressure, reducing it to three quarters its original length. It is then unwrapped and pressed to remove the deep marks. It is then again rolled, colored, oiled, varnished, pressed, and dried. By means of parallel or cross lines on the rollers, the upper surface of the paper is made to resemble leather exactly in all its varieties. The paper being pressed to one third, or even to one half, its original thickness, and the passage through the rollers giving it a fine-grained appearance, makes it valuable to picture-printers, as the surface has the appearance of crêpe silk.

There is another variety of leather-paper which is smooth and transparent, resembling hog-skin very much. This is manufactured by a process of hammering, and is the higher priced.

Leath′er-peb′bling Ma-chine′. One in which a fancy surface is given to dressed leather, resembling morocco, levant, hog-skin, or other fancy style. The leather is passed upon a bed beneath a roller having the desired pattern. The pattern is given by soft metal, which has been cast upon an original surface of the required character (see LEATHER-EMBOSSING), or the pattern of the roller is obtained by taking an electrotype copy of some selected piece of leather and transferring to the roller.

Leath′er-pierc′ing Ma-chine′. A machine for stabbing objects of leather, as, for instance, straps or soles for stitching. In the example, the leather is fed first to the piercing-tool, and then to the die which forces the wire into the openings, the two operations being performed simultaneously in consecutive openings. The wire is fed by a cam acting on feed-wheels, is cut by a chisel, and placed in proper position for the driving-die.

Fig 2866.



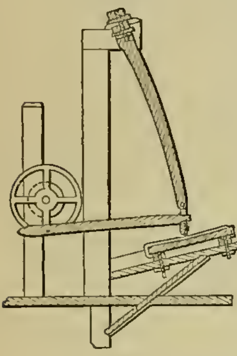
Leather-Piercing Machine.

Leath′er-pol′ish-er. A machine in which the surface of leather is condensed and polished beneath a reciprocating slicking-tool.

The leather is placed upon a table whose top is curved to agree with the arc of oscillation of the tool. The glassing-tool has an elastic bearing at its pivot, which enables it to yield to inequalities, and it is reciprocated by connection to a wrist on a hand-wheel.

Leath′er-press′ing Ma-chine′. A machine in which leather previously damped, and in some cases after receiving a preliminary local stretching, is pressed into form between corrugated or salient and receding surfaces, as the case may warrant. Used for making harness-pads and many other purposes.

Fig. 2867.



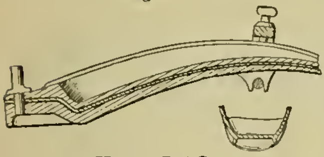
Leather-Polishing Machine.

In the example, the pad-holder consists of a thin shell of cast-iron, having on its bottom two ribs to form a support for the holder when clamped on the stitching-horse.

Leath′er-punch. A hand-tool for making holes in leather for the insertion of eyelets or lacing.

Fig. 2869 has a lock-plate pivoted by its shank within the jaw of the punch, and is operated by a key-like handle, so that it may be made to hold and release different cutting-tools. The folded end of the strap is operated upon by the cutter, and an oblong opening is formed thereby.

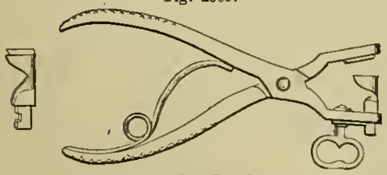
Fig. 2868.



Harness-Pad Press.

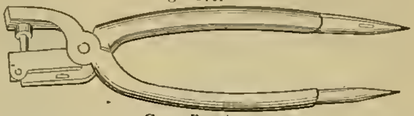
Fig. 2870 is a belt-punch, in which the jaws and punching-devices are combined with a knife-blade, a punch, a needle, and an awl, arranged with reference to each other upon the respective portions.

Fig. 2869.



Spring-Punch.

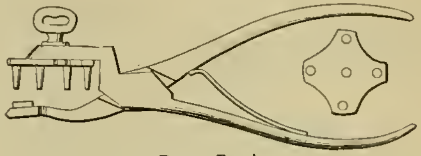
Fig. 2870.



Gage-Punch.

Fig. 2871 is a spring-punch, having a series of tubular cutters which differ in size, and either of which may be readily brought into requisition.

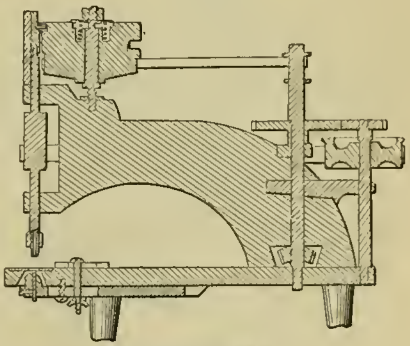
Fig. 2871.



Rotary Punch.

Leath′er-punch′ing Ma-chine′. A machine in which punch and die are automatically operated, while the material is fed between them by hand or otherwise. The punch has an annular sleeve-die which makes a circular imprint around the opening, a pin beneath forcing the pellet into the throat of the die. The punch and die-stock are reciprocated by a wrist and cam-wheel, a certain elasticity of the latter on its shaft providing for the requirements of varying thicknesses of leather. The punch is revolved by band and wheel.

Fig. 2872.



Leather-Punching Machine.

Leath′er-quilt′ing Ma-chine′. A form of sewing-machine.

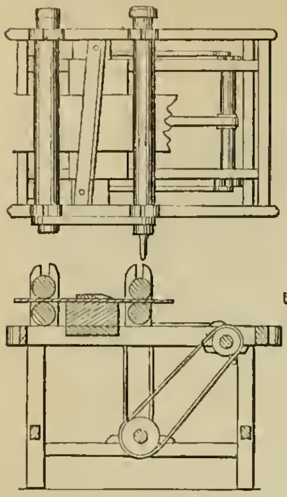
Leath′er-rais′ing Ma-chine′. (*Harness.*) A machine for giving raised and ornamented or beaded edges to straps. A *leather-creasing machine.*

Leath′er-re-duc′ing Ma-chine′. A machine to shave or reduce the inequalities of the flesh side and bring the piece of leather to a uniform thickness.

In the example, the machine has pairs of receiving and delivering rolls, and between them a flat reciprocating knife, which is set obliquely across the path of the leather and thus delivers a draw-cut.

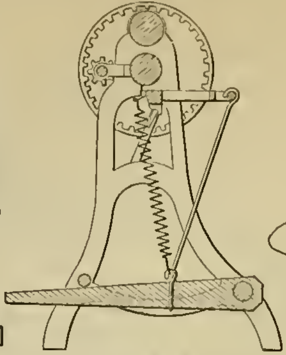
Leath′er-roll′ing Ma-chine′. A machine to compress and harden leather, instead of hammering it. The journals of the lower or pressure roller are mounted in a movable lever frame, which is provided on the under side of either end with projec-

Fig. 2873.



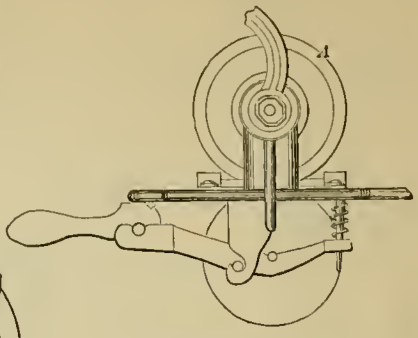
Leather-Reducing Machine.

Fig. 2874.



Leather-Rolling Machine.

Fig. 2877.

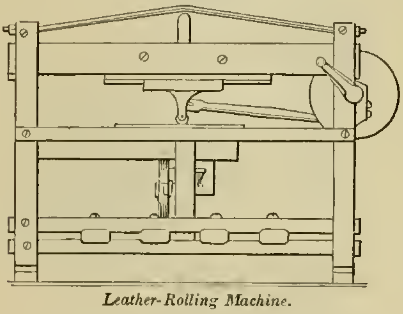


Leather-Scalloping Machine.

tions resting upon joints, which are supported upon the central portion of a cross-piece in the main frame, in such manner as to operate with the lever frame like a toggle-joint, in addition to the usual compound lever employed for moving the pressure-roller.

In another machine, the skin of leather is placed on the table, which is raised more or less by toggle-levers, to regulate the pressure of the roller. The roller is journaled to a slide reciprocated by connection to a crank. The tool is a steel roller or glass edge.

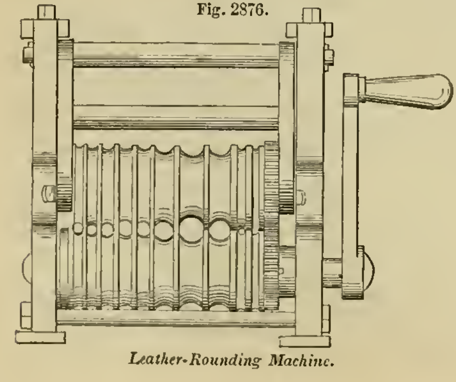
Fig. 2875.



Leather-Rolling Machine.

Leath′er-round′ing Ma-chine′. (*Harness-making.*) A machine for making round lines or whip-covers from flat strips of leather, by gradually turning the edges inward and strongly compressing the material. In the example, the rolls have graduated circular apertures between them, and the upper one is carried in a frame pivoted so as to be adjustable in distance from the other roller. The action is somewhat similar to that of rolling gun-barrels from skelps.

Fig. 2876.

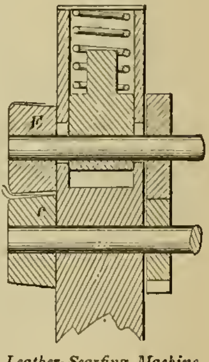


Leather-Rounding Machine.

Leath′er-scal′lop-ing Ma-chine′. A machine for giving a wavy outline to the edges of leather straps to be used in making ornamental harness, and for other purposes. The example has a pair of wavy-edged disks set at any required distance apart, according to the width of strap operated upon. In the drawing, the scalloped shape of the disk *A* is not apparent, and the farther disk is hidden by the near one. The pressure of the bed-roller against the scalloped disks is increased by a cam-lever at one end of the supporting lever of the bed-roller. Motion is given to the scalloped disks by a winch.

Leath′er-scarf′ing Ma-chine′. One for beveling the edges of leather, slanting off the thickness to enable pieces to be united by a scarf-joint. In the example, the stationary horizontal cutter, opposed to the space between the rollers *E c*, cuts the leather obliquely as it passes through between them. *Scarfing*, *skiving*, *chamfering*, and *feather-edging* are synonymous terms; the first two more often applied to leather generally, and the last to *beveling* leather for soles, leaving a blunt edge. The lap-seam uniting the vamp and quarters, in fine work, is sometimes formed with skived edges to avoid a ridge. In coarse work, as plow-shoes, the leather about the ankle-opening is chamfered from the inside to prevent chafing. Leather is also skived for making lap-joints in round work and belting.

Fig. 2878.

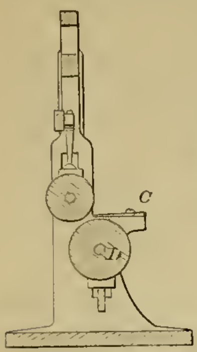


Leather-Scarfing Machine.

Leath′er-scour′ing Ma-chine′. A form of leather-finishing machine, or rather one of the modes of operation of such a machine, which is usually adapted for *scouring*, *graining*, or *boarding* or *polishing*, according to the character of the tool which is brought upon the skin under treatment. See Leather-finishing Machine.

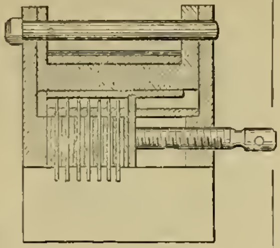
Leath′er-skiv′ing Ma-chine′. A machine for shaving leather to a thickness, skiving off a portion of the flesh side. In the illustration, the leather is passed obliquely upward between the rollers and against the edge of the knife *C*, whose position relatively to the adjustable roller *D* determines the thickness of the leather which passes between the knife and roller, the skive passing above the knife.

Fig. 2879.



Leather-Skiving Machine.

Fig. 2880.

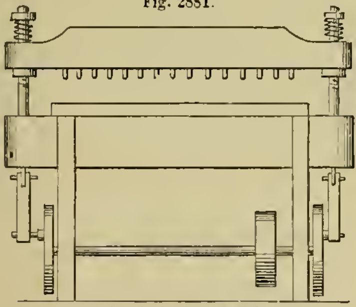


Leather-slitting Machine.

Leath′er-slit′ting Ma-chine′. A machine used principally by harness-makers and saddlers, for cutting leather into straps; the knives are adjustable in distance from each other, to fit them to form straps of different widths. In the example, a series of knives is placed between guides separated by plates and clamped by a set-screw. A segmental, leather-covered frame is hung so as to be brought down over the cutters or thrown up therefrom. The leather, after reduction to the proper thickness, is placed on the cutters and the block brought down thereon. The leather is then drawn through between the gang of cutters and the segmental plate above, which form a surface against which the knives cut.

Leath′er-soft′en-er. A machine for working dry hides or leather, to make them flexible, and enable them to be worked without breaking. It is a preliminary to the operations of tanning dry hides or of finishing processes with tanned skins. The machine has corrugated rollers which press and extend the leather, or it acts by pounding. In the example, the bed has a series of depressions, and the cross-head a series of matching projections, between which the leather is passed. The cross-head has vertical reciprocation from two cranks on a rotating shaft beneath.

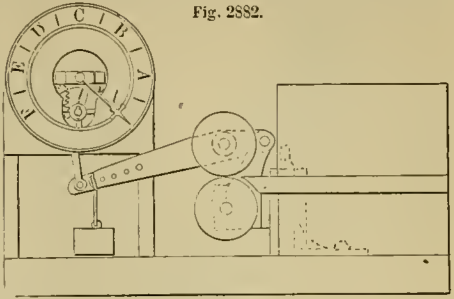
Fig. 2881.



Leather-Softening Machine.

Leath′er-sort′ing Ma-chine′. A machine in which leather strips are assorted according to thickness. In the example, the strips of leather cut from the skin to form shoe-binding are thus sorted. Connected with the contacting surfaces, between which the strips pass, is mechanism indicating by a finger and dial the thickness of the passing strip.

Fig. 2882.

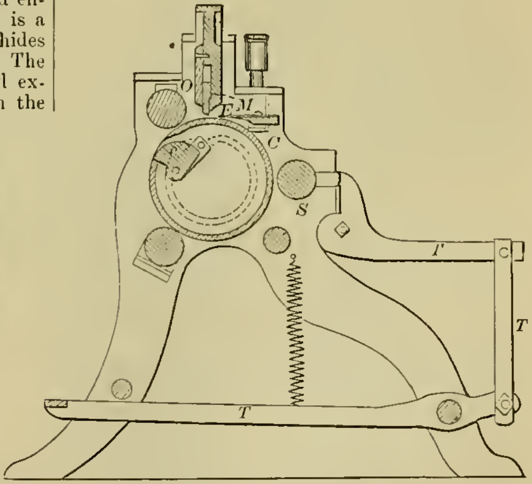


Leather-Sorting Machine.

Leath′er-split′ting Ma-chine′. An apparatus for dividing leather into two or more layers. Split leather is much used in making boots and shoes of cheap quality. The advantage in using the splitting-machine is that the quantity of leather surface is doubled. By splitting so as to preserve the *grain side*, one sheet of very fair leather may be obtained, while the other (*skiving*) is fit for trunk-covers, etc. The machine consists essentially of one or more rollers, which draw the leather against the edge of a horizontally arranged long knife, by which it is divided, one half passing above and the other below the knife.

In Stearns's machine (Fig. 2883), the leather is drawn forward by the tooth *c* on the carrying cylinder *C*, passes between the roller *O* and presser-bar *E*, and after being split by the adjustable knife *M* is drawn between the carrying cylinder and the roller *S*, in order to compress and smooth it; the amount of pressure being governed by the treadle and levers *T T T*.

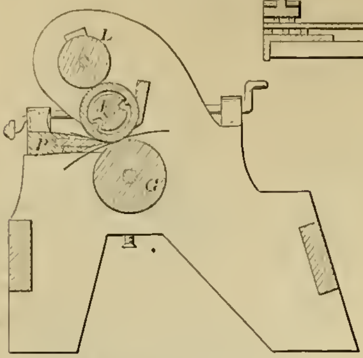
Fig. 2883.



Stearns's Leather-Splitting Machine.

In Marden's machine (Fig. 2884), the leather is drawn to the knife *P* between the rollers *G J*, the latter gears loosely with both the rolls *G L*, and its bearings are elongated vertically, that it may rise and fall to admit leather of varying thickness.

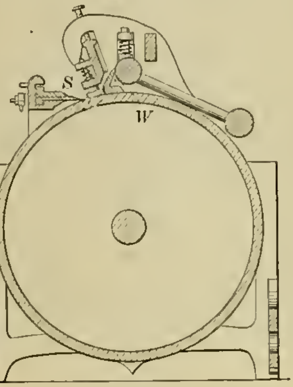
Fig. 2884.



Marden's Leather-Splitter.

Fig. 2885, the knife *S* reciprocates longitudinally, the cylinder is adjustable, and the leather is held down by a foot on the presser-bar *W*.

Fig. 2885.

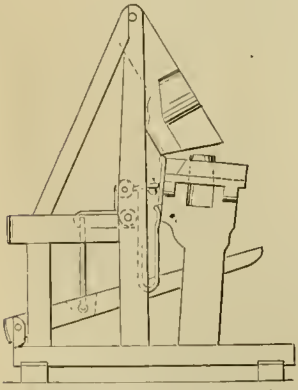


Leather-Splitter.

In another machine, the leather is split by an endless, knife-edged, steel band, sharpened by an emery-wheel while running.

Leath′er-stamp. A machine for stamping and shaping leather. The die and follower are jointed to form a toggle. The lever operates the bell-crank lever and toggle-joint, and brings the follower down upon the knife or die-plate, and thereby cuts the leather to the shape of the face of the die.

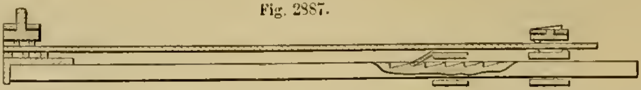
Fig. 2886.



Machine for Stamping and Shaving Leather.

Leath′er-stretch′er. A frame in which a side of leather is stretched, that it may dry flat. Some frames have tenter-hooks, others are made with sides expanded by wedges, like a painter's canvas. In the example, the bar has one fixed and one movable clamp, and between them is a slide-bar having a pawl to catch in a ratchet in the main bar, and rubber springs acting on the movable clamp.

Fig. 2887.



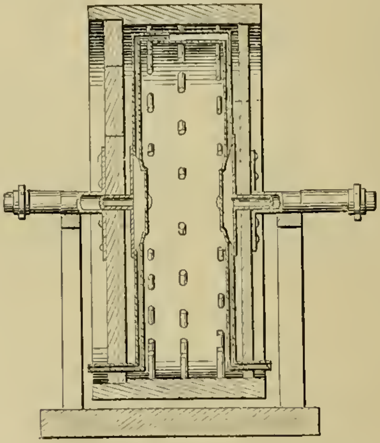
Leather-Stretcher.

Leath′er-strip′ing. (*Shoemaking.*) A machine for marking binding-leather with stripes to be cut into strips for shoe-binding, etc.

Leath′er-strip′ping Ma-chine′. A machine for cutting sides of leather into strips of uniform width, from which soles and heels are afterwards to be punched by hand or by power.

Leath′er-stuff′er. A machine or a revolving chamber in which hides are made supple and stuffed with dubbing, to make them soft and pliable. It is the equivalent of the breaking-machine, which is used to break dried hides before tanning. The hand-process is to rub and bend them gently until the fibers yield and gradually absorb moisture. In the stuffer shown in the figure, the heating-chambers of the cylinder are placed inside the heads, and receive steam through the tubular gudgeons. The steam passes off through radial pipes. The hides tumble about in the box, become softened by heat and impact, and absorb the dubbing, which is tallow mixed with fish-oil or petroleum.

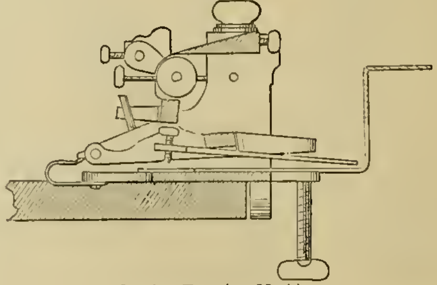
Fig. 2888.



Leather-Stuffer.

Leath′er-ta′per-ing Ma-chine′. A machine

Fig. 2889.

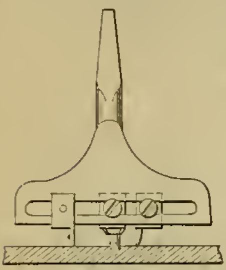


Leather-Tapering Machine.

in which leather straps may be shaved or beveled toward the end. Such a machine is arranged so as to be adapted to any width or thickness of leather. In the example, the cutter is hinged at one end to a stationary frame, and is vertically adjustable at the other end. The axis of the friction-roller connected with the vertically adjustable frame is directly under the cutting-edge of the knife. The roller is supported on a sliding frame that is gradually raised toward the knife, for tapering the ends of leather belts.

Leath′er-wash′er. Tools for cutting leather-washers are on the principle of the trepan or the annular auger. The example shows one in which the cutters are both adjustable relatively to the center-pin, so as to cut a washer of any size with a hole of any size. The washers are cut by revolving or turning the tool upon the center-pin, in the material from which the washer is to be made. The tool is held in a brace.

Fig. 2890.



Washer-Cutter.

Leav′en. Sour dough, for producing fermentation in a quantity of freshly made dough. A substitute for *yeast.* See Bread.

Le-clanche′ Bat′ter-y. A form of galvanic battery invented by Georges Lionel Leclanche, a French electrician.

Two forms of battery are known by this name: —

1. A porous cup in which the carbon or – element is placed, the remaining space in the cup being filled with a mixture of peroxide of manganese, chlorohydrate of ammonia, and sawdust. This cup is placed in a cell in which the zinc or + element is also placed. One liquid is used containing a salt which has no chemical action on the peroxide of manganese, but which is capable, by its electrolytical decomposition, of rendering soluble the oxides of manganese. The salt commonly used in the exciting liquid is muriate of ammonia. The battery-cup is hermetically sealed for convenience of transportation. Patented August 23, 1867. Reissued February 17, 1874.

2. A plate of copper with wire attached is covered in the jar with powdered carbonate of copper; over this is placed a stratum of sand, in which is imbedded the zinc with wire attached. The whole is then saturated with a solution of chlorohydrate of ammonia. June 5, 1866. Reissued February 17, 1874.

Lec′tern. (*Architecture.*) The reader's desk in a church.

Ledge. 1. (*Architecture.*) A small molding, as the Doric drop-ledge.

2. (*Joinery.*) *a.* A piece against which something rests; as the batten on the back of a door, the fillet against which a door closes, etc.

b. A shelf.

3. (*Mining.*) A stratum of metal-bearing rock.

4. (*Shipbuilding.*) A thwart-ship piece in the deck-framing. See Shelf-piece.

A support for the decks, parallel to and intermediate between the beams. See Head-ledge.

5. (*Printing.*) A piece of furniture; a stick used in wedging up.

Ledg′er. 1. (*Scaffolding.*) A horizontal pole, parallel to the walls, lashed to the *standards* or vertical poles, and supporting the *putlogs* on which the boards of the bricklayers' scaffold rest.

2. (*Masonry.*) A large, flat cap-stone, over a tomb for instance.

Ledg′er-blade. The stationary blade with a rectilinear edge, placed as a tangent to the spirally bladed cylinder, by which cloth is shorn and the nap reduced to a length.

Another form of cloth-shearing machine has a semicircular ledger-blade, and a large revolving-wheel containing 8 small cutting-disks, revolved by planetary pinions, and acting as shears in connection with the edge of the ledger-blade. See Cloth-shearing Machine.

Ledg′ment. A string-course, or horizontal suite of moldings, such as the base-moldings of a building.

Lee. (*Nautical.*) The side of a ship opposite to that from which the wind blows; the sheltered side. The *lee-way* of a vessel is the amount of its drifting to *leeward.*

Lee-board. (*Nautical.*) A board lowered on the lee side of a flat-bottomed vessel to act as a temporary keel in avoiding lee-way, preventing the vessel drifting to leeward.

A *center-board* is a lee-board, raised and lowered in a water-tight well amidships. See Center-board; Sliding-keel.

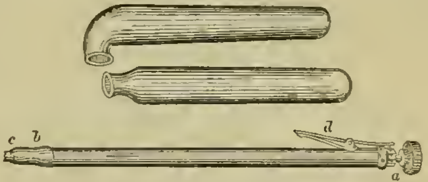
Leech. (*Nautical.*) The side edge of a square sail. The foremost edge (for the time being) is the *luff* or *weather-leech.*

In a *fore-and-aft* sail, the after edge is the *leech.*

Leech, Ar-ti-fi′cial. (*Surgical.*) A light glass tube from which the air is expelled by the vapor of ether, and whose mouth is then applied to a previously scarified portion of the body.

To expel the air from a tube, a few drops of ether are poured into it, and it is then immersed as far as the mouth in hot water until the ether boils briskly. The mouth of the tube is then applied to the skin, and held for an instant, when it will be found to be firmly attached, and can be left to itself. Each tube will draw about two ounces of blood. For uterine practice they are made long enough to be applied through a speculum.

Fig 2891.



Artificial Leech and Scarifier.

The scarifier is simply a tube one eighth inch in diameter, having a cutting-edge at one extremity. By a simple device this is made to rotate rapidly, making, when applied to the skin, a circular incision, the depth of which is regulated by a gage.

In the cut, *a* represents the buttons by turning which the instrument is wound up, *d* the trigger by which the spring is released, *c* the cutting-edge, and *b* the gage for regulating the depth of the incision.

Themison, a physician of Laodicea who flourished a little before Celsus (first century A. D.), mentions the use of leeches.

Michael Servetus, burnt at Geneva in 1553, announced and explained the circulation of the blood, correctly describing the action of the heart, the duty of the arteries and the veins, and the influence of the lungs. He correctly describes the single circulation, and is the first to employ the term of *anastomosis* to express the communication between the veins and arteries in the tissues. See Servetus, "De Christianissimi Restitutione." See Lancet.

Leech-line. (*Nautical.*) A line attached to the leech-rope on the edge of a sail, and passing up through a block on the yard, to haul on the leech; as the *bunt* and *leech lines*, the *preventer leech-line*.

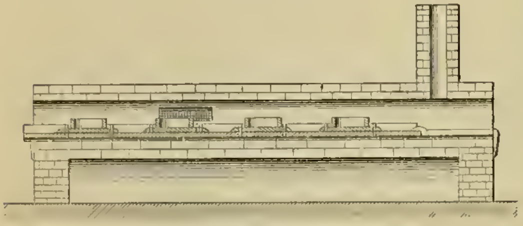
Leech-rope. (*Nautical.*) That part of a bolt-rope along the vertical edge of a sail. The *leeches* are hauled by *leech-lines*, which pass up through blocks on the yards, and *brail* up the sail.

Lee′fange. (*Nautical.*) An iron across a deck or on the taffrail, for the sheet of a fore-and-aft sail to slip on in tacking.

Leer. The annealing chamber or arch of a glass manufactory. *Lier.*

It is sometimes a simple oven, or it may be a long chamber through which the ware is pushed in trays, the period of passage being sufficient for the annealing operation. In the example, the heat is received at an opening between the points of reception and discharge, and is graduated toward both ends.

Fig. 2892.

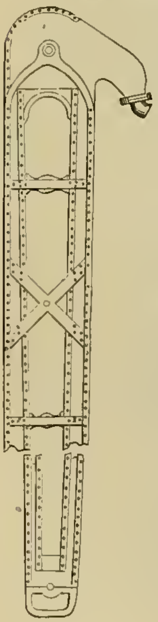


Leer.

Left-hand Rope. Rope laid up and twisted "against the sun," as it is termed. *Water-laid* rope.

Left-hand′ed Screw. A screw whose threads advance "against the sun," that is, from right to left. This is the opposite to the common, or *right-handed* screw, which is operated by turning it in the direction of the hands of a watch.

Fig. 2893.



Elevator-Leg.

Leg. 1. (*Elevator.*) The movable dependent case containing the lower end of the belt of iron buckets of a grain-elevator. See Elevator.

2. (*Furniture.*) A support of a table, chair, stove, etc.

3. One limb of a compass. The legs are called *pencil*; *pen*, *wheel*, *extension*, *reversible*, *point* legs, etc., according to their furnishing or adaptation.

Leg, Ar-ti-fi′cial. A prosthetic lower limb, which is made specially for amputations above or below the knee. The form is usually in imitation of the natural leg, but sometimes it is made skeleton-wise for lightness, as in Fig. 2894.

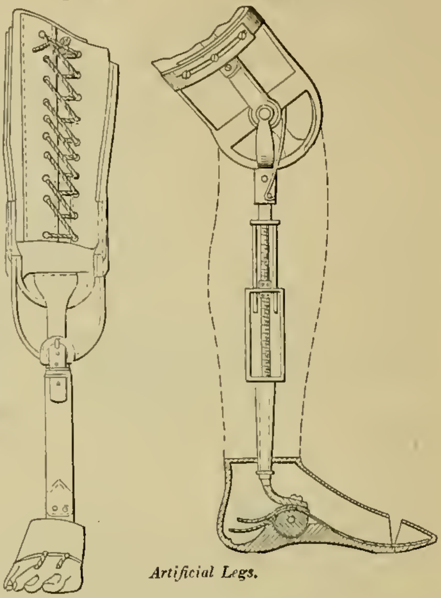
Among the materials used for its structure are raw-hide, which is very light and stiff for its strength; splints crossing at right angles and glued together; bands and strips of wood interlaced; hollow shell of wood; basket-work of wire; vulcanite; gutta-percha.

"The cripple may go out on the Sabbath with his wooden leg: such is the dictum of Rabbi Meir; but Rabbi José prohibits it." — Mishna.

The compass-joint for the knee, and the ball-and-socket joint for the ankle, are described in Pott's English patent, 1801.

Fig. 2894 is an artificial leg adapted for leg amputation at the upper third, where the knee rests in a cushioned socket, or it may answer for the less common amputation at the knee-joint, the axis of movement being above the knee-rest and in prolongation of the axis of motion of the knee. *b b* are branches of the thigh-straps; depending from the knee-joint are branches which connect with and brace the tibia post.

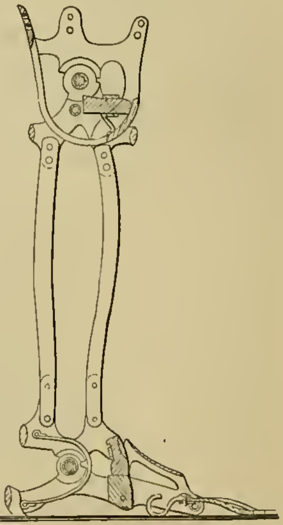
Fig. 2894. Fig. 2895.



Artificial Legs.

Fig. 2895 is a leg adapted for thigh amputations. The bar of the leg is adjustable in length, and is planted upon a segment of a cylinder, which has a backward and forward oscillation in its socket; the toe and heel leaf-springs modify and limit its vibrations. The toe-spring extends the toe-section, which is hinged to the front part of the foot, and flexed by the act of walking. The slotted hoops and set-screws of the thigh adjust its capacity. An axial coil on the knee-articulation extends the leg for forward movement when raised from the ground.

Fig. 2896.

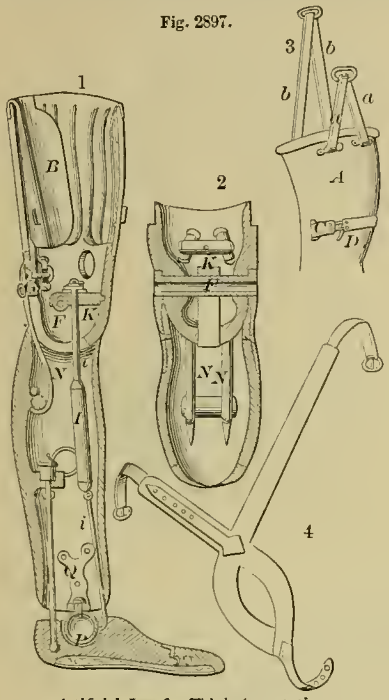


Iron-Leg.

In Fig. 2896, the frame is made of malleable cast-iron, with projections to correspond with the natural processes. Straps unite the anterior and posterior portions of the knee-frame and keep the covering in place. The toes are of spring metal, and attached separately to the foot; a spring at the ankle articulation depresses the heel.

Fig. 2897 is an artificial leg for thigh amputations. The socket *A* has a pad *B* and strap *D* for adjusting the size to the stump. *K*, in 1 and 2, is a bridge-piece in the upper section, resting on the knee-bolt *F*, and affording the superior point of attachment for the extensor-spring *I* and tendons *i i*, which throw the foot upward and forward as soon as it is lifted from the ground in walking. The hamstrings *N N* are attached to the posterior portions of the thigh and leg, to act as checks to the forward motion of the leg.

Fig. 2897.

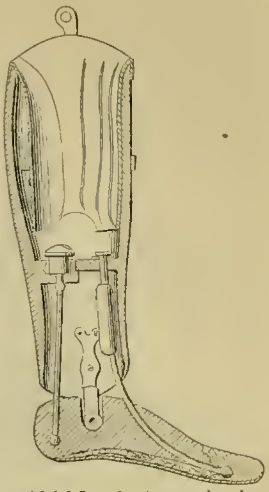


Artificial Leg for Thigh Amputations.

The ankle-joint consists of a socket in the foot, and a ball *P* attached by its neck and the iron frame *Q* to the leg, and has a horizontal stud upon it, fitting its appropriate recess in the socket in the foot, so as to prevent vibration in a horizontal plane, while leaving the joint free for motion in vertical planes, as described. The elastic straps *a b* (3) are proportioned as to length and strength, and afford a means of attaching the suspensory yoke (4), whose straps pass over the shoulders, so as not alone to bring the weight upon the framework of the body, but also to enable the shoulders, by their motion, to influence the action of the artificial limb. See patents of Bly, Condell, and others.

Fig. 2898 is an artificial limb intended for amputations below the knee, and is supported by straps secured to the sides of the socket, and an elastic band secured to the front of the socket, the said straps and band uniting in a stronger elastic strap which passes upward, and is suspended from a yoke-strap over the shoulder. The foot-piece has a socketed axial-bolt passing transversely through its rear portion, which is secured to a bar projecting up into the leg, and forms the ankle-joint.

Fig. 2898.



Artificial Leg for Amputations below the Knee.

Le′gend. An inscription or motto in heraldry or on a coin.

Leg′gings. Wrappers used in connection with shoes or bootees, to form a protection for the legs in hunting, riding, or in rough and exposed work. They are very common among the agricultural part of the population of England, and in some parts of the continent they seem to be considered a necessary part of the hunting-costume. They are made of pliable, unblacked leather, dressed like buckskin, and are buttoned down the outer edges.

When used to protect the pantaloons or boots of an equestrian, they are sometimes called spatterdashes. One form has pliable springs in the upper edge and just above the ankle. The legging is sprung open to admit the foot, and the springs then close the legging around the leg.

The Romans had leather spatterdashes, buttoned at the sides, and probably introduced them into England. They were common among the Anglo-Saxons.

Leg and Foot Guard. (*Menage.*) A device to protect a horse's feet or legs.

They are of several kinds.

1. To prevent the cutting of the fetlock or foot by *interfering* or *overreaching*; that is, by striking the fore or hind foot against its fellow as they pass each other in motion, or striking the heel or shoe of the front foot by the toe of the hind foot or shoe.
2. To prevent the cutting of the knees in kneeling or falling forward on to the knees.
3. To prevent the unhairing or abrasion of the hide by hopples. See Hopple.

Rotch's flexible elastic horseshoe, patented in England in 1810, and with improvements in 1830, consisted of a sheet-metal sole and a body of india-rubber made to fit over the crown and upon the pastern. The immediate purpose of the caoutchouc cover was to hold on the sole to which a regular bar-shoe was riveted, if necessary. The india-rubber covering, in the case of *interfering* horses, was prolonged over the fetlock in order to keep the hide from abrasion by the blows of the other foot, or from being barked or cut by the toe of a hind foot in horses addicted to *overreaching*.

Fig. 2899 shows several kinds.

a has a protecting pad, which catches in the crevice between the heel and the shoe, and is fastened by a hook engaging with the clip in front.

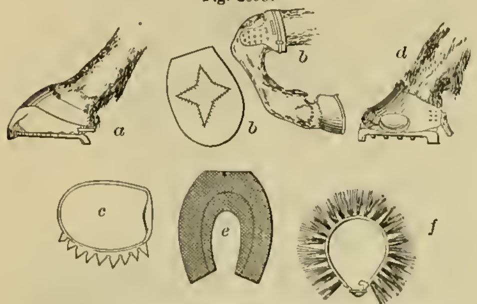
b has a pad or fender to fit the inside of the knee-joint and ankle-joint of a horse addicted to interfering; it has also an interlining or stiffener, and a whalebone strip at the upper end of the fender to prevent the pad from turning round the leg.

In *c*, a band surrounds the hoof at its crest, with flexible projections of caoutchouc, to prevent injury from interfering.

In *d*, the spur is inserted between the shoe and the hoof, and holds in position the inflated pad on the strap, which is secured around the hoof.

In *e*, the upper surface of the elastic inner shoe conforms to the shape of the hoof; the under surface rests on the shoe, and the peripheral flange prevents cutting by interference.

Fig. 2899.



Leg and Foot Guards for Horses.

f has a strap with bristles protruding.

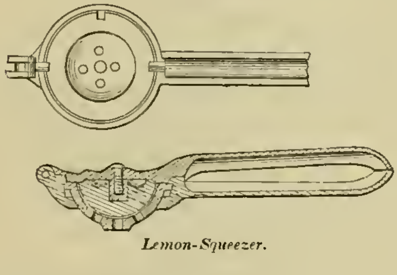
2. A lined sleeve, as a hopple-ring, to prevent abrasion of the fetlock. See HOPPLE.

3. A stout piece of leather, strengthened by a longitudinal iron plate. It is strapped to the right leg of an artillery-driver, to prevent injury from the pole of the carriage.

Leis'ter. A pronged fish-spear.

Lem'on-squeez'er. One for pressing the juice from lemons. In the example, the parts have a cup and a bulb respectively, and are pressed together by the handles.

Fig. 2900.



Lemon-Squeezer.

The making of orangeade and lemonade was introduced into England from France about 1632. These fine acids need sugar, and this is a comparatively modern ingredient in Europe. See SUGAR.

Length'en-ing-bar. An extension-piece for the leg of a drafting compass, when the reach of the ordinary legs is insufficient.

Length'en-ing-piece. (*Shipbuilding.*) One of the timbers added to the ribs above the *top-timbers*, to impart the necessary hight to the sides of the vessel.

Length'en-ing-rod. A rod with a screw and screw-socket at the respective ends; attached endwise to form a long shank for an auger or drill in deep boring.

Le'no. (*Fabric.*) An open cotton goods, thinner than *book-muslin*, used for veils, window-curtains, etc. It is plain, colored, or checked.

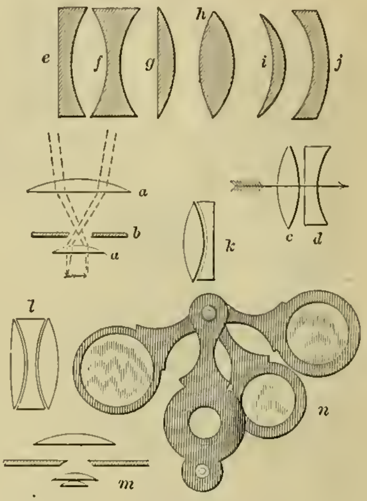
Lens. A piece of a transparent substance fashioned into a shape affording two regular opposite surfaces, both curved, or one curved and the other plane. The curved surfaces are usually spherical, and the ordinary lenses of this description are of six varieties. They are: —

e, *plano-concave.*
f, *double concave.*
g, *plano-convex.*
h, *double convex.*
i, *meniscus.*
j, *concavo-convex.*

A lens changes the direction of rays of light, diminishing or increasing the apparent size of objects viewed through it. Combinations of lenses increase this effect. For an explanation of the principles, see treatises on optics.

There are varieties of lenses peculiar from their proportions, their construction, arrangement, or their specific effects.

Fig. 2901.



Lenses.

The *crossed lens* is a double convex, in which the radius of one face is six times that of the other.

The *polyzonal lens* is built up of several pieces arranged in zones or rings.

The *multiplying lens* is plano-convex, and its curved surface is covered with a number of plane faces or facets, each of which affords a separate image.

The *aplanatic lens* is a lens constructed of different media, so as to correct the unequal refrangibility of the different rays.

The *achromatic lens k* is a combination of a double convex lens of crown-glass and a plano-concave or a concavo-convex lens of flint-glass. The advantages of a lens formed in this manner are freedom from spherical aberration or distortion, and the rays of light are not decomposed into the primary colors; in other words, the light passes through the lens and suffers no change thereby. They were formerly combinations of three lenses, as shown at *l*. They were made by Dollond in 1753. See ACHROMATIC LENS.

The *Coddington lens* is of spherical form, and has a deep equatorial groove around it filled with opaque matter, acting as a diaphragm to diminish the quantity of light and exclude lateral rays.

A spherical silica lens is ascribed to an experiment of Sir Humphry Davy. One end of a wheat straw is ignited, and the spear is allowed to consume gradually. The cinder is then heated in the blue flame of a burner, and from the silica obtained a solid globule of glass is formed, which is said to be well adapted to microscopic purposes.

A *cylindrical lens* has a body formed of a segment of a cylinder, or of two such segments united by their bases. A *Stanhope* lens.

A *diamond lens* is made from a diamond whose high refractive power is supposed to render it specially suitable for an eye-glass. Diamond lenses were made by Andrew Pritchard in 1824.

A *doublet* is an arrangement of two plano-convex lenses, invented by Wollaston, as shown at *a a*; *b* is a diaphragm. *c d* is Herschel's doublet.

A *triplet m* is an arrangement of three plano-convex lenses in a microscope. Invented by Holland.

n is also a threefold arrangement of lenses, any two or all of which may be used in combination, according to the power desired.

Eye-glass; the lens nearest to the eye in a simple arrangement, and the one nearest to the eye of the glasses forming the combination *eye-piece* of a telescope or microscope.

Compound eye-glasses are *doublets* and *triplets* (which see). See Negative Eye-piece.

An *immersion lens* is an achromatic objective for the microscope, which is used with a drop of water between the front lens and the cover of the object examined. See Immersion-lens.

Object-glass; the *field*-glass, or the one farthest from the eye, in the combination of lenses forming a telescope or microscope.

Periscopic lens; a concavo-convex lens, the ratio of the radii of whose respective faces constitutes it a magnifying or diminishing lens; the general curve of the lens approximating that of the cornea and increasing the distinctness of the image when viewed obliquely.

Polyscope; a plano-convex lens, whose curved side has facets by which the images are multiplied. A *multiplying-lens.*

Polyoptron; a plano-convex lens, whose curved face has a number of *concave* facets which afford a number of diminished images.

The *spherical lens* is of a globular shape, and has usually an equatorial groove filled with an opaque object to exclude lateral rays. A *Coddington lens.*

The *Stanhope lens* is of a cylindrical form, and has convex ends having different radii.

It is, perhaps, impossible to determine when lenses were first made. The first observations of their effects were, no doubt, with drops of dew upon leaves, and occasionally by a spawl of crystal or a tear of vitreous matter from the inside of a furnace.

Whether the means by which Archimedes burnt the fleet of Marcellus at Syracuse was a combination of mirrors or lenses, it is hard now to determine. Probably mirrors. The same may be said of the burning by Proclus of the besieging ships of Vitalian the Scythian, at Constantinople, in the sixth century.

Refraction was observed by the ancients, and Archimedes is said to have written a book upon the subject. Plutarch speaks of instruments used by Archimedes "to manifest to the eye the largeness of the sun."

The appearance of a straight stick when thrust obliquely into water seems to have led the ancient philosophers to consider the subject. They determined that a ray of light was bent in passing from one medium to another; and Ptolemy, the astronomer and physicist, says that "the light of the heavenly bodies falling upon our gross atmosphere is bent out of its rectilinear course, which causes these luminaries to appear to rise sooner than they do in reality."

Euclid's treatise on optics was about 280 B. C. He is the one who told his royal master Ptolemy Philadelphus, "There is no royal road to learning, sir."

"Ptolemy was the first to measure refractions, and is therefore the founder of an important part of optical science." — Humboldt.

"The magnifying power of hollow glass spheres filled with water (Seneca, 1, 6) was, indeed, as familiar to the ancients as the action of burning glasses or crystals (Aristoph. Nub. V. 765 [424 B. C.]) and Nero's emerald (Pliny, xxvii. 5)." — Humboldt's *Cosmos.*

Layard found in the ruin called Nimroud a plano-convex lens of rock-crystal 1½ inches in diameter and $\frac{9}{10}$ of an inch thick. It shows the marks of the lapidary's wheel. It gives a focus 4½ inches from the plane side. Sir David Brewster says, "It was used as a lens, either for magnifying or for condensing the rays of the sun." Two glass bowls were found in the same chamber. Before the discovery of the lens, it had been surmised that the minute inscriptions in the cuneiform character must have been executed by the aid of a magnifying-glass.

There are other notices of lenses scattered through the pages of antiquity. Pliny mentions that the ancients had globes of glass and crystal, and that Nero used glasses when he watched the fights of the gladiators. The old scoundrel was probably troubled with myopia, and had concave glasses. This we must suppose rather than that he had a combination of lenses similar to a telescope or opera-glass. Lactaneus says that a hollow glass sphere full of water will produce the effect of a solid sphere of glass. Iamblichus, in his "Life of Pythagoras," tells us that the latter strove to contrive instruments that should aid hearing as effectually as optic glasses and other contrivances aided sight.

Coming down from the time of Ptolemy to the revival of learning and science under the Saracens, we find that Alhazen, in the twelfth century, wrote on the refraction of rays and the magnifying power of lenses. Draper's remark here is too good to omit.

"I join, as, doubtless, all natural philosophers will do, in the pious prayer of Alhazen, that, 'in the day of judgment, the All-Merciful will take pity on the soul of Abu-r-Raihân, because he was the first of the race of men to construct a table of specific gravities'; and I will add Alhazen's name thereto, for he was the first to trace the curvilinear path of a ray of light through the air."

Abu-r-Raihân was a native of Byrun in the valley of the Indus, and a friend of Avicenna, who lived with him at the Arabian academy in Charezm. His history of India belongs to the years 1030 – 32.

Vitellio, a Pole, wrote a treatise on lenses about 1270.

The magnifying power of segments of spheres was known by the Florentine Salvino degli Armati, who died 1317.

To come down to later times, we find that spectacles were well known in the thirteenth century, and it is not known by whom they were invented. The invention has been credited to Roger Bacon (1250), and to Alexander de Spina (1280).

Roger Bacon speaks in regard to the effect of lenses as familiar, and the remarks he makes belong to the second branch of the subject, which concerns the combinations of lenses to produce the compound microscope and the telescope.

This invention consists in placing lenses of certain character at proper distances on a common axis. The character will determine the effect, and the focal length will determine the proper distance; the common axis is imperative. Who first held two lenses in the proper relation, so as to produce an effect the result of their combination?

A few of the items in this inquisition may be noted.

Roger Bacon (1250) says: —

"We can give such figures to transparent bodies, and *dispose them in such order*, with respect to the eye and the objects, that the rays shall be refracted and bent towards any place we please; so that *we shall see the object near at hand*, or at a distance, under any angle we please. And thus from an incredible distance we may read the smallest letters, and may number the particles of dust and sand by reason of the bigness of the angle under which we may see them."

The change in apparent magnitude of distant and near objects by a proper disposition of several lenses of the required character involves the invention of the telescope and compound microscope.

In a book printed in 1551, "the glasse he [Friar Bacon] *made* at Oxford" is referred to, and the venerable philosopher is defended from the assumption that its marvels were due to the infernal power; "for," said the writer, "I know the reason to be good and natural, and to be arright by geometry, and to stand as well with reason as to see your face in a glass."

This must have been the combination of lenses referred to by Bacon, as a mere lens was well known and would excite no marvel, spectacles having been well known for three centuries, and the naked lens for a time that the memory of man runneth not to the contrary.

Frascatoro, who died in 1553, states the matter properly: "If any one will look through two lenses, one placed over the other, he will see everything much larger and clearer."

J. Baptista Porta (about 1560) states: "If you know how to combine a convex and a concave glass, one of each sort, you will see, far or near, objects larger and clearer." He is believed to have invented the camera-obscura about this time.

Dr. Dee says (1570) that "perspective glasses" will enable a commander to ascertain the strength of an enemy's forces; referring apparently to an optical instrument then in use.

Leonard Digges (about 1571) appears to have been able, "by proportional glasses duly situate," to discover things afar off, read letters and inscriptions on coins at a distance, and tell what was passing seven miles off. Such is the claim in his son's book, second edition, published in 1591.

Jansen (about 1608), a spectacle-maker of Middleburg, Holland, was struck by the effect of a concave and a convex lens held in the proper relation and distance. For the purpose of observation, he fixed the glasses on a board in proper position, and afterwards in a tube. He seems to have considered it interesting but not valuable, and Prince Maurice of Nassau became possessed of it.

Lippersheim, also of Middleburg, seems to have been concerned in it in some way.

Another claimant of the invention about the same date is Metius, who was a glass-cutter, and casually observed the effect of a concave and convex lens held in line in the hands. The three latter claimants had their supporters as the authors of the invention.

Descartes, who lived near the time, supported the claims of Metius. Borelli, about 1650, examined the question, and decided in favor of Jansen and Lippersheim. Porta is said to have hastened his death, which happened in 1615, by the fatigue and anxiety incurred in supporting his claims.

Galileo had a hint of the invention, studied it out, and made a telescope which he soon put to use. See TELESCOPE.

Kepler (1571–1630) was, perhaps, the first to state with precision the effects of lenses in making the pencils of light converge or diverge. He showed that a plano-convex lens makes rays that were parallel to its axis to meet at the distance of the diameter of the sphere of convexity; but that if both the sides of the lens be equally convex, the rays will have their focus at the distance of the radius of the circle corresponding to that degree of convexity.

Cavallieri laid down the rules in regard to lenses whose sides are unequally convex. As the sum of both the diameters is to one of them, so is the other to the distance of the focus. The rule for convex glasses is applicable to concave, with the difference that the focus is on the contrary side of the glass.

Kepler, in his "Catoptrics," explains the rationale of the system of lenses in a telescope. Scheiner constructed one on this principle in 1630. His description is as follows: "If you insert two similar lenses (that is, both convex) in a tube, and place your eye at a convenient distance, you will see all terrestrial objects, inverted indeed, but magnified and very distinct, with a considerable extent of view." He afterward added two more glasses, which reversed the image and brought it to the natural position.

Rheita was the first to employ the combination of three lenses, the *terrestrial telescope*.

Snellius of Leyden, Descartes (1596–1650), and Leibnitz (1646–1716) stated the doctrine of refraction more or less fully; and Grimaldi, an Italian painter, demonstrated the ellipticity of the sun's image after refraction through a prism; Newton (1642–1727) determined that it was owing to the difference in the refrangibility of the respective portions of the rays.

Newton supposed that *refraction* and *dispersion* were indissolubly united, but Dollond demonstrated that by using two different kinds of glass he could abolish the color, and yet leave a residue of refraction.

Refraction has reference to the deflection of the ray, *dispersion* to the diverging of the components of the ray, incident to the different refrangibility of the parts of which it is constituted. *Dispersion* is therefore *decomposition*, while *refraction* is *bending* at an angle. The *direction* of the dispersion depends upon the form of the surface on which the ray impinges; the *extent*, upon the nature of the medium. The flat face of a vertical prism gives a strictly lateral divergence, and simply widens the image, the colors resulting from the decomposition taking up their places in parallelism, the red as the least refractive at one edge, and the violet as the most refractive at the other edge. There is also a non-visible portion of spectrum at each end; *heat* at the *red* end, *actinium* at the violet end.

The amount of *dispersion* of light, or the length of the spectrum formed by prisms having the *same refracting angle*, varies greatly in different media. Newton supposed that the *dispersion* was always proportional to the *refraction*, but Dollond ascertained that although the average *refraction* of the ray might be the same in two media, yet the *dispersion* or diverging effect might be much less in one than in the other.

Euler (1707–83) was the first to state that it must be possible to produce an achromatic lens by using media of different densities. Dollond, in trying by experiments to disprove this supposition, proved its truth. He adopted flint and crown glass, which have a difference in refractive powers in favor of the latter, accompanied by a still greater difference in dispersive powers in favor of the former. He took two lenses, one concave and the other convex, — which are, in effect, equal to two prisms refracting in different ways, — so arranged that the *dispersive* powers of the flint-glass would be corrected by the crown-glass, and the image produced by the excess of refraction of the latter would be sufficiently colorless for the purpose.

The difficulties incident to procuring lenses of homogeneous quality, large size, and free from striæ, have been very great, and deserve a passing notice. Sir Isaac Newton declared them insurmountable, and the English, French, and Germans of the last century labored hard at the problem. The Academy of Sciences at Paris offered prizes, and subsequently a commission consisting of Herschel, Faraday, Dollond, and Roget were instructed to pursue the inquiry. The excise system of England at that time sat like a foul bird upon all the nests where glass was hatched, and prevented the experiments, tying the hands of this noble quarternion of philosophers with a few yards of red tape applied by some seedy-looking individual, with a pen behind his ear and no speculation in his eye.

Munich at last carried the palm; her skill being originally derived from Guinand, a poor peasant of Neufchatel, Switzerland, who was brought up to the watch-trade. He made experiments, and gradually shifted himself into the manufacture of optical instruments, finally allying himself with Utzschneider and Frauenhofer of Munich, whose establishment yet has a world-wide reputation: he succeeded in soldering glass. Pure disks of flint-glass were exhibited in London in 1851, having a diameter of 29 inches and weighing 224 pounds.

Guinand's mode of making lenses is stated by Mr. Pellatt to have consisted in stirring the glass while at the highest point of fusion; cooling down the entire contents of the pot in a mass, and when annealed and cooled, separating unstriated portions by cleavage, afterwards softening the piece in clay molds which gave the shape. The plan has been pursued by his successors.

A powerful lens was made some years since by Parker of London. It was of flint-glass, 3 feet in diameter; 3¼ inches thick at the center; focal distance, 6 feet 8 inches; diameter of the burning focus, 1 inch; weight, 212 pounds. The rays refracted by this lens were received on another, the diameter of which in the frame was 13 inches, and its focal length 29 inches. This reduced the diameter of the burning focus to ½ inch, quadrupling its power. It cost $3,500, and melted: —

Pure gold	20	grains in	4	seconds.
Silver	20	"	3	"
Copper	33	"	20	"
Platinum	10	"	3	"
Cast-iron (a cube)	10	"	3	"
Steel	10	"	12	"
Common slate	10	"	2	"
A topaz	3	"	45	"
An emerald	2	"	25	"
Crystal	7	"	6	"
Lava	10	"	7	"
Flint	10	"	30	"
Jasper	10	"	25	"
Carnelian	10	"	75	"
Pumice-stone	10	"	24	"

Wood burned immediately; water flashed into steam; bones fell into a calcined form at once.

This glass was carried to China by Lord Macartney, and was left in Pekin. It was probably stolen or destroyed in the sacking of the summer palace by the allies.

A flint-glass lens, weighing 224 pounds, was exhibited at the London Exposition, 1851.

A burning-lens of great power may be obtained by fixing two circular disks of thin glass at the opposite ends of a tube, say 1 inch long, and injecting into the space between them, under pressure, turpentine, bleached oil, or other liquid of high refractive power. When the glass attains the required curvature, close the stop-cock and mount the fluid-lens for use.

The lens of the new Naval Observatory at Washington has been made by Alvan Clarke & Sons, of Cambridgeport, Mass. It is 26 inches in diameter; the telescope is now in working position in the building erected for it under the superintendence of Professor Newcomb.

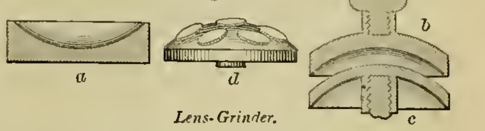
See the following varieties: —

Achromatic lens.
Aplanatic lens.
Bull's-eye.
Coddington lens.
Concavo-convex lens
Condensing-lens.
Convex lens.
Convexo-concave lens.
Convexo-convex lens.
Crossed lens.
Cylindrical lens.
Diacaustic lens.
Diamond-lens.
Double-concave lens.
Double-convex lens.
Doublet.
Eye-glass.
Eye-lens.
Field-lens.
Fluid-lens.
Immersion-lens.
Lenticula.
Lunette.
Meniscus.
Microscopic lens.
Multiplying-lens.
Object-glass.
Orthoscopic lens.
Pebble.
Periscopic lens.
Photographic lens.
Plano-concave lens.
Plano-convex lens.
Polyoptron.
Polyscope.
Polyzonal lens.
Spectacle-lens.
Spherical lens.
Sphereometer.
Spot-lens.
Stanhope lens.
Stereoscopic lens
Telescopic lens.
Triplet.
Varnish-lens.

(*Lens Grinding.*) Lenses are so ground that their faces shall form a portion of a spherical surface. The tools employed are, first, a concave shell of cast-iron (*a*, Fig. 2902). This is cast from a wooden pattern of the true curvature of the lens, formed by means of a templet having a radius equal to that of the required curve, and by it, with the aid of coarse emery, the lens is ground approximately to the true form. Two templets, one convex and the other concave, are made of sheet-brass or copper, or, for large-sized lenses, of crown-glass. These serve as guides for turning the convex and concave tools *b c* to a proper sphericity.

The piece of glass of which the lens is formed is clipped around the edges to bring it to a circular form by means of flat pliers of soft iron, which does not slip from the glass as steel would, leaving it of somewhat greater diameter than the finished lens, and is then attached, by means of cement, to a concave, circular holdfast, somewhat smaller than the lens. The concave tool *a* is now used for bringing the glass to a spherical surface. For this purpose emery is employed, coarser at first and then finer, as the face of the lens begins to assume its true form. The tool *a* is turned both circularly and transversely of the lens, so as to bring the two surfaces in contact in every possible position in order to insure perfect sphericity. From time to time the concave tool *b* is ground in a similar way upon the convex tool *c*, in order to preserve the correctness of its surface.

Fig. 2902.



Lens-Grinder.

The lens is polished in one of the iron shells *a*, the interior of which is coated with cement, over which a piece of cloth is placed and pressed into shape by the convex tool. This is covered with putty powder (peroxide of tin). The manipulations are similar to those just described. Finally, the edges of the lens are ground to their true diameter.

d is a convex tool or *runner* of cast-iron, of about ½ inch less radius than the templet, used as a support for common glasses, a number of which are ground together.

Another contrivance for polishing lenses and other bodies of spherical form consists of a cup connected by a ball-and-socket joint and a bent arm, with a rotating upright shaft set concentric to the body to be polished. The cup, being set eccentrically on the joint, has an independent rotation at the same time that it revolves around the common axis. This prevents any part of the surface of the cup from coming repeatedly in contact with the same parts of the body which is being ground or polished.

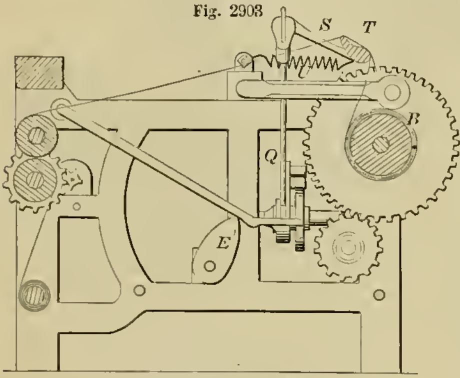
Len-tic′u-la. A small lens.

Le-pine′-watch. A flat form of watch, invented by Lepine of Paris.

The wheels are held by bars, technically called *cocks*, instead of being pivoted in two parallel circular plates.

Let-off. (*Weaving.*) An arrangement in a loom by which the yarn is paid off from the beam at such a rate as it shall be required by the weaving-process, and which is dependent upon the rate of the *picks*, the sizes of the warp and weft thread, the compactness with which it is beaten up by the lay. The *take-up* is the winding on to the *cloth-beam* of the completed web, and proceeds coincidently with the *let-off* from the *yarn-beam*. Regularity of *let-off* is secured by making the rate of surface motion of the *yarn-beam* depend upon the tension of the yarn ; and the rate of revolution of the beam, to secure equal speed of let-off, will become rapid as the bulk of yarn diminishes upon the roller. The devices for this purpose are numerous. In the example, the same cam *E′* operates both the *take-up* and *let-off* devices ; the strain of the yarn on the *whip-roll T* operates through the arm *S* and rod *Q*, pawls which act upon the ratchet by which the yarn-beam *B* is rotated.

Fig. 2903



Let-off and Take-up.

Let′ter. (*Printing.*) A character used in printing. Type either of metal or wood. Used collectively to represent type, as "a case of letter," "a font of letter."

Fat letter ; a type with body and face broad in proportion to its hight.

Lean letter ; type thin or narrow in proportion to its hight.

Body letter ; that type in which the main portion of a book or paper is printed. It consists generally of a font of type containing Roman CAPITALS (caps.), small capitals (small caps.), small letters (lower case), with a proper proportion of *ITALIC CAPS.* and *italic lower-case* letters. Technical works require numerous sorts in addition to the above. See Font.

Body letter is distinguishable by the size of the type, those in most common use being —

Pearl.
Agate.
Nonpareil.
Minion.
Brevier.
Bourgeois.
Long Primer.
Small Pica.
Pica.

Half-minion, *half-brevier*, and *diamond*, sizes smaller than *pearl*, are used in notes of reference, side-notes, etc., but rarely for body letter. *English*, *Columbian*, *great primer*, and *paragon*, larger than *pica*, are used in circulars, display, and some legal works. Sizes larger than these are multiples of a smaller body (generally pica, known as 2-line pica, 3-line pica, etc.), and are used in printing posters. The body of letters differs with various type-founders. Nonpareil is generally about one twelfth of an inch ; i. e. twelve lines of nonpareil measure one inch down the column. Pica is double nonpareil ; 12-line pica type, therefore, measures about two inches in hight.

Letter is characterized by various names, according to the face. Besides *roman* and *italic* body type, which may be *old-style*, *new-style*, *Scotch-face*, *light-face*, *hair-line*, etc., job printers use a great variety of letter in the varied styles of printing. *Gothic*, *antique*, *Runic*, *Celtic*, *black*, *German text*, *Old English*, *script*, *title*, and scores of others might be enumerated. Nearly all of these, besides being cast to all the sizes before mentioned, are made *extra condensed* (very lean), *condensed*, *standard*, and *expanded* (fat).

Type-founders, to supply all the orders they are likely to receive, are compelled to keep on hand several thousand varieties of letter, or the matrixes for casting them.

Ascending and *descending* letters extend respectively above and below the general level of the line. b d l are examples of the former, p q y of the latter.

Kerned letter. Where some portion of the face overhangs the body, as the dot of an f. Nearly all the long letters in italic and script fonts are kerned.

Accented letter (see Font).

Let′ter-bal′ance. A device to weigh letters for mailing. See Letter-scale.

Let′ter-board. (*Printing.*) A board on which pages or columns of type are temporarily placed.

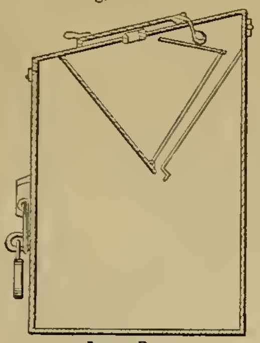
Let′ter-box. One to receive letters.

1. A locked box attached to a post in the public street, for convenience of mailing, the letters being gathered from time to time by carriers.

The box (Fig. 2904) is for attachment to a lamp-post. The letter-passage in the top has a cover whose cam-projection operates a lever inside, and the lever is connected to the free edge of the hinged plate, so as to close the aperture between the plates when the lid is raised. When the lid is closed, the letter slides off the plates through the aperture.

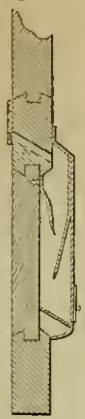
2. A box attached inside a door to catch the letters and cards left by carriers or callers. The

Fig. 2904.



Letter-Box.

Fig. 2905.

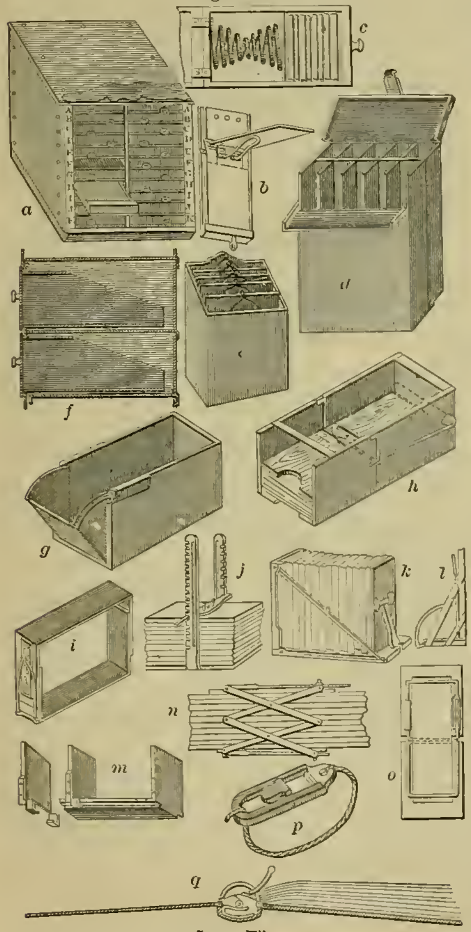


Office-Door Letter-Box.

door-plate has provision for a slip containing the name of the occupant, and has a flap covering a chute leading to a letter-box, whose serrated plate prevents the surreptitious abstraction of letters from the outside.

3. An office-box to hold letters accumulating during the day, awaiting mail-time.

Fig. 2906.



Letter-Files.

Let'ter-case. 1. (*Printing.*) A partitioned tray in which assorted letters are placed. A *case.*

2. A portfolio.

Let'ter-clip. A spring-clasp to hold letters or other memoranda together.

Let'ter-file. A box, case, folio, or envelope, for containing letters to which reference is required to be made.

a is case with labeled drawers.

b is one of the drawers belonging to *a*, having a spring flap to hold down the letters.

c is a drawer with a spring to compact the letters against the end.

d is a box with labeled divisions and falling flap and lid.

e has pockets with lifters.

f has trays which slide into cases.

g is a tray with a let-down front.

h is a tray with a spring follower to keep down the letters compactly.

i has two three-sided pieces, which are drawn together by springs to embrace the papers.

j has racks with notches which hold the cross-bar upon the follower-board above the pile of letters.

k has a tray with a back, and a brace which locks against the pressure-board.

l shows a pressure-board held against the papers by a spring.

m has a shifting-board which may be rigid in any position. On the left, the shifting-board is shown separately.

n has a lazy-tongs arrangement to connect the two boards.

o has a spring wire-clamp.

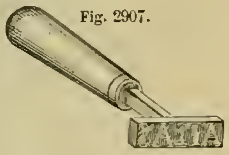
p has a cord and locking-plate.

q has flaps like a portfolio, and a binding-clamp at the back.

Let'ter-ing-box. (*Bookbinding, etc.*) A case to hold a set of movable type when composed to form a name or address, for lettering books, marking linen, etc.

Let'ter-ing-tool. A bookbinder's tool for stamping the gilt titles on the backs of books. For titles in common use, as "Atlas," "Holy Bible," etc., the whole word or words are cut on the face of the tool. In other cases movable type of various sizes are provided, which are adjusted in a slot fitted to receive them.

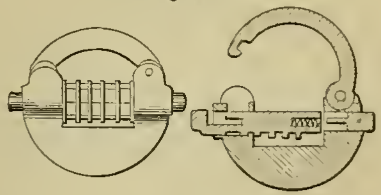
Fig. 2907.



Lettering-Tool.

Let'ter-lock. A lock whose bolt is surrounded by several rings having notches through which a set of studs on the bolt must pass before the lock can be opened. These notches are so arranged as to prevent the passage of the bolt except when certain letters on a series of exterior rings are brought into line with each other so as to form a particular word or combination on which the lock has been set.

Fig. 2908.



Letter-Lock.

It is mentioned in Beaumont and Fletcher's play of "The Noble Gentleman," 1615.

> "A cap-case for your linen and your plate,
> With a strange lock that opens with A. M. E. N."

Regnier, about the middle of the seventeenth century, made improvements in the letter-lock, and is generally credited with its invention, though this has been contested. His lock is thus described: "Broad steel rings, four, five, or eight deep, upon each of which the alphabet was engraved, turned upon a cylinder of steel, and the lock only separated when the letters forming a particular word were in a straight line with one another. This word was selected from among a thousand, and the choice was the secret of the purchaser. Any one not knowing the word might turn the ring round for years without finding the right one."

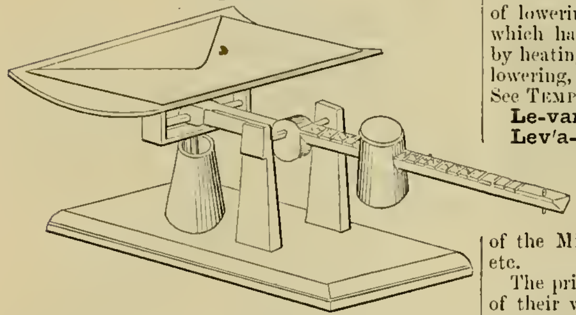
Let′ter-pa′per. (*Paper.*) Paper of post or note size, for epistolary use. The ordinary size of post is 10 × 16 inches when *flat*, and 8 × 10 when folded. Note-paper is smaller, and varies in size much.

Let′ter-press Print′ing. The ordinary form of printing in which the salient device is inked and the ink transferred to a sheet which is pressed thereupon. See PRINTING.

Let′ter-punch. A steel punch having a letter engraved on its end. Such are used to make matrixes for type; also to mark other articles of metal by giving an impression thereon when struck by a hammer.

Let′ter-scale. A balance for weighing letters and papers for mailing. That shown has a graduated beam with figures upon its flat, upper side.

Fig. 2909.



Letter-Balance.

Other forms are suspensory, having spiral springs, or rest upon a stem supported by a spring.

Let′ter-stamp. A form of stamp for defacing postage-stamps; or for attaching the place of mailing, destination, notices for carrier, deficient postage, "too late," "forward," and what not.

The United States Post-Office Department uses a hand-stamp for postmarking letters and canceling or defacing their postage-stamps. The tool consists of two small cylinders about an inch apart, fastened to a wooden handle. One cylinder bears type for the postmark, which may be removed and changed. The other cylinder carries a cork, its face generally cut in the form of a star, cross, or some fanciful device. This cork is struck upon the postage-stamp by the same blow which imprints the postmark upon the envelope. The stamp is inked by a dab upon a piece of printers' roller-composition. Letters to be postmarked are spread out upon a table covered with leather or rubber, and are postmarked and their stamps canceled as fast as blows can be struck with the postmarking and canceling stamp, or, when the latter is in the hands of an expert, nearly as fast as a person can count.

Stamps bearing such legends as "3 due," "missent," "forward to writer," etc., are small sticks of boxwood, about 4½ inches long and 1 inch in diameter, turned to a handle at one end, and the words engraved on the other. They are struck upon the letters in the same way as the postmarking and canceling stamps. Metallic stamps were formerly used for this purpose, but they have been nearly or quite superseded by those of wood.

In the General Post-Office, London, 140 stamp-canceling machines are employed. The object is to deface the stamp on letters, and impress the date, which can be done with one machine at the rate of 200 letters per minute. It consists of an apparatus in which the letters are ranged in rows, and has a double joint, so that it can run to and fro with a range of about a yard. The dies, of which there are two, — one for effacing the postage-stamp, and one for impressing the date, — are fixed to one frame, and are inked by the same roller, which is always kept in contact with a long porous pad, curved, to coincide with the path of the roller, as it runs down to pass over the dies, or up out of their way. The ink-reservoir lies on the pad, which is kept saturated. One blow from the hand of the operator impresses both stamps. Four stout wires around the effacing-die project a little beyond it, so that in stamping letters with bulky inclosures, the portion of the envelope to be stamped may be pressed flat before it is brought into contact with the die.

Let′ting-down. (*Metal-working.*) The process of lowering the temper of a steel tool or spring, which has been made flint hard and then reduced by heating to the degree of hardness required. In lowering, the temper is known by the color reached. See TEMPERING.

Le-vant′ine. (*Fabric.*) A kind of silk cloth.

Lev′a-tor. (*Surgical.*) A lever for raising a depressed portion of the skull. It belongs to the trephine case.

Lev′ee. An embankment to restrain water, and of a magnitude such as those of the Mississippi, Ganges, Holland, Po, Thames, etc.

The principal rivers noted for the periodical rising of their waters are the Nile, the Ganges, the Euphrates, and the Mississippi. Of these, the Nile, which flows from the mountains and lakes of Central Africa, begins to rise in June, and by the middle of August attains an elevation of 24 to 28 feet in the upper country, and less towards the mouth, the inundation flooding the cultivatable valley of Egypt. The Egyptian embankments are described by Herodotus and Strabo. The Ganges, flowing from the Himalayas, rises 32 feet from April to August, and creates a flood of 100 miles in width. The Euphrates, from Mount Ararat, rises 12 feet between March and June, and covers the Babylonian plains. The Mississippi rises with the melting of the snows, its various tributaries, the Missouri, Ohio, Arkansas, and Red rivers, turning in their supplies from the elevated interior regions. At a distance from the ocean its rise is 50 feet, while nearer the sea its rise is considerably reduced by the vast tract which it covers.

The Mississippi was discovered by De Soto, 1542, and explored at its upper end by Father Marquette and M. Joliet about 1672. M. La Salle traversed its whole length in 1677, and De Iberville was the first to enter it from the sea.

The dikes of Holland are marvelous, and are referred to under DIKE, DRAINING (which see). The Haarlem Lake is one of the latest recoveries from the sea. It was 15 miles long and 7 broad, and was drained by embanking and pumping, the work being completed in 1852. Three steam-engines were employed for several years. (See PUMPING-ENGINE; also pages 116, 739.) It is now proposed to inclose and pump out the Zuyder Zee, a part of which was once habitable but was overwhelmed by a storm which tore down the dikes.

It has been calculated that nearly nine hundred thousand acres have been gained in the Netherlands by diking and draining. The province of Zealand consists of islands washed by the sea on their western coasts, and separated by the many channels through which the Schelde and some other rivers find their way to the ocean. In the twelfth century, these islands were much smaller and more numerous than at present. They have been gradually enlarged, and, in several instances, at last connected by the extension of their system of dikes. Walcheren is formed of ten islets united into one. At the middle of the fifteenth century, Gœree and Overflakkee consisted of separate islands, containing altogether about ten thousand acres. By means of above sixty successive advances of the dikes, they have been brought to compose a single island, whose area is not less than sixty thousand acres. The first dikes of Holland are attributed to the Romans.

A levee 6,000 yards in length defends the Romney Marsh, Essex, England, from overflow by the sea. The levee was made during the occupancy of Britain by the Romans, and is kept in good order, 24,000 acres of rich land being thus obtained. The fresh water in the ditches passes off at the lowest state of the tide by three sluices.

In Lincolnshire, England, 400,000 acres of fever-and-ague breeding swamp-land have been transformed into fields of wheat, barley, and oats, and excellent meadows. See SCOOP-WHEEL.

Lev′el. An instrument for indicating a horizontal line, or determining the position as to horizontality of an object or surface to which it is applied. See also CONTACT-LEVEL.

The Roman instruments for leveling were the *libra aquaria* and the dioptera of Hipparchus, the father of astronomical geography. The name is derived from *libella*, Lat. a balance, from the similarity in form, the long arm and perpendicular post. The word *libro* meant to level or to weigh.

The *libra aquaria*, we may deduce from Vitruvius, to have been a tube with upturned ends and holding water. It was probably mounted on an axis so as to be oscillated like a balance (*libra*), to adjust it on a vertical plane. Vitruvius remarks that Archimedes had stated that a surface of water was not level, as it partook of the convexity of the earth, yet, he observes, the water will rise in the ends of the tube to an equal hight if the instrument be held level.

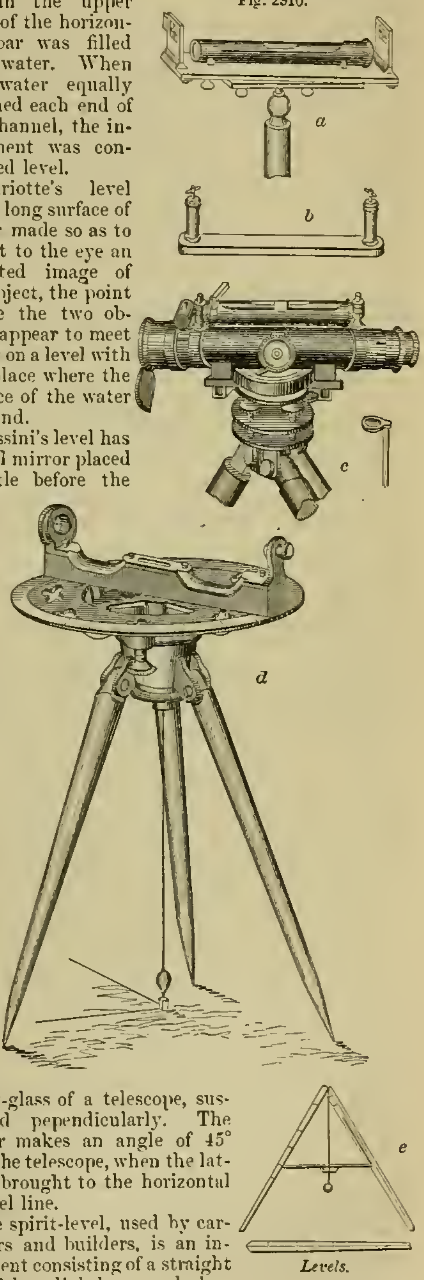
"The surface of water is not flat, but, on the contrary, convex, of a spherical shape. On this account, one who is on the sea, with a lighthouse in the distance, first descries its summit, and afterwards makes out to discover, little by little, what is below the summit, all of which was before, as a matter of course, concealed; for, excepting the convexity of the earth, there is nothing to hide every other part but the summit, in the case supposed." — AL KHÂZINÎ (twelfth century) in "The Book of the Balance of Wisdom."

Al Khâzinî was at the court of, and dedicated this work to the Saljûke Sultan Sanjar, who reigned over a large part of the Khalifate of Bagdâd, 1117–57. It is not clear that he was identical with Alhazen, the Iberian Saracen. (See pages 141, 212, 1154.)

Another Roman level was the *chorobates*, which was a light wooden frame about 20 feet in length, and mounted on a leg at each of its extremities. The longitudinal piece and the end pieces were braced by diagonals marked with vertical lines. A plumb-line suspended at each extremity swung over a diagonal, and indicated, by reference to the line, the horizontality of the instrument. It was much like the modern level.

When the wind disturbed the quietude of the plumb-line, a channel in the upper edge of the horizontal bar was filled with water. When the water equally touched each end of the channel, the instrument was considered level.

Fig. 2910.



Levels.

Mariotte's level has a long surface of water made so as to reflect to the eye an inverted image of the object, the point where the two objects appear to meet being on a level with the place where the surface of the water is found.

Cassini's level has a steel mirror placed a little before the object-glass of a telescope, suspended pependicularly. The mirror makes an angle of 45° with the telescope, when the latter is brought to the horizontal or level line.

The spirit-level, used by carpenters and builders, is an instrument consisting of a straight bar with a slightly curved glass tube containing alcohol. The tangent of the tube is the straight-edge of the instrument. For surveyors, the instrument is mounted on a stand and tripod and provided with sights, for use in leveling. One form is shown in the illustration (*a*, Fig. 2910). The spirit-tube is inclosed in a brass case and mounted on a stand, whose end plates are pierced for sights. Screws beneath the bed-plate permit accurate adjustment. Invented by Thevénot.

A description of his instrument, accompanied with figures, was first published in the "Journal des Savants," Paris, November 15, 1666, under this title: "*Machine nouvelle pour la conduite des eaux, pour les bâtiments, pour la navigation, et pour la plupart des autres arts.*" The instrument is there called an air-level; and is described as a glass tube, hermetically sealed at both ends, containing spirits of wine, which do not freeze, and a small quantity of air forming a bubble. It is stated that the instrument is capable of giving, with much exactness, the direction of the horizon, the perpendicular to the horizon, and vertical angles; and that it is easier to make, more convenient to use, and indicates a level line more readily and accurately than any other instrument.

Parker's level (*b*) consists of a glass tube of small bore, the two ends being bent at right angles and closed. The ends are about three inches high, and marked at a certain level; the tube is charged with quicksilver, so as to stand at the marked point in the tube-ends. Floats resting on the surface of the mercury have stems which pass outside and support sights through which objects are viewed. The instrument is supported on a tripod.

Gravatt's surveyor's level (*c*) consists of a telescope provided with spirit-levels. It is furnished with screws for minute adjustment, and is mounted on a tripod.

Sibley's level (*d*) is made of cast-iron, and is a cheap form of the instrument, possessing sufficient accuracy for common uses.

At one end it is provided with a sight having a small aperture with a short tube attached. At the opposite end of the level is a ring with cross wires, so adjusted that the center of the sight aperture and the intersection of the wires are level when the bubble at the center indicates that the instrument is level.

The level stands on a circular graduated table, from the center of the under side of which is suspended a plumb in the usual manner. This plumb being adjusted over any point (as the corner of a building-lot) and the first line laid out, stakes can be set in a line drawn at any desired angle to the first line, by simply turning the level upon a central pivot, provided for that purpose, the required number of degrees as indicated on the graduated table.

Brown's level (*e*) is shaped like a pair of compasses; the cross-bar, which is marked at midlength, shuts up between the legs when closed for transportation, in which condition the instrument resembles a walking-stick. It has the usual plumb-line.

The level is used to find a line parallel to the horizon. Practically speaking, two places are on a level which are equally distant from the center of the earth, but as the line of sight is a tangent and does not follow the curvature, in an observation, the excess of the apparent over the true level will be 7.9618 inches at a station a mile distant from the point of observation. Hence, proportioning the excesses in altitude according to the square of the distances, the following table is obtained, showing the hight of the apparent above the true level for every 100 yards of distance on the one hand, and from ¼ of a mile to 14 miles on the other.

Table.

Distance in Yards.	Difference of Level in Inches.	Distance in Miles.	Difference of Level in Feet and Inches.
100	.026	¼	0.05
200	.103	½	0.2
300	.231	¾	0.45
400	.411	1	0.8
500	.643	2	2.8
600	.925	3	6.0
700	1.260	4	10.7
800	1.645	5	16.7
900	2.081	6	23.11
1,000	2.570	7	32.6
1,100	3.110	8	42.6
1,200	3.701	9	53.9
1,300	4.344	10	66.4
1,400	5.038	11	80.3
1,500	5.784	12	95.7
1,600	6.580	13	112.2
1,700	7.425	14	130.1

Hebert gives the following illustrations of the useful application of the table: —

This table is adapted to several useful purposes.

First. To find the hight of the apparent level above the true at any distance.

If the given distance is in the table, the correction of the level is found in the same line with it; thus, at the distance of 1,000 yards, the correction is 2.57, or about 2½ inches, and at the distance of 10 miles is 66 feet 4 inches. But if the exact distance is not found in the table, then multiply the square of the distance in yards by 2.57 and then divide by 1,000,000, or cut off six places on the right for decimals, the rest are inches; or multiply the square of the distance in miles by 66 feet 4 inches, and divide by 100.

Secondly. To find the extent of the visible horizon, or how far an observer can see from any given hight on a horizontal plane, as at sea, suppose the eye of the observer, on the top of a ship's mast at sea, is at the hight of 130 feet above the water, he will then see about 14 miles round; or from the top of a cliff by the seaside, the hight of which is 66 feet, a person may see to the distance of nearly 10 miles on the surface of the sea. Also, when the top of a hill, or the light in a lighthouse, or such like, whose hight is 130 feet, first comes into the view of an eye on board a ship, the table shows that the distance of the ship from it is 14 miles, if the eye is at the surface of the water; but if the hight of the eye in the ship is 80 feet, then the distance will be increased by nearly 11 miles, making in all about 25 miles in distance.

Thirdly. Suppose a spring on one side of a hill and a house on an opposite hill, with a valley between them; that the spring seen from the house appears by a leveling instrument on a level with the foundation of the house, which, suppose, is a mile distant from it; then is the spring 8 inches above the true level of the house, and this distance would be barely sufficient for the water to be brought in pipes from the spring to the house, the pipes being laid all the way in the ground.

Fourthly. If the hight or distance exceed the limits of the table, then first, if the distance be given, divide it by 2, by 3, or by 4, etc., till the quotient comes within the distances on the table; then take out the hight answering to the quotient and multiply it by the square of the divisor, that is, by 4, 9, 16, etc., for the hight required. Thus, if the top of a hill is just seen at the distance of 40 miles, then 40 divided by 4 gives 10, the answer to which in the table is $66\frac{1}{3}$ feet, which being multiplied by 16, the square of 4, gives $1,061\frac{1}{3}$ feet for the hight of the hill. But when the hight is given, divide it by one of those square numbers, 4, 9, 16, 25, etc., till the quotient comes within the limits of the table, and multiply the quotient by the square root of the divisor, that is, by 2, 3, 4, or 5, etc., for the distance sought; so when the top of the Peak of Teneriffe, said to be about 3 miles or 15,840 feet high, just comes into view at sea, divide 15,840 by 225, or the square of 15, and the quotient is 70, nearly; the answer to which in the table is by proportion nearly $10\frac{2}{7}$ miles; then multiply $10\frac{2}{7}$ by 15, $= 154\frac{2}{7}$ miles for the distance of the Peak.

In what has been stated, no regard has been paid to the effect of refraction in elevating the apparent places of objects. But as the operation of refraction, in curving the rays of light proceeding from objects near the horizon, is considerable, it can by no means be neglected when the difference between the true and apparent elevation is estimated at considerable distances. It is now ascertained that, for horizontal refractions, the radius of curvature of the curve of refraction is about 7 times the radius of the earth; in consequence of which, the distance at which an object can be seen by refraction is to the distance at which it would be seen without refraction nearly as 14 to 13, — the refraction augmenting the distance at which an object can be seen by about $\frac{1}{13}$ of itself. By reason of this refraction, too, it happens that it is necessary to diminish, by $\frac{1}{7}$ of itself, the hight of the apparent above the true level, as given in the table of reductions. Thus at 1,000 yards, the true difference of level, when the allowance is made for the effect of refraction, will be $2.570 - .367 = 2.203$ inches. At 2 miles it would be $32 - 4.5 = 27\frac{3}{7}$ inches, and so on.

A *level* tube, in order to be accurate, must be ground in the inside surface, against which the bubble plays, to a concavity, the curvature of which is determined according to its length of radius, and which again is governed by the sensitiveness or accuracy of reading required. For a common leveling-instrument, for instance, a curvature of 150 feet radius is all-sufficient, while for astronomical determinations radii of from 700 to 1,200 feet are often required. Unground tubes, although frequently used, are utterly unreliable, and even among the ground ones many are found that show in their length great inequalities of radius. This arises from the difficulty of shaping and using skillfully the metallic mandrel or core on which the glass tube receives its form, since it has to be formed empirically and by trial, no arrangement being possible by which the form of the mandrel could be otherwise tested. Very similar to the shaping of large lenses for telescope objectives, the forms must be corrected by frequent trials of the result.

The mandrel on which the tube is ground to an arc of a given radius has a strip, say 60° of its surface, which corresponds in its curve with the interior diameter of its tube and the camber or arc required; but the mandrel is so much smaller than the tube that the latter may be reciprocated upon it, both in the rotary and longitudinal directions, the motions, in fact, being a combination of the two, much as in grinding lenses, allowing for the difference due to the motion of a tube on a mandrel and a lens on its shaping-block. The tube is thus ground with flour emery, and then with polishing powder, upon a surface the exact counterpart of the shape required, the different portions of the tube being brought in succession to the said grinding-surface by the rolling, or, as it may be called, figure-of-8 motion described. The length of the grinding strip on the mandrel should bear a given relation to the length of the tube, so that not alone should the tube receive an equal action at each part of its length, but the grinding-surface itself may retain its shape unimpaired. The excess of length of the mandrel may be, say, one quarter greater than that of the tube.

The longer the radius to which a tube is ground, the lesser will be the versed sine of the arc relatively to the chord, and the longer will be the seconds division of the graduations of the tube. One second (1″) of arc is equal to $\frac{1}{206000}$ part of the radius of the circle of which the tube is an arc. A level-tube ground to a radius of 1,000 feet will have its second (1″) graduations 0.058733 + of an inch apart, nearly $\frac{6}{100}$ of an inch. The level-trier constructed and used by Mr. Würdemann (the eminent optical and surveying instrument maker, of Washington, D. C., to whom I am indebted for the present detailed information) has second (″) graduations of 1 millimetre, and is ground to a radius of about 680 feet.

The English practice is to imbed the level-tube in plaster in a brass case, with an opening exposing the range of the bubble, in which condition it is subject to all the contractions and expansions of its envelope, a little more pressure upon any one part of the tube than on any other throwing the tube out of true, so that given lengths of different parts of the tube have a different value. Mr. Würdemann, on the contrary, suspends the tube as independently as possible, putting a band of paper around each end of the tube and clamping it in its brass holder by numerous white-pine wedges, leaving the greater length of the level free, suspended between the ends.

It appears from what has been said in the earlier portion of this article, that water was the liquid first employed in leveling, but at a distant period wine and eventually spirits came to be employed to avoid the difficulty due to freezing of the liquid. This change was also an improvement in respect of the greater mobility of the liquid. The comparative sluggishness or viscidity of a liquid is expressed in the time that a bubble of air takes to traverse a certain distance in a certain sized tube.

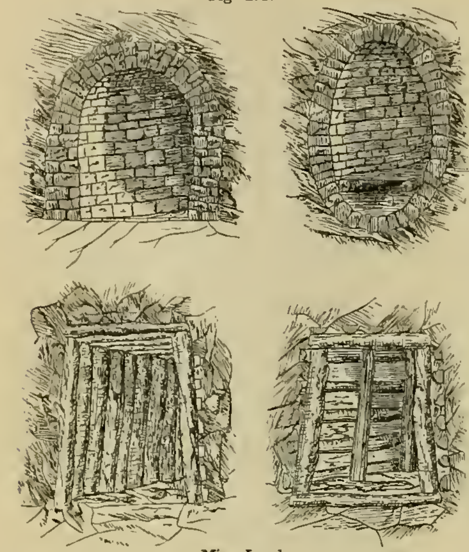
The result is expressed by water, 100; alcohol, 15; sulphuric ether, 5; chloroform, 3.

The English make long level-tubes apparently to avoid the difficulty arising from the expansion and contraction of the liquid, which decrease and increase, respectively, the size of the bubble. The American practice is to make short levels, and this has been rendered possible by placing a chamber at the end, into which any portion of the air of the bubble, short of the whole, may be admitted and detained, so that a bubble of an equal size may be attained when working at various temperatures. The *chambering* of the level-tube was introduced by Pistor and Martins, instrument-makers of a European reputation. The chamber is made by cementing a glass partition near one end of the tube, a small hole on the edge of the glass disk making a connection between the main portion of the tube and the chamber. By holding the tube with the hole upward, tipping it chamber upward, and then rotating the tube on its axis, any required portion of the air may be imprisoned in the chamber, to adapt the instrument to work in an atmosphere of any temperature, with a bubble of a normal size. Mr. Würdemann was the first to hermetically seal a tube containing the chamber, previous to which time it was closed by glass plates, bladder, and glue.

The most curious and delicate apparatus for leveling, in dividing and graduating instruments, and adapted for many other purposes, is the *contact-level* invented by Repsold, a celebrated instrument-maker of Hamburg. It is described on page 612, and room cannot be spared for duplicate descriptions.

2. (*Mining.*) *a.* A horizontal gallery or passage in a mine. The workings at different depths are said to be at the different *levels*, — the 50 or 60 fathom level, and so on.

Fig. 2911



Mine-Levels.

b. An adit or drift forming a drain for water.

A level which opens to the surface at the side of a valley is called a *day-level*, and forms a means of natural drainage without pumping.

A *drowned* or *blind level* is a drainage-gallery which has the form of an inverted siphon.

A *dip-head level* is the one which proceeds from the foot of the engine-shaft right and left, and from which the *rooms* proceed.

c. A gutter for water to run in.

See under the following heads: —

Air-level.
Artillery-level.
Batter-level.
Battering plumb-rule.
Bevel plumb-rule.
Bubble.
Carpenter's level.
Contact-level.
Dumpy-level.
Foot-level.
Gunner's level.
Level (mining).
Leveling-block.
Leveling-staff.
Level-lines.
Libella.
Pendulum-level.
Plumb-level.
Plumb-rule.
Reflecting-level.
Road-level.
Self-recording level.
Slope-level.
Spirit-level.
Triangular level.
Water-level.
Y-level.

Lev'el-er. 1. A billiard-table foot having a screw adjustment for hight, in order to level the table.

2. An earth-scraper for leveling a site.

Fig. 2912.

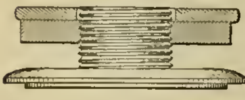


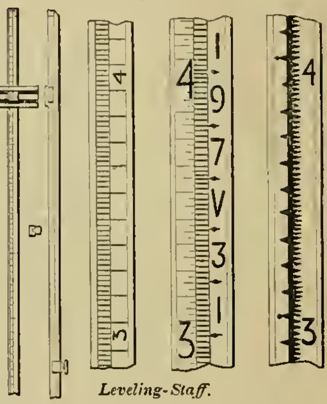
Table-Leveler.

Lev'el-ing-block. A leveling platform, consisting of large iron plates laid together and secured. The respective plates may be 8 or 10 feet long, 5 or 6 wide, and 6 inches thick. They are completely covered with holes, about 1½ inches in diameter and 4 or 5 inches apart from center to center. The mold of a given frame having been laid on the leveling-block, the figure of the molding edge is marked on it with chalk, and iron pins are stuck in the holes, so that when the iron rib is made to touch those pins it will have the proper form. In order the more easily to produce any required figure, the heads of the pins are furnished with eccentric disks or cams, by the shifting and turning of which the figure of the frame can be adjusted with great precision. Each disk has several center-holes, any one of which can be fitted on the pin.

The iron bar of the frame, having been raised to a bright orange heat in a reverberatory furnace, called a *reheating furnace*, is taken out by the smiths, laid on the *leveling-block*, and rapidly bent by means of tongs, hammers, mallets, and levers, so as to lie touching the heads of the pins.

Lev'el-ing-staff. An instrument, one form of which consists of two strips 6½ feet long, united by a longitudinal tenon and mortise so as to slide on each other and extend to a length of 12 feet. The divisions are in feet, inches, and fractions, and count from the bottom. A cross-piece or *vane* slides on the staff, and has an aperture to enable the staff graduations to be read. Inlaying with white wood gives more conspicuousness to the staff when viewed by the leveler.

Fig. 2913



Leveling-Staff.

The staff is planted by an assistant, and the vane raised or lowered according to the signals of the engineer, until the center line of the vane coincides with the horizontal hair of the telescope. When the cross-wire of the vane is raised so high as to intersect 6 feet, it encounters a stop. If it be necessary to raise it higher, it is raised by elevating the front portion of the staff and the vane with it.

The staffs are graduated in various ways. Some have the duodecimal graduation; others the feet divided into inches and tenths; others the feet divided into hundredths, rejecting the inches.

Lev'el-ing-stand. (*Photography.*) An instrument used to support a glass plate in a horizontal position, so that it shall retain developing or other fluids upon its upper surface. Its usual form is a tripod, of suitable hight to stand in the developing-trough; with three adjusting-screws by which the operation of leveling is accomplished.

Lev'el-lines. (*Shipbuilding.*) Lines representing the boundaries of sections drawn at different hights and parallel with the keel.

Water-lines are drawn parallel with the line of flotation or the true horizontal.

When the ship floats on "an even keel," the *level*-lines and *water*-lines coincide.

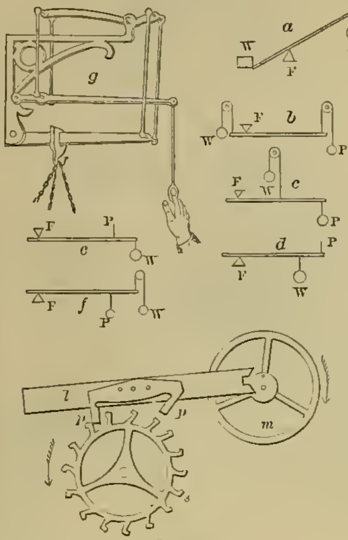
Le'ver. 1. (*Mechanics.*) A bar or other rigid instrument having a fixed point or a fulcrum, and other points for the exercise of power and application to the object to be moved. There are three varieties, known as levers of the first, second, and third class, in which the fulcrum is respectively, —

1. Between the weight and the power, as at *a b*.
2. Opposite to the power, as at *c d*.
3. Opposite to the weight, as at *c f*.

g is a *compound lever* or system of levers, the basis of the ordinary weighing-machines.

In the illustration three levers are shown. When a system of this kind is in equilibrium, of course the ratio of the power to the load will be compounded of the ratios subsisting between the arms of each lever; or, in other words, the power multiplied by the continued product of the alternate arms, commencing from the power, is equal to the weight multiplied by the continued product of the alternate arms, beginning from the weight.

Fig. 2914.



Levers.

2. (*Horology.*) A form of escapement.

In Fig. 2914, *l* is the *lever* having *pallets p p*; *s* is the *scape-wheel*, *m* the *balance*. The lever to which the pallets *p p* are attached turns upon a center-pin, so that the ends of the lever move backward and forward through small arcs, as the pallets are alternately released from the scape-wheel. One end of the lever has a little nick in it, which, as it passes backward and forward, catches a pin upon the balance and throws it right and left. As the lever, for example, moves to the left, one of the pallets catches a tooth of the scape-wheel, and stops the train; at the same time the balance is thrown round so that the pin passes out of the nick, and the balance swings free to the extent of the impulse; that is, it is *detached* from the lever. As it swings back under pressure of the hair-spring, the pin catches in the nick again, and, moving the lever back, unlocks the pallet, when instantly the other pallet is caught by another tooth, and the lever throws the balance the other way. The balance, therefore, in its isochronal swing, throwing the lever this way and that, and alternately locking and unlocking the teeth of the scape-wheel, determines the rate of movement of the train. This is known as the *patent lever, detached lever*, or *detached escapement*.

3. (*Surgical.*) An obstetric instrument, curved at its extremity, and having a fenestra. It is used in extracting the head of a child. A *vectis*. See also Obstetrical Forceps.

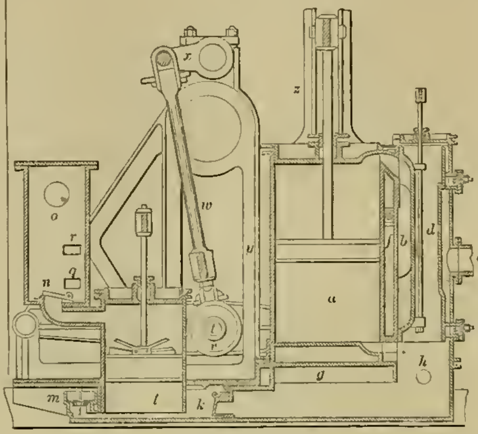
4. (*Dental.*) *a.* A tool for extracting stumps.

b. A *turnkey*.

Le′ver-brace. A carpenter's hand-brace.

Le′ver-en′gine. A modification of the *side-beam engine*, in which the beams are levers of the second kind, the fulcrum being at one extremity of the lever and the piston-rod connection at the other, the connecting-rod to the crank being joined to the beam at a point between the two.

Fig. 2915.



Lever-Engine.

a is the cylinder. *c*, the steam-pipe.

b, the slide-case or valve-chamber.

d, the long slide-valve, whose hollow forms the eduction-passage.

f, the way-shaft by which the valve is worked.

g, the condenser, cast in one piece with the bed-plate, and forming a pedestal to the cylinder.

h, the injection-pipe. *k*, the foot-valve.

l, the air-pump, inserted in a chamber formed in the bed-plate.

m, the blow-through valve. *n*, the delivery-valve.

o, the hot-well.

q r, the passages connected with the feed-pump, one forming the port for the supply of feed-water to the boiler, and the other the port by which the surplus is returned from the pump when the regulating valves or cocks of the feed-pipe to the boiler are closed. See Feed-pump.

t, the lever-beam gudgeon. *v*, the beam.

w, the connecting-rod. *x*, the crank.

y, the side-frame, firmly secured to the bed-plate, and to strong flanges cast on the cylinder.

z, the guides in which the cross-head moves.

Le′ver-es-cape′ment. The *lever*-escapement was invented by Mudge about 1780, and improved by Breguet of Paris and Roskell of Liverpool.

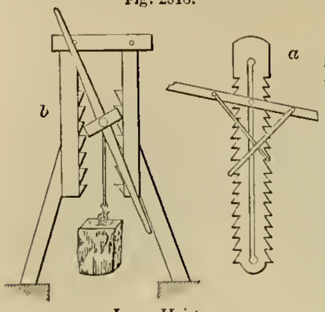
In its first form, the end of the *lever* had a segment-*rack* which engaged a *pinion* on the *arbor* of the *balance*. The improved form consisted in substituting a *fork* for the *rack*, making what is called the *detached lever*, patented by Roskell. (See Fig. 2914.) The lever vibrates on a center and carries the *pallets* (or *anchor*), and its forked end alternately engages with and is engaged by a ruby pin attached to a disk on the balance-arbor. The lever or fork, having the impulse given to it from the wheel, and then striking against the ruby pin, gives the motion to the balance from which it was disengaged, till brought back by the hair-spring; the ruby pin then strikes the fork and disengages the wheel, thus allowing it to go on.

This causes two distinct beats. See JEWEL.

Le'ver-hoist. (*Hoisting.*) Lagarouse's lever (*a*) is a contrivance for converting a reciprocating circular motion into a continuous rectilinear.

The device is susceptible of several modifications. In the illustration, it consists of a lever reciprocating vertically on a fixed axis, and having a pair of stirrups which act alternately in the serrations on the respective sides of the rack. As one end of the lever is depressed, one stirrup is made effective, and a dog retains the rack at the obtained elevation. The other end of the lever is then depressed with a repetition of the result stated.

Fig. 2916.



Lever-Hoists.

b is a similar arrangement for hoisting, described by the Marquis of Worcester in his "Century of Inventions," 1655, and stated to have been seen by him in the Arsenal of Venice. The cross-bar at the midlength of the lever has a fulcrum on alternate sides of the frame. The teeth are pivoted, and yield as the cross-bar presses against them from below, but afford a safe bearing when the bar rests upon them. The lever is oscillated and each sweep is effective. Several of our lever-jacks are substantially similar.

Le'ver-jack. A form of hoist having a *lever*, *post*, and pawl. See LIFTING-JACK.

Le'ver-ob-stet'ric. (*Surgical.*) *Vectis.* A spoon-shaped instrument employed in certain cases of protracted labor.

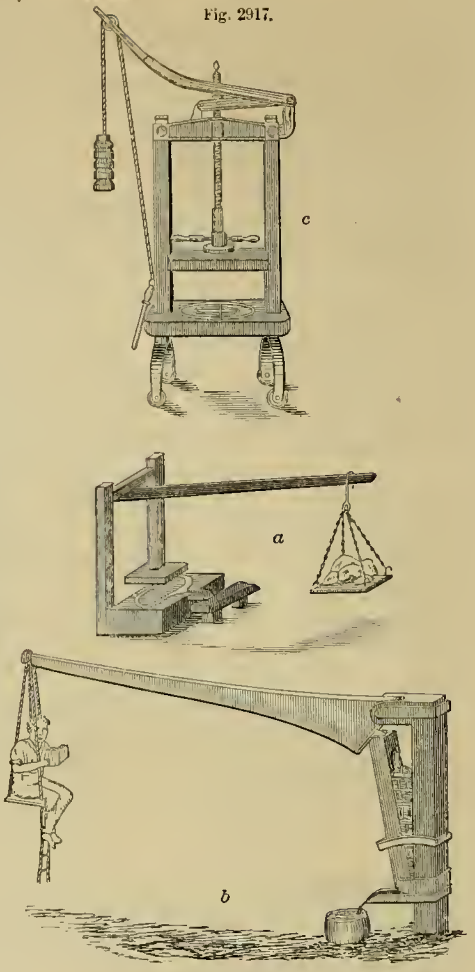
Le'ver-press. One of the simplest and most evident forms of pressing apparatus.

It assumes many forms: cider-presses, lard or tallow squeezers, cheese-presses, are constructed to obtain pressure by a lever, which is depressed by a suspended weight, as at *a*, by tackle or by a screw. See OIL, CHEESE, COTTON, HAY-BALING PRESS.

Hebert's oil-press *b* has a standing and a movable jaw with a lever by which the latter is oscillated. Depressions in the faces of the jaws hold the bag of olives, or other oil-producing fruit or seeds. The operator is worth his weight in stones or anything else and something more, as he can climb up to his perch.

c is a cheese-press having a screw for quick motion and a compound lever and suspended weight for continuous pressure. The nut of the screw is boxed in the short lever, which is of the second class. The long lever is of the same class.

Fig. 2917.



Lever-Presses.

Le'ver-punch. A punch operated by the rolling motion of two cam-faced levers which are approached by a screw.

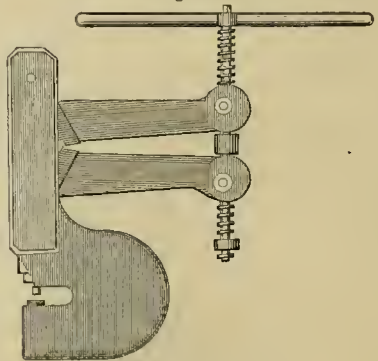
Le'ver-valve. A safety-valve kept in its seat by the pressure of a lever with an adjustable weight. The invention of Dr. Papin of Blois.

In locomotives a spring is used at the end of the lever instead of a weight; the pressure being regulated by a screw and indicated on a brass plate.

Under ordinary circumstances the valve-lever has a number of weights, which are added as occasion requires, or the weight is shifted in or out on the lever. See SAFETY-VALVE.

Lev-i-ga'tion. A process of rubbing a moist material between two hard surfaces, as in grinding pigments and printer's ink.

Fig. 2918.



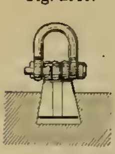
Duplex Lever-Punch.

Trituration is distinguished from levigation in the respect that the material in *trituration* is *dry*; in *levigation* it is *wet*.

When the process is by *muller* and *slab*, it is technically *porphyrization*.

Lew'is. 1. A device for lifting stones which was used many centuries back but received its name from a Frenchman who brought it to its present form. He was an architect on the works of Louis XIV., and gave it the name it bears in compliment to his master. It consists of two dovetail tenons, which are expanded by a key in a dovetail mortise in the stone, and shackled to the hoisting-chain. The dovetail pieces are first inserted and then forced apart by the middle key, so as to occupy the undercut portion of the mortise. All three are then shackled to the lifting-chain.

Fig. 2919.



Lewis.

The *lewis* was used by the ancient Romans, and the peculiar mortise marks are found in the stones of the Flavian amphitheater.

2. A kind of shears used in cropping woolen cloth.

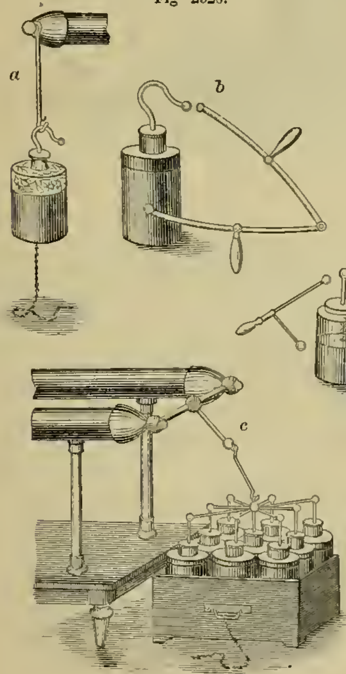
Lew'is-bolt. A wedge-shaped bolt secured in its socket by lead, and used as a *lewis* in lifting. See 7, Fig. 768.

Ley. A solution of an alkali. See Lye.

Ley'den-bat'ter-y. A number of Leyden-jars connected externally by resting on a metallic surface, and connected internally by rods and wires. See *c*, Fig. 2920.

Ley'den-jar. This is a glass jar coated both inside and out with tinfoil, for about four fifths of its hight. The mouth is closed by a cork, through which passes a metallic rod, terminating above in a knob and connected below with the inner coating, either by a chain or by pieces of tinfoil with which the jar is filled. If the inner coating be connected with an electrical machine, and the outer coating with the earth, the former acquires a positive and the latter a negative charge. On connecting them together, by means of a metallic discharger with non-conducting handles, as shown at *b*, a spark is obtained. *c* is a battery formed by connecting together in series all the outer and all the inner surfaces of several jars, so that the united force of the whole is concentrated in the act of discharging.

Fig 2920.



Leyden-Jars.

The principle of the Leyden-jar was discovered by Muschenbroeck at Leyden in 1745, hence its name. Von Kleist in Germany made the same discovery in the same year.

Gralath in Germany, 1746, contrived the electric battery by combining a series of jars; and finally Drs. Watson and Bevis, by covering the outside of the jar with tinfoil, brought it to the complete state in which we now have it.

The Leyden-jar is a condenser, its two coatings of tinfoil performing the parts of a collecting plate and a condensing plate.

Li-bel'la. 1. A small balance.

2. A Level (which see).

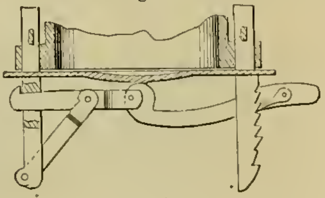
Lick'er-in. (*Carding-machine.*) A drum with *cards* on its periphery presented at the throat of a carding-machine, so as to catch or *lick in* the cotton filaments as they are presented by the passage of the *lap* between the feed-rollers. See Carding-machine.

Lid. A cover, cap, or shutter, as of a box; or of the objective or eye-glass of an optical instrument; or of the charging end of a retort; or of the works or the face of a watch; of a hatchway, etc.

Lid-clos'er. 1. A clamp for the covers of gas-retorts, which, after charging, are closed with a luted joint to prevent escape of gas.

2. Manholes of boilers and tanks are also closed with a bridge-piece and screw.

Fig. 2921.



Lid-Closer.

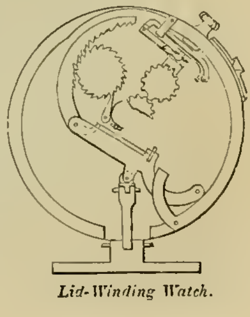
Lid-wind'ing Watch. One in which the opening of the lid, as occurring several times during the day, is made to wind up the going mechanism.

In the patent of Ramuz, 1868, the cover is connected to a lever which is operated by opening and closing the cover, and acts through a gimbal-joint upon a lever to which a curved ratchet-bar is pivoted. The curved ratchet-bar engages a ratchet-wheel, which communicates with the works so as to partially wind the same when the cover is opened to observe the time.

Theurer's patent of 1866 seems to have been the first of the kind. Mozart's of 1873 may also be noticed.

Lie'ber-kühn. (*Optics.*) An annular reflector attached to the nose of the object-glass, and serving to illuminate an object by reflecting the rays which pass around the object through the slip on the stand.

Fig. 2922.



Lid-Winding Watch.

Lierne. A branch rib introduced between the principal ribs of a groined arch, so as to form an ornamental pattern.

Life-boat. A boat with air-chambers or floats of cork, to give it great buoyancy and allow it to carry a load even when filled with water.

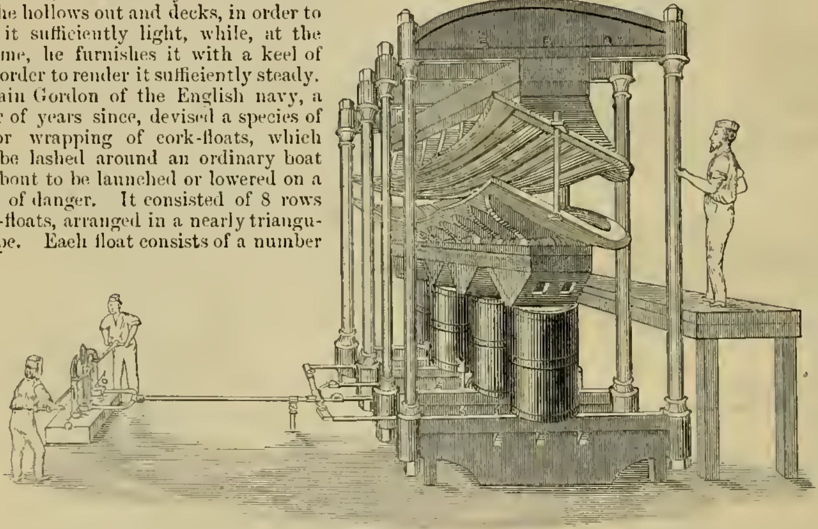
A common boat may be turned to a life-boat by increasing its flotative power. This may be done by bags of cork shavings, packages of cork, inflated bags, air-tight chambers, casks of air, etc. In cases of emergency, various means have been devised by ingenious men under the inspiration of danger or the force of professional training and habit. Brimmer's life-boat, used in England at the close of the last century, had kegs lashed inside the gunwale, bilge-keels, and a keel weighted with iron.

The belemnite, a calcareous fossil, the internal bone of an extinct family of cephalapods, seems to have united the principle of the *float* to that of the *sinker*, as we see it in some of our modern life-boats, which are steadied on their keel by one principle and preserved from foundering by the other; as in the boy's mimic smack which he hollows out and decks, in order to render it sufficiently light, while, at the same time, he furnishes it with a keel of lead in order to render it sufficiently steady.

Captain Gordon of the English navy, a number of years since, devised a species of buoy or wrapping of cork-floats, which might be lashed around an ordinary boat when about to be launched or lowered on a mission of danger. It consisted of 8 rows of cork-floats, arranged in a nearly triangular shape. Each float consists of a number of pieces of cork 1 foot long, 6 inches wide, and 1¼ inches thick, laid three thicknesses together, placed end to end till of the required length, and secured by split bamboo and lashings. The upper strake is the longest, say 9 feet long, and each succeeding strake is 1 foot shorter than the one above it. The strakes are secured together by 4 stout cords, which are seized together between each strake. The 8 combined strakes are so wrapped around an ordinary boat amidships, that the longest strake is just below the gunwale, and the shortest about the keel. The other side of the boat is similarly furnished. For a boat of large class a number of such floats may be provided. Two buoys like that described will displace 14⅔ cubic feet of water, and if added to a boat 28 feet long, and capable of containing 24 men, would leave a buoyancy of 718 pounds for their support.

Luken's life-boat, used in England about 1785, had projecting gunwales and double sides under them, serving as air-chambers, and air-tight chambers under the thwarts or rowers' seats. This arrangement increased the buoyancy and stability of the boat very much.

Fig 2923.



Hydraulic Press.

In 1789, Mr. Greathead of South Shields invented his boat, which proved so successful that it is said that previous to 1804 nearly 300 lives had been saved through its instrumentality near the mouth of the Tynemouth Haven.

This boat was about 30 feet in length by 10 in breadth, and 3½ feet deep, having a great sheer from the waist to the ends, which were both sharp and rose with a high curve. The gunwale projected several inches, and the sides were cased and lined with cork, secured by sheet-copper and copper nails. The quantity of cork employed was 700 pounds, the outside layer being 4 inches thick, extending along the whole side of the boat; the inside layer was somewhat thicker. The boat was rowed by ten oars, and an oar was employed for steering.

A two-wheeled sling-cart with arched axle was used for transporting the boat to the beach where it was desired to launch it. Mr. Greathead received a Parliamentary grant of £1,200 for his invention, and various rewards from different societies.

Francis's *metallic* life-boats are made between heavy dies, which swage one half the boat at a time by means of hydraulic pressure. The cut is sufficiently plain, requiring no lengthy description. The iron plates are corrugated to insure sufficient stiffness, the dies being grooved to fit each other and give the form to the plate pressed between them.

Water-tight compartments are distributed in different parts of the boat, so as not to be involved in any casualty which occurs in the staving of the boat.

The most important part of the construction consists in the longitudinal corrugations formed in the sheet-metal, by which the strength and stiffness are very much increased.

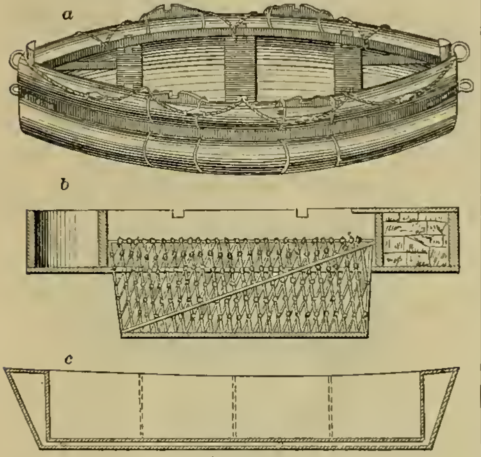
Francis, in his patent of 1839, describes metallic tubes laid longitudinally in the bottom of the boat, and divided by transverse partitions, which were connected by metallic bands or braces running crosswise of the boat, and which served as floats. Over these the flooring was laid. The framing and planking were laid much as in the ordinary manner. The boat was partially decked over at the ends, forming compartments, and had transverse thwarts, between the two middle ones of which was a windlass for raising and lowering the anchor, which was suspended by a cable passing through a hole in the bottom; other holes were provided in the bottom for freeing the boat from water. The boat had a metallic keel.

Noble's life-boat (*a*, Fig. 2924) has a hold covered by a flexible air and water tight covering supported by and fastened to a sustaining frame. This cover may be made double, so as to be inflated and add to the buoyancy of the boat.

The hold is ventilated by a hollow mast with separated passages for the indraft of fresh and the exit of impure air.

In Fig. 2924, *b* represents a boat whose central part has no bottom. The top and bottom of the two end compartments are precisely alike, and act as floats. A net is suspended in the vacant middle space, so that, in whatever position the boat falls when launched, persons may be sustained by the suspended net and prevented from sinking; or, in case of capsizing while in the water, may clamber from one side to the other, the net falling to the lower side.

Fig. 2924.



Life-Boats.

Tier's life and sporting boat (*c*, Fig. 2924) has an inner and outer shell, the space between them being decked over and divided by partitions. The inner shell forms the open space for the boatman.

Another form of boat consists of a cylinder terminating at each end in a conic frustum. It has hinged doors, and is moved through the water by a propeller driven by a shaft having an endless screw turned by gear-wheels worked by hand-crank in the interior of the boat.

A modification of this boat is also cylindrical, and the axes are journaled in a flotative frame, instead of making the cylinder separately buoyant. It is driven by an end propeller worked by a crank in the interior of the boat.

Beeching's life-boat, which received the prize of 100 guineas offered by the Duke of Northumberland in 1850, among nearly 300 competitors, is in form something like a whale-boat. It is about 36 feet in extreme length, 9½ feet in extreme breadth, and 3½ feet in depth. A cork-fender, about 7 inches square, runs around outside a few inches below the gunwale. Extra buoyancy is given by air-cases placed in all the vacant spaces of the boat. These, with the cork-fender, give a buoyancy or upward tendency of more than eight tons, counteracting to that extent the weight or downward tendency of the boat and its crew. For ballast, the boat is provided with water-tanks capable of containing about two tons, and there are pipes for emptying these tanks very quickly. If the boat be upset, the heavy iron keel and the filled water-tanks near the bottom, aided by the light air-cases near the top, tend to right it. It is rigged with a lug foresail and a mizzen. The draft of water, with thirty persons on board, is about two feet; the weight of the boat and its fittings is about three tons and a half, and the cost £250. It is capable of carrying seventy-five persons with safety.

The boat of the National Life-Boat Institution, England, is the invention of Mr. Peake, master shipwright of Devonport Dockyard. It is a strong boat, 30 feet long, 8 feet beam, and rowed by 8 to 12 oars, double-banked. It is nearly flat-bottomed, but the bow and stern rise 2 feet higher than the midship portion. Running along the upper part of each side, and occupying 4 feet at each end, are air-tight chambers, which impart sufficient buoyancy to float the boat and crew when the boat is filled with water. The iron keel weighs 800 pounds, and in connection with the curved shape of the boat infallibly rights the same when upset.

The boat has a false bottom above the water-line, and the space between the two is packed with cork and light wood. Passing through this light stuff are open-ended tubes, 6 inches in diameter, which carry down any water that is shipped by the boat.

The saving of life by life-boats in the British Islands, 1824–65, was 14,980 persons.

Life-buoy. (*Nautical.*) A buoy or float which is thrown overboard to sustain a person until assistance arrives.

It has various forms: —

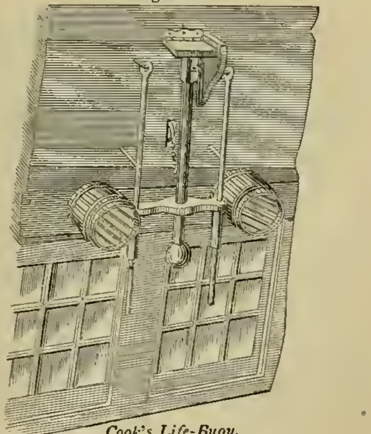
In one, each of the stools in the cabin has an air-tight tin case fastened beneath the seat.

2. An india-rubber belt capable of inflation.

3. A painted canvas case, of an annular shape, 31 inches in diameter, 6 inches wide, and 4 inches thick. It contains 12 pounds of cork, in thin layers.

Lieutenant Cook of the English navy invented a life-buoy which is provided on board all the vessels of that service. It consists of two hollow copper vessels connected by a horizontal bar, through the

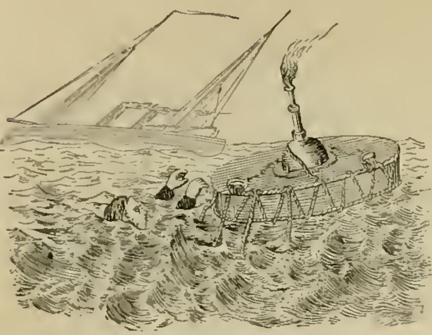
Fig. 2925.



Cook's Life-Buoy.

middle of which is fixed vertically a strong staff formed of a metallic tube, the upper extremity of which supports the fuse. The lower part of the staff has a balance-weight which drops out when the buoy falls, and maintains the staff upright in the water. The apparatus is kept suspended at the quarter, is detached by a trigger, and the act of releasing it drops a gun-lock hammer and ignites the fuse, which blazes for a considerable time and attracts the man overboard while it directs the crew of the boat to the assistance of the person. It will support two persons.

Fig. 2926.



Life-Buoy.

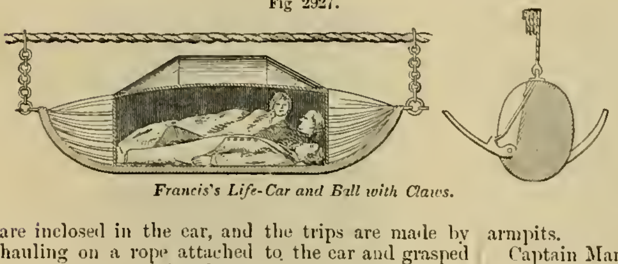
The life-buoy (Fig. 2926) is of similar character. The fuse composition is not extinguished by water.

Life-car. This is an apparatus used to communicate between a wreck and the shore, for the purpose of rescuing persons on board.

Francis's life-car resembles a boat, being a water-tight metallic shell, with a hatchway or cover, and is adapted to travel on ropes whose ends are connected to the ship and to the shore respectively. This connection is made by means of firing from a mortar a shot having a cord attached. The cord is so coiled upon a rack as to pay off freely as the shot is fired and falls beyond the vessel. The cord, being caught by those on board, is made the means for sending ashore a hawser or larger cord on which the life-car may be suspended.

The passengers, to the number of 3 or 4 at a time, are inclosed in the car, and the trips are made by hauling on a rope attached to the car and grasped by parties on board and ashore.

Fig 2927.



Francis's Life-Car and Ball with Claws.

One of these cars was the means of saving 200 passengers from the "Ayrshire," which went ashore at Long Branch, January, 1850.

Life-guard. (*Locomotive-engine.*) Safeguard, rail-guard, sweeper. The device embracing the brooms fixed in front of a locomotive for clearing small obstructions from the track.

Life-line. (*Nautical.*) *a.* A line stretched above a yard to enable seamen to stand thereon in manning yards.

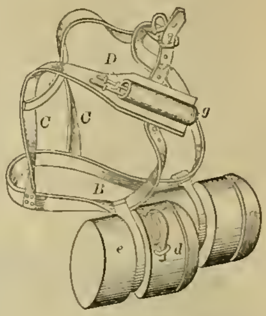
b. A line stretched from object to object on deck, for the men to grasp in bad weather and heavy sea.

c. A line attached at one end to a life-buoy and floating loosely, to assist a person in grasping it.

Life-pre-serv'er. 1. A device to enable a person to float in water in case of accident.

A cork-jacket or inflatable belt or waistcoat are ordinary devices for this purpose. Fig. 2928 shows a more pretentious life-preserver, constructed of two hollow drums or floats, with openings to receive valuable papers or documents, and with depressions *d* to receive the straps *e*. *B C* are the body-belt and shoulder-straps; the pocket *g* is intended to receive a signal-flag.

Fig. 2928.

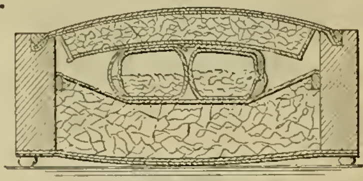


Life-Float.

Besides these articles for wear in an emergency are life-preserving mattresses, seats, berths, buckets, rafts, floats, and, in some cases, the general furniture and even doors of the cabins are specially made to subserve the purpose.

In Fig. 2929, two mattresses filled with cork have between them an air-bag, confined in a fibrous sack to prevent rupture, the whole forming an elastic bed, which may be separated into several distinct life-preservers in accidents on water.

Fig. 2929.



Life-Mattress.

Life-preservers of cork date back to the time of the early Romans. The Roman messenger sent by Camillus to the Capitol, when besieged, swam the Tiber with a cork-jacket.

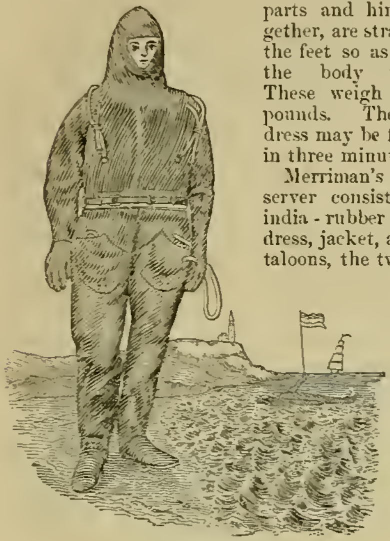
The *bamboo habit*, or Chinese life-preserver, consists of four pieces of bamboo, about a man's length, placed at right angles in parallel pairs, and tied firmly at the four corners, leaving an opening for the body, so that one pair of bamboos rests beneath the armpits.

Captain Manby's apparatus is used in England to communicate with stranded or shipwrecked vessels. A shot thrown by a mortar has a line attached to it, and being thrown over the vessel the line is the means of hauling a rope on board, and thus communication is established with the shore, by hammock or cradle, which is arranged to traverse on the rope. (See LIFE-CAR.) Light-balls are thrown up and explode by fuse at a hight of 300 yards, so as to illuminate a large area and afford a view of the vessel in distress. The apparatus has been the means of saving several hundred lives. Captain Manby died

November 18, 1854, aged 89 years. For apparatus to enable a person to traverse foul air without inspiring it, see INHALER.

Stoner's life-preserver is of india-rubber, and made in one piece, the only openings being in the head-piece and at the wrists; the former is secured by bands passing over the top of the head and a flap under the chin. Suspenders pass over the shoulders from the waist, and an exterior waist-belt is buckled around the body. A cork jacket is buckled around the waist beneath the rubber garment, and is prevented from slipping by shoulder-straps. The lower parts of the dress are of thicker material than the upper, and leaden soles, made in two parts and hinged together, are strapped to the feet so as to keep the body upright. These weigh 7 to 8 pounds. The whole dress may be fitted on in three minutes.

Fig. 2930.



Life-Preserver.

Merriman's life-preserver consists of an india-rubber head-dress, jacket, and pantaloons, the two latter connected by a joint, around which is secured a belt to insure the junction being air-tight. It weighs about 14 pounds, and it is said can be inflated in 1½ minutes. The contained air serves to keep the body warm as well as to buoy it up. When in the water the bearer floats upon his back, having about one third of his body above the surface.

With each of these life-preservers is provided a case for holding water and provisions, and a small flag and staff to attract attention.

Ormsbee's life-preserver consists of inflatable sleeves, leggings, hip-bands, which may be worn with but little inconvenience when in positions of danger, or in learning to swim. Or they may be carried in the pocket.

2. A loaded stick or cane with a leaden head, used as a protection against assailants.

Lift. 1. (*Nautical.*) A rope stretching from a mast-head to the end of a yard, to *trim* it (*squaring*), or in *topping* (*yards apeak*).

A *topping-lift* is a rope which raises the after end of a boom.

2. A hoisting-machine. See list under HOISTING.

a. An elevator for goods or material in a furnace or mine. See ELEVATOR; FURNACE-HOIST; MAN-ENGINE, etc.

b. A *dumb-waiter.*

3. An exercising machine. See LIFTING-MACHINE.

4. The distance which an ore-stamp rises and falls.

5. (*Lathe.*) One of the several flats or grooves for the belt on the driving and cone wheels of a lathe. The varying diameters of the lifts are for changes of speed.

6. (*Shoemaking.*) One thickness or layer of leather in the *tap* which forms the heel of a boot.

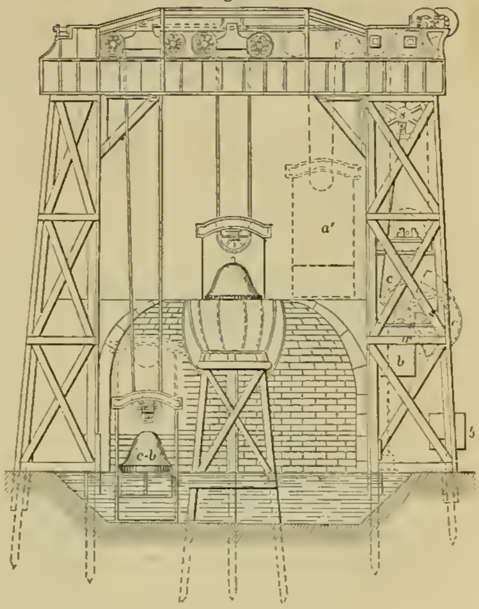
7. (*Hydraulic Engineering.*) *a.* The amount by which a canal-boat is elevated in a lock. The difference in level between the upper and lower *pounds.*

b. The rise of an undershot-wheel above the water-surface.

c. A substitute for canal-locks, the boats being lifted and lowered by machinery from level to level.

The boats are floated in water during transfer; gates and sluices in the main *line* are dispensed with; the boat is transferred from one level to another without loss of water.

Fig. 2931.



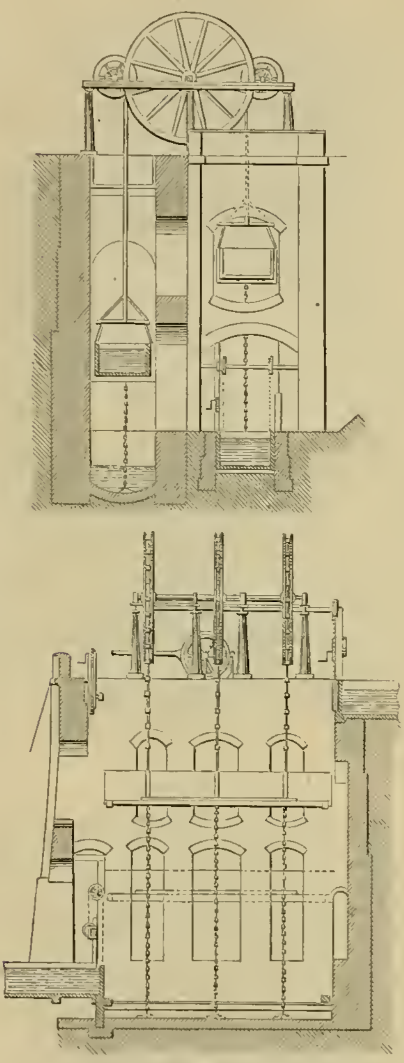
Slate's Canal-Lift.

The lower level is divided into two branches, which are carried along each side of the upper level to a length a little over that of the canal-boat. The depth of each branch is sufficient to allow the boat *c-b* to float over the top of an iron caisson or tank *A*, filled with water and sufficiently large to float a loaded boat. An elevated framework is constructed to overarch the three basins, and is provided with transverse rails and carriages, containing the wheels over which run the suspending chains by which the caissons, their contained water, and the floating boat are lifted or lowered. The caissons, which lie in the bottoms of the basins to receive their load, are suspended by straps from cross-bearers, to which the suspending chains are connected. The chain which suspends one caisson and boat passes over drums on one carriage, and that which suspends the other caisson and boat passes over the drums on another carriage; the chain at each end of the lift being the same, passing in continuity over the different drums and around the long shaft at the side of the framework, so that, as the shaft revolves, the chain winds on one set of drums and unwinds from the other, one boat rising as the other descends.

The action is as follows: —

Two boats approaching the lift from contrary directions are floated over the sunken caissons in the lower and upper basins respectively. The load is uniform, whether the caisson contain a boat or otherwise, as the caisson is full of water in either case, and the boat displaces a weight of water exactly equal to its own weight. The shaft *s'* is rotated by steam or water power, and the chains wind on the cams *c c*, causing the upper shaft *s* to move down in the framework and draw the caissons with their loads out of the water. The weight of the caisson is balanced by a weight *w*, which acts by a short or long leverage on the cams, according to the position of the caissons in or out of the water respectively. The buckets *b b* suspended from the shaft *s'* may be filled as required to assist the power in working the shaft.

Fig. 2932.



Canal-Lift (Great Western Canal of England).

The caissons being lifted out of the water, the upper caisson is moved on the railway across the canal, so as to be suspended over the lower basin, ready to descend.

When in this position the two caissons are in equilibrium, each suspended clear of the water, and over the lower basin, the upper one occupying the position in dotted lines *a'*. The equilibrium is then disturbed, by allowing some water to escape from the lower caisson, which thereupon rises, the positions of the respective caissons changing. The lately raised caisson is then moved over the upper basin by the traversing of its carriage on the railway above. Now all is in order for the descent of the caissons into the respective basins. The power is then applied to the shaft *s'* which allows the shaft *s* to rise, and the caissons are lowered simultaneously, the boats are floated over the ends of the caissons and resume their journeys.

On the Great Western Canal of England lifts are employed, 46 feet in hight and consisting of 2 chambers with a pier of masonry between them. Each chamber is of sufficient capacity to contain a timber cradle, in which the ascending or descending boat is placed. The cradle, when on the level of the canal, allows the boat to float into it by raising a water-tight gate at one end. The two cradles which work in the chambers, when full of water or when both or either of them contain a boat, balance each other on strong chains, which pass over 3 cast-iron wheels, and are so arranged that the water in the upper cradle is kept about 2 inches below that in the pond, which gives it a slight preponderance, sufficient to set the machinery in motion. The boats weigh 8 tons, and pass up or down the lift of 46 feet in about 3 minutes, consuming 2 tons only of water.

The upper view (Fig. 2932) is half a front view and half a transverse section of this lift. The lower view is a longitudinal section.

Lift-bridge. A bridge designed to lift to allow a canal-boat to pass, when the viaduct is but a short distance above the water-level. It is hung by the four corners to four chains, which pass over pulleys and have counterpoises at their other ends.

Lift'er. 1. (*Paper-making.*) A cast-iron wheel with buckets revolving in a case, lifting pulp from the reservoir or *pulp-chest*, and passing it to the trough, from whence it flows on to the traveling web. On the latter it is shaken, partially drained of its water, and is then delivered by the *coucher* to the first pair of pressing-rollers.

2. An elevator or hoisting-apparatus.

3. (*Steam-engine.*) The arm on a lifting-rod that raises the puppet-valve.

The upper portion of the figure (2933) is a top view of a Western steamboat engine, the lower portion is a side elevation on a somewhat enlarged scale. The lifter is shown in the middle, having curved surfaces at the points of contact with the valve-levers.

4. (*Founding.*) A tool used by a molder in elevating the *cope* from the *drag*.

5. *a*. A domestic tool for raising or adjusting the lids of a stove.

b. An implement for holding hot plates or dishes.

6. (*Surgical.*) A *levator* or lifting lever used in injuries to the cranium. It belongs to the trephine case. An *elevator*. The forms are four; known as the *common*, Louis', Petit's, the triploid.

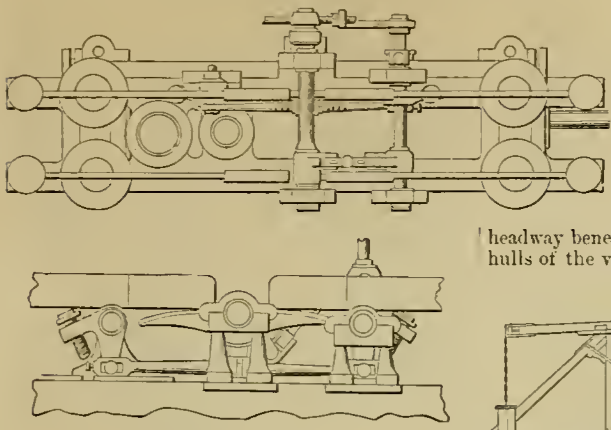
7. A *cam* or *wiper* used in raising a stamper or beetle, or in depressing the tail of a tilt-hammer helve.

Lift-gate. A gate which lifts instead of swinging on a pintle, as, —

A portcullis.

A farm-gate counterbalanced, and rising in guides, like a sash.

Fig. 2933.

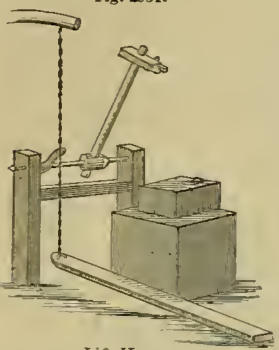


Valve-Lever Lifter.

A canal-lock, graving-dock, or sluice-gate which rises in vertical grooves in the walls.

Lift-ham'mer. The lift-hammer is a light form of tilt-hammer in which the hammer is raised by a spring and depressed by a treadle. When the hammer has a head of depressed contour, acting in concert with a counterpart tool on the anvil, it becomes a swage, the top and bottom tools answering to those of a *drop*. For this purpose, the vertical movement is preferable. The intention of the apparatus is to enable the blacksmith to dispense with an assistant, a *striker*, but it has not come into extensive use and is not likely to. It is asking too much of one man to attend to both operations skillfully.

Fig. 2934.



Lift-Hammer.

Lift'ing-bar. 1. (*Knitting-machine.*) A horizontal rod or bar having a short intermittent vertical or nearly vertical reciprocation, and which at the proper moment operates to lift the *jacks*.

2. (*Weaving.*) The movable frame of a Jacquard loom in which the lifting-blades are fastened.

Lift'ing-blade. (*Weaving.*) An iron rule to receive the lifting-wires of a Jacquard loom when hoisted.

Lift'ing-bridge. The *lifting-bridge* is the simplest of all drawbridges, being merely a platform hinged to the bank, curb, or scarp at one end, the other being lifted by chains or cords worked by windlass or weights. It is used in crossing the canals in Holland, where the roadway is nearly on a level with the water.

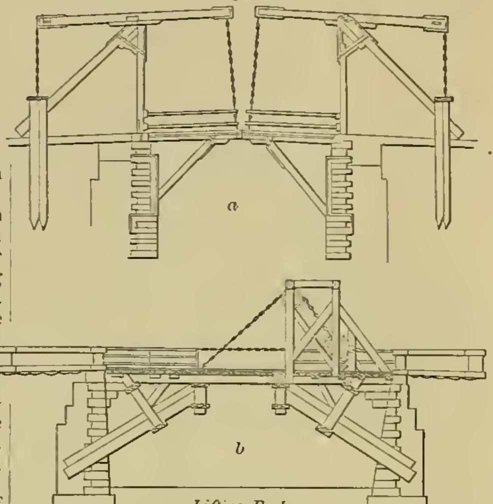
It is also used in fortifications.

The drawbridges (*a*) of Brussels were balanced by weights attached to chains passing over standards that stood immediately over the walls of the canal, and were braced and stayed by timbers and iron ties. The weight of the draws was borne by struts beneath, which were footed in set-offs in the faces of the masonry, and rested at their upper ends against jogs beneath the sill-timbers of the bridge.

Perronet, the great French engineer, 1708–94, was the chief engineer of the *Ponts et Chaussées* from 1747, and did more for the science of bridge-building than any of his contemporaries.

He contrived a drawbridge (*b*) which had a short middle draw to allow the masts of vessels to pass when the headway beneath the bridge was sufficient for the hulls of the vessels. This middle section is hinged to one portion of the bridge and lifted by a chain and winch.

Fig. 2935.



Lifting-Bridges.

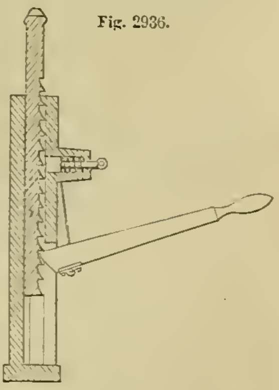
Lift'ing-gear. (*Steam-engine.*) The apparatus for lifting a safety-valve from within a boiler. It consists of levers connected to the valve and to a screw worked by a handle outside the boiler. See LIFTER.

Lift'ing-jack. A hoisting-implement operated by a lever, a screw and lever, or by hydraulic pressure. The figures show forms of the *lever-jack*. For other varieties, see list under JACK.

Fig. 2936 has a rack-bar raised by a lever pivoted in a strap, and the rack is sustained by a sliding spring catch.

In Fig. 2937, the upper ends of the legs are connected by a lever, by whose depression they are erected and the wagon-axle raised.

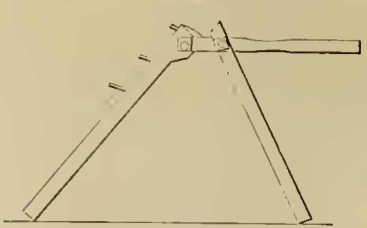
Fig. 2936.



Lifting-Jack.

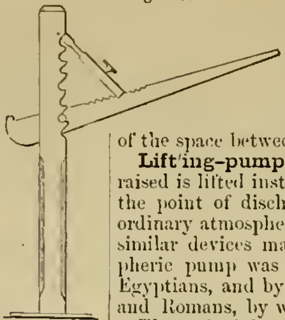
In Fig. 2938, the fulcrum-pin of the lever rests in rounded notches in the standard, and is held down by an extension pawl which is pivoted to the stand-

Fig. 2937.



Lifting-Jack.

Fig. 2938.

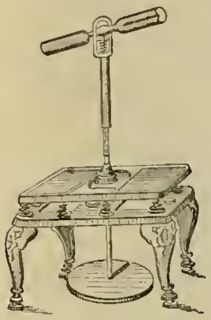


Lever-Jack.

ard and engages a ratchet on the upper side of the lever.

Lift'ing-ma-chine'. An exercising-machine belonging to the furnishing of a gymnasium, in which a weight is so disposed with handles or straps for the hands, hips, or shoulders, that a person may conveniently try his strength, and improve by persistent trying at gradually increasing weights. Weights or springs are used, sometimes in connection with a dynamometer, to indicate the force exerted.

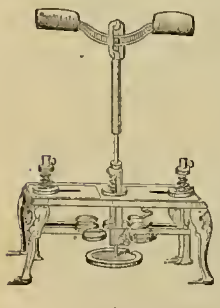
Fig. 2939.



Weight Lifting-Apparatus.

Fig. 2939 shows Butler's standard health-lift, giving a dead-weight lift softened by spring-action. The platform on which a person stands in lifting rests upon ten volute springs on the frame, the legs of the frame resting also on volute springs on the floor. Rubber cushions and cartilages soften every movement. Through the center of the machine passes an upright rod, having at its upper end a stirrup through which the handle is passed transversely, while at the lower extremity, beneath the platform, is a disk to receive the weights, of from one to fifty pounds each. The handle passes through springs at the platform level, which sustain the weight and gradually release it as it is lifted clear. Weights to the amount of 600 pounds are provided. The machine occupies a space of 26 × 32 inches on the floor; 26 inches to the top of the platform. The person stands a-straddle of the handle, and lifts with one hand in front and the other in the rear.

Fig. 2940.



Spring Lifting-Machine.

Fig. 2940 is a machine in which graduated springs are substituted for weights.

Many other forms of exercising-machines are used, some for the bedridden, some specially adapted for victims of spine disease, some for general exercise of the muscles to improve the tone of the system. See Exercising-machine.

Lift'ing-piece. (*Horology.*) A lever having a tooth which engages in notches in the *count-wheel* to restrain the striking. The *count-wheel* has 78 divisions, and notches are cut in it at the successive distances of 1, 2, 3, 4, etc., of the divisions. The lifting-piece being raised by a pin or a snail on one of the hour-wheels, the tooth of the lifting-piece rests on the rim of the count-wheel until the prescribed number of blows is given, according to the length of the space between the notches.

Lift'ing-pump. One by which the liquid to be raised is lifted instead of forced from its receptacle to the point of discharge. To this class belongs the ordinary atmospheric pump. The chain-pump and similar devices may also be included. The atmospheric pump was probably known to the ancient Egyptians, and by them handed down to the Greeks and Romans, by whom it was little used.

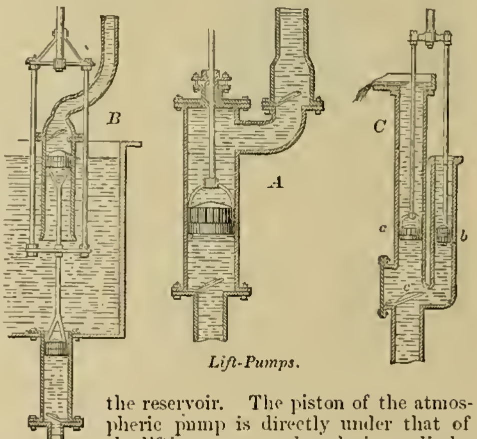
The principle was explained by Torricelli, the pupil of Galileo, whose attention, as well as that of his master, was drawn to the matter by the unsuccessful efforts of the Florentine pump-makers to raise water by its means to a hight much over 30 feet. In fact, at elevations above the sea-level, it can only be lifted to a hight in feet about equal to the number of inches at which the mercury in the barometer stands; one inch of mercury corresponding to about 13 inches of water. See Lift-pump.

Lift'ing-tongs. The tongs with concave jaws used in grasping crucibles. See Crucible-tongs.

Lift-pump. *A* (Fig. 2941) shows one form of modern lifting-pump. The head of the pump is closed, and the water may be lifted through the side tube to any elevation consistent with the strength of the tube.

B is a double-piston pump adapted to situations where the pump cannot be conveniently inserted in the reservoir. The piston of the atmospheric pump is directly under that of the lifting-pump, and works in a cylinder attached to the bottom of the cistern. Each is attached to the same rod and worked by the same frame.

Fig 2941.



Lift-Pumps.

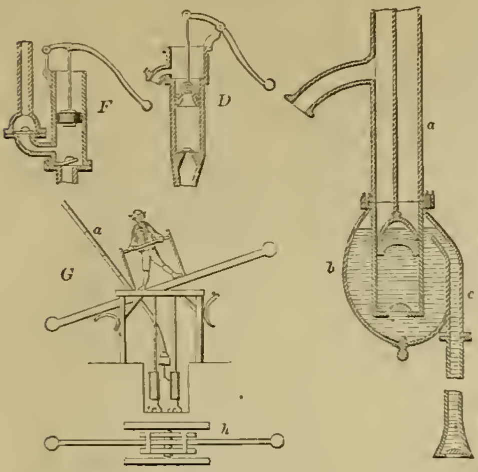
In *C* two pistons *a b* are placed in two cylinders, side by side, and are operated simultaneously by attachment to a cross-head, both drawing up the water at the same time. The downward movement, as it closes the valve *c*, forces the water upward through the cylinder *a*, maintaining a continuous discharge.

D (Fig. 2942) is an atmospheric pump. The upper valve is of peculiar construction.

F is a solid-piston pump, which lifts the water to the barrel, and on its downward stroke forces water up the pipe.

G is a double-cylinder balance-beam pump. The pistons are alternately raised and lowered by a man throwing his weight alternately on either side of the beam, and discharge the contents of the cylinders through the pipe *a*. *h* is a plan of the beam and its frame, on which the man stands.

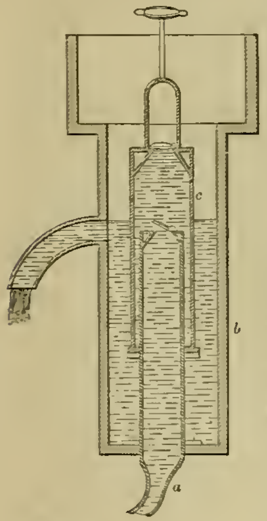
Fig. 2942.



Lift-Pumps.

In Lecorche's pump (to the right), the cylinder *a* is surrounded by an air-tight vessel *b*, which, being originally filled with water to a hight sufficient to cover the piston, always keeps the valve wet. Each stroke creates a vacuum in the vessel *b*, causing the water to rise in the cylinders *a c*, whose valves are lifted at the same time. This arrangement also obviates the shock caused by the water when the piston is worked rapidly.

Fig 2943.



Muschenbroeck's Lift-Pump.

Fig. 2943 is a pump described by Muschenbroeck. The upper end of the suction-pipe *a* enters a small cistern *b*, and is surrounded by a cylinder *c*, the lower part of which fits closely around it. The valves of both open upwardly. The upward movement of the cylinder *c* causes a vacuum in both it and *a*, which become filled with water, the downward movement of *c* causing the water therein to overflow into the cistern *b*, whence it is discharged.

Lift'ing-rod. (*Steam-engine.*) A rod receiving motion from the rock-shaft, and imparting motion to the *lifter* of the puppet-valve.

Lift'ing-screw. A form of hoist in which a screw is used. See JACK-SCREW.

Lift'ing-set. The series of pumps by which water is raised from the bottom of a mine by successive lifts. See CORNISH ENGINE.

Lift'ing-wires. (*Weaving.*) The wires by which the warp-threads are raised and lowered to produce the pattern in a Jacquard apparatus.

Lift-latch Lock. (*Locksmithing.*) A lock in which the latch is pivoted and *lifted* free of the keeper, passing through a notch in the box, instead of being simply retracted.

Lift-lock. (*Engineering.*) A canal-lock, in which a boat is *lifted* by the introduction of water, so as to raise it to the upper level. See LIFT, 7.

Lift-tent'er. 1. A contrivance adopted in European windmills for regulating the distance apart of the mill-stones, according to the speed of the vanes. It is of the nature of the steam-governor, having suspended balls which fly out by accession of speed, and thus act upon the *bridge-tree* by which the runner is supported.

2. A ball-governor arrangement to regulate the speed of a windmill's vanes. This use of the contrivance preceded that of its application to the steam-engine.

Lift-wall. (*Hydraulic Engineering.*) The wall at the head of a canal-lock chamber. See CANAL-LOCK.

Lift Wa'ter-wheel. 1. An under-shot wheel.

2. A water-wheel whose gudgeons and bearings may be raised or lowered to adapt it to varying hights of water supply.

Lig'a-ting-for'ceps. A pair of grasping fingers protruding from a sleeve and closed by retraction into the sleeve. Other forms are used, the specific construction depending upon the nature of the operation and the size of the available opening for its application.

Lig'a-ture. 1. (*Printing.*) Two or more letters cast on one shank; as ff, ffi, etc.

This was formerly very common, and was carried to an excess by Earl Stanhope, who called them *logotypes*.

They are now confined to some diphthongs and the &, which is derived from *&*, the *logotype* of *et*.

2. (*Surgical.*) *a.* A thread to tie arteries or veins.

b. A wire cord or thread used in removing tumors, etc. See ECRASEUR.

c. The bandage used for phlebotomy.

Galen recommends silk thread for tying blood-vessels in surgical operations.

The ligation of the femoral artery was first performed by Hunter, about 1785.

That of the external iliac by Abernethy, 1796.

The internal iliac by Alexander Stevens, in 1812.

The common iliac successfully by Dr. Valentine Mott, in 1827.

The common carotid by Sir Astley Cooper (successfully), in 1808.

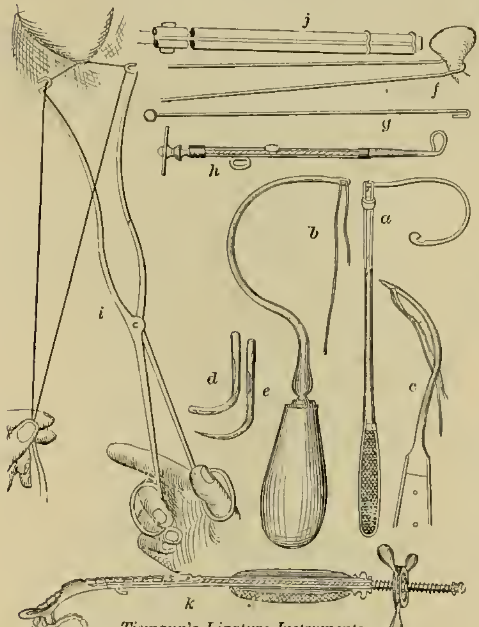
The innominata by Mott in 1818, and successfully by Dr. J. W. Smythe in 1864.

"Ambrose Paré, born at Laval, in France, in 1509, was a member of the fraternity of barber-surgeons; but, such was the reputation he acquired as an operator, he was made surgeon to four successive sovereigns of France, and, among others, to the weak and cruel Charles IX., by whom, however, although Paré was a Huguenot, his life was saved on the terrible night of the massacre of St. Bartholomew, by detaining him in the royal chamber until morning. With Paré, who lived little more than 300 years ago, we may commence to date the achievements and triumphs of modern surgery. Hitherto, after amputations, the bleeding-vessels had generally been secured by searing them with cauterizing irons, or by dipping the end of the stump in boiling oil or molten lead. Paré revived the ligature, which, although it had been suggested, and probably adopted in a few cases several centuries before, had been forgotten or abandoned by his immediate predecessors. Such was the mortality under the old process of securing the vessels, that Guy de Chauliac declared it was better to let the limb drop off than to amputate it with the knife; and he advised ligating firmly at the nearest joint, and thus to cause gangrene and sloughing of the limb below. Since Paré wrote, great improvements have been made in the application of the ligature, and its usefulness has been greatly extended; especially is it proper to mention its application for the reduction of vascular tumors, including elephantiasis, for the relief of epilepsy, and for various other maladies in which it is known that organs are suffering from an excess of blood; but the greatest achievements of the ligature have been in the cure of aneurisms." — F. H. HAMILTON, M. D.

The ligature occasions obliterations or adhesion of the arterial parietes by cutting through the middle and internal coats, the adhesion being favored by the formation of a coagulum, which acts in some degree as a barrier against the impulse of the blood, and subsequently disappears by absorption.

Lig′a-ture-car′ri-er. A surgical instrument with a bent stem for passing a ligature around an artery which is to be ligated, a bone which is to be divided by a chain-saw, or other object which is to be cut.

Fig 2944.



Tiemann's Ligature Instruments.

In the absence of special instruments therefor, the duty is performed by a curved needle carrying a thread.

a, Fig. 2944, is Post's chain-saw carrier. *b* is Tiemann's instrument to carry ligature for chain-saw. *c* is an aneurism needle. *d e* are Mott's aneurism needles. *f g h* are Van Buren's artery-ligating instruments. *i* is Carrol's knot-tyer. *j* is Gooche's double cannula for uterine polypus. *k* is Charriere's lengthened chain-ecraseur.

Lig′a-ture-ty′er. An instrument to carry flax or silk thread, or silver wire, for tying off arteries, aneurisms, tumors, polypi, or piles, etc. See Fig. 2944, LIGATURE-CARRIER.

In Carrol's ligature-tyer (*i*, Fig. 2944) the ligature, being held by the blunt hooks, which are at right angles to the branches, is readily passed around the tumor, and the instrument withdrawn; a single knot is tied, which is easily slid up to the tumor and tightened, the instrument operating after the manner of a glove-stretcher. A second knot is tied in the same manner, and with almost as great facility and rapidity as could be achieved by the fingers in an accessible situation. It might also be of service to tighten a ligature upon a vessel at the bottom of a deep wound where the fingers cannot be readily used.

When the artery alone is tied, the ligature is said to be *immediate*. When any of the surrounding parts are included, it is said to be *mediate*.

Lig′ger. A line with a float and bait laid for night fishing.

Light. 1. An illuminating body, as a burning candle, lamp, etc. A lime, calcium, electric, Drummond, oxyhydrogen, etc., light. See list, *infra*.

A calculation of the respective values and costs of different lighting materials is as follows: —

Six mold candles weighing one pound will burn forty hours, if lighted in succession. One gallon of sperm-oil, burnt during the same time, will give a light equal to fifteen of such candles. Twelve cubic feet of gas will give a light equal to the six candles during the same time.

Prices vary at times, and that of gas varies from $1.70 to $7.00 for 1,000 feet in different parts of the United States, but at the prices annexed the following will be a comparative statement for forty hours' burning of an equal power: —

15 pounds of sperm-candles, at 20 cents	$3.00
1 gallon sperm-oil, at $2.00 . .	2.00
180 cubic feet of gas, at $3.00 . . .	.54

2. (*Nautical.*) A burning lamp, cluster of lamps, or beacon fire, serving as a warning and guide to mariners arriving off a coast or in the neighborhood, of dangerous rocks or shoals. See LIGHTHOUSE.

It is usually displayed from a tower, called a lighthouse, and has several variations, incident to the mode of production or emission and direction, and to the visible characteristics by which the mariner distinguishes one light from another when arriving off a coast, so as to ascertain his geographical position, and his bearings as to his port or course.

In early times the light was a fire of burning wood. Such were the lights of the famous Pharos of Alexandria, and the Tour de Corduan at the mouth of the Garonne. In 1812, the Lizard Point light, Cornwall, England, was maintained with coal fires. The same may be said of the Isle of May light, Frith of Forth, Scotland, in 1816. This, in fact, was the usual light at that time in positions readily accessible.

The Eddystone light first consisted of tallow candles stuck in a hoop, and afterwards of twenty-four wax candles.

The *Argand lamp*, invented in 1784, and bearing the name of its distinguished inventor, rendered a better light possible. See ARGAND.

It was introduced into the Tour de Corduan soon after its invention, and associated with paraboloid reflectors in a revolving frame. This is the *catoptric* system, invented by Tulère of the French Royal Engineers of Bridges and Roads. See CATOPTRIC LIGHT.

Argand burners and paraboloid reflectors were substituted for wax candles in the Eddystone lighthouse in 1807.

In the *dioptric* light the beams are transmitted through lenses, instead of being reflected by mirrors.

Lenses were adopted in some lighthouses about 1752–59, but owing to the imperfections of glass and manufacture, they were not in much favor till the improvements of Fresnel about 1810. See DIOPTRIC LIGHT.

The *cata-dioptric light* is a combination of the two, as its name indicates. See CATA-DIOPTRIC LIGHT.

The *oxyhydrogen light* and the *voltaic light* from carbon points have been proposed, owing to their brilliancy. See ELECTRIC LIGHT.

The term *leading-light* indicates such a disposition of two lights on distinct towers as to indicate a course, a channel, or a danger. See LEADING-LIGHT.

A *floating* light is one at the mast-head of a vessel moored on a spit or shoal where no adequate foundation exists for a permanent structure. See FLOATING-LIGHT.

The characters of the light furnished to the mariner are varied, so that when he comes in sight of a given light he may tell by its color or behavior where he is.

These distinctive lights are thus enumerated: —

Fixed.
Revolving.
Intermittent.
Flashing.
Colored.
Double.

The *fixed* light gives a constant and steady radiance.

The *revolving* light is produced by the revolution of a frame with three or four sides, having reflectors grouped on each side with their axes parallel. The frame rotates once in a minute, or once in two minutes, as may be required, the light fluctuating between full strength and total darkness, the changes being gradual. See REVOLVING-LIGHT.

The *intermittent* light is produced by the perpendicular motion of circular shades in front of the reflectors, by which the light is alternately hidden and displayed. The alternations of light and darkness are sudden, and occur at intervals of about thirty seconds.

The *flashing* light is produced by a revolving frame, the mirrors of which are arranged on 8 sides. The reflectors on each side are arranged with their rims or faces in one vertical plane, and their axes in a line inclined to the perpendicular. This disposition, in connection with the rate of motion, gives a flash of light every 5 seconds, alternating with comparative dimness. There is no eclipse, but a pulsating effect; bright and dim, bright and dim.

The *colored* light may be of various colors, but for important situations and distant view *red* is alone used. A variety is given in revolving lights by alternating *red* with *two whites* or *one white*, or *two reds* with *one white*. Also by associating a *red* and a *white* light in a *double light*.

Colored media absorb so much light as to detract from their usefulness. They have been generally discarded in French lighthouses.

The *double* light is exhibited from 2 towers, which may be of equal hight, but usually differ in hight. It is used as another mode of marking a particular headland, as at the Lizard Point and Calf of Man, in British waters. It also affords a *leading* light, as the conjunction of the two lights in one line is made to indicate a course or a warning. See DOUBLE LIGHT.

These lights may be variously combined. The catoptric admits of the following variety: —

1. Fixed.
2. Revolving white.
3. Revolving red and white.
4. Revolving red with two whites.
5. Revolving white with two reds.
6. Flashing.
7. Intermittent.
8. Double fixed.
9. Double revolving.

The variations in the dioptric lights are *fixed* and *revolving*; the main distinctions of the latter being founded upon the time between flashes.

According to the British and French regulations, vessels, between sunset and sunrise, are ordered to carry lights as follows: —

A *green* lamp on the starboard side and a *red* light on the port side, visible throughout an arc of 10 points from right ahead to 2 points abaft the beam. An inboard screen prevents the light from being seen from the opposite side. Steamships, in addition, carry a white light at the foremast head, visible through an arc of 20 points, extending between points 2 points abaft the beam on each side.

Steam vessels towing other vessels to carry *two* foremast head-lights, in addition to the side lamps.

Vessels at anchor to carry a white light, visible all round, and not exceeding 20 feet above the hull.

3. (*Shipbuilding.*) An opening in the deck or side of a vessel, as *deck-light*, etc.

A *side-light* is also known as a *light-port*. The water-tight shutter by which it is protected in stormy weather is known as a *dead-light*.

4. A pane of glass.

Light and Pho′tic Ap-pli′an-ces. See under the following heads: —

Aphlogistic lamp.
Argand-burner.
Argand-lamp.
Argand gas-burner.
Astral-lamp.
Beale-light.
Bengal-light.
Blue-light.
Boccius-lamp
Bracket.
Branch.
Bude-lamp.
Bull's-eye.
Burner.
Calcium-light.
Candelabrum.
Candle.
Candle-mold.
Candle-stick.
Carbon-light.
Carbureting-machine
Cata-dioptric light.
Catoptric light.
Chandelier.
Cigar-lighter.
Clock-work lamp.
Colored light.
Cresset.
Cric.
Dark-lantern.
Davy-lamp.
Deck and side light.
Deflector.
Dioptric light.
Dobereiner's lamp.
Double light.
Drop-light.
Drummond-light.
Electric light.
Electrophorus.
Extinguisher.
Fan-light.
Fantail.
Fishtail-burner.
Fixed light
Flashing light.
Flash-pipe.
Floating-light.
Foot light.
Fountain-reservoir lamp.
Gas.
Gas-alarm.
Gasalier.
Gas-bracket.
Gas-burner.
Gas-lighter.
Gas-lighting by electricity.
Gas-torch.
Girandole
Head-light.
Holophotal light.
Hydrocarbon-burner.
Hydrogen-lamp.
Hydrostatic lamp.
Illuminating-clocks.
Illuminator.
Insect-trap lantern.
Intermittent light.
Lamp.
Lamp-burner.
Lamp-chimney.
Lamp-chimney adjuster
Lamp-cone.
Lamp-elevator.
Lamp-hanger.
Lamp-post.
Lamp-shade.
Lamp-tongs.
Lamp-wick.
Lantern.
Leading-light.
Light.
Light-ball.
Light-barrel.
Lighter. Gas
Lighthouse.
Lighting-devices.
Lighting gas by electricity.
Light-room.
Light-ship.
Lime-light.
Link.
Lucifer.
Lucimeter.
Luster.
Magnesium-lamp.
Magnesium-light.
Match.
Match-box.
Match-boxing machine.
Match-safe.
Mechanical lamp.
Night-light.
Nursing-lamp.
Oxycalcium-light.
Oxyhydrogen-light.
Parachute-light.
Petroleum-burner.
Petroleum-lamp
Photics.
Photometer.
Promethean.
Pump-lamp.
Pyrophorus.

Pyrotechnics.
Reflector.
Revolving-light
Rush-light.
Safety-lamp.
Sconce.
Shade-lamp.
Signal-lamp.
Sinumbra-lamp.
Skylight.
Snuffers.
Solar-lamp.
Submarine lamp.
Tar-lamp.
Torch.
Vapor-burner.
Vault-light.
Voltaic light.
Wick.
Wick-trimmer.
Zirconia-light.

Light-ball. (*Ordnance.*) The ordinary light-ball, which has been in military use for centuries, consists of a canvas sack of elongated shape, filled with a combustible and illuminating composition. It is used for lighting up works in sieges, and also for discovering the position of an enemy; in the latter case it is charged with a shell to prevent its being approached, and is fired from a piece of ordnance. As from its position on the ground it can illuminate but a limited area, parachute light-balls have been proposed. That of Sir William Congreve was to be attached to a rocket. General Boxer's light-ball was adopted into the British service in 1850. It consists of a mass of sulphur, saltpeter, and red orpiment, inclosed in a hemispherical case of tinned iron, which is attached by chains and cords to a large calico parachute that is compressed into a similar hemispherical casing, the two forming a sphere, having an annular depression surrounding it. A second tinned-iron case fits over the first, and has a fuse communicating with a train of quickmatch in the annular groove before mentioned, and also with the bursting charge. This projectile is fired from a mortar.

Light-bar′rel. An empty barrel, pierced with holes and filled with tarred shavings, to light up a breach.

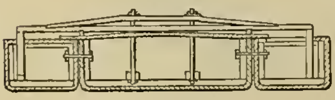
Light-boat. A vessel carrying a warning light. See Light-ship.

Light′en-ing. The peculiar brightness of silver at the moment when the maximum of purity is attained.

"The moment when the oxidation of the lead ceases, and when consequently the cupellation is finished, is marked by a peculiar appearance called lightening. During the whole period of oxidation, the metallic bath appears more brilliant than the walls of the furnace. Its temperature is in fact higher; for not only does it share in the heat of the furnace, but its temperature is also raised by the heat disengaged by the chemical combination of the lead with the oxygen. When, however, the lead is completely oxidized, the second source of heat no longer exists; the disk of metallic silver soon sinks down to the temperature of the furnace, and, instead of being as brilliant as before, it becomes dull. On the other hand, at the moment when the last traces of lead oxidize, there is on the surface of the metallic bath only a thin pellicle of fused litharge; this quickly becomes thinner and thinner, and presents in rapid succession the colors of thin plates or of the soap-bubble, then becomes torn up like a veil, and discloses the surface of the silver beneath." — Regnault.

This development of purity and capacity for perfect reflection in the silver from which all dross has been removed, is a favorite simile in the Bible, where the "refiner and purifier of silver" is represented as "sitting" watching the process, whose success is evidenced by the perfect reflection of the Master's face. Fulguration.

Fig. 2945.



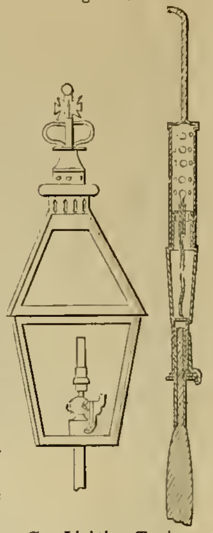
Lighter.

Light′er. 1. (*Vessel.*) *a.* A barge for transporting merchandise and stores, on rivers and canals, over bars, and to and from vessels moored in a stream, or where they cannot be laden from or discharged on to a wharf or pier alongside.

b. A craft for taking a part of the burden of a vessel to assist it over shoal places. In the example, the lighters are attached to the boat's sides by transverse braced beams and bolts, extending through the sides, and act as *camels.*

2. A torch or electrophorus for lighting gas. An *allumette* for lighting lamps or candles. The example is a torch for street-lamps. The lamp-frame has a small trap-door at the bottom, through which the hook is introduced to turn the cock by its bell-crank lever. The torch lamp is protected by a cylinder, whose perforations are large enough to allow passage of inflamed gas.

Fig. 2946.



Gas-Lighting Torch.

Light′er-screw. (*Milling.*) A screw for adjusting the relative distances of the *runner* and *bed-stone.* The *runner* rests on a *spindle,* which is supported on a *bridge-tree;* the *lighter-screw* raises and lowers the latter. See Grinding-mill.

Light′house. The ancient word *Pharos,* a lighthouse, is probably derived from *Phrah,* the Egyptian god personating the sun.

Pthah, in the Egyptian mythology, was the embodiment of stability. The essential portion of the figure strikingly resembles the figure of the Eddystone lighthouse, which Smeaton derived from the observation of the trunk of a tree. The figure (*a,* Fig. 2947) is shown divested of the arms and head-dress of the god whom it shrouds.

The most celebrated lighthouse of antiquity is that erected on the island of Pharos, harbor of Alexandria. It was built by the orders of Ptolemy Soter, by the architect Sostratus, and finished under Ptolemy Philadelphus, 280 B. C. The wonderful energy of Alexander's mind seems to have comprehended all at a glance. He visited the little town of Rhacotis, saw his superb city as by a dream of enchantment, his Macedonian mantle covering the ground between the river and Lake Mareotis. He gave his orders to Dinocrates, the architect of the temple of Diana at Ephesus, settled the main details of the plan, and never saw the place again.

The Pharos was 450 feet high, and the light was visible at a distance of 42 miles (300 stadia, *Josephus*). It was built of white marble, and cost 800 talents, $825,500, if the talents were Attic. It was formed in several stories, decreasing in dimensions towards the top, where fires were lighted in cressets. The ground-plan was hexagonal, the sides alternately concave and convex; each a stadium in length; the 2d and 3d stories were of the same form; the 4th was square, with a round tower at each angle; the 5th circular, continued to the top, to which a winding staircase conducted. The whole was surrounded by a sea-wall, and was on the right hand of the harbor-entrance, opposite the promontory of Lochias, on which was the royal palace.

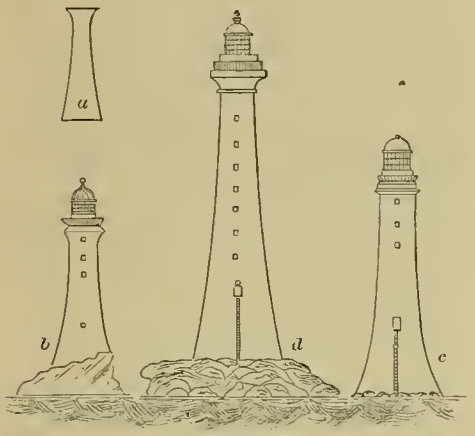
Fires were kept lighted on the summit, and it was inscribed, "King Ptolemy to the gods, the saviors, for the benefit of sailors." Sostratus carved his own name beneath and filled it with mortar, upon which Ptolemy's name was inscribed. In process of time the mortar scaled off and brought the name of the architect to the surface. The tower fell A. D. 1303.

Other ancient lighthouses were situated at Messina, Ostea, Ravenna, Puteoli, Caprea, Rhodes, Dover, the Thracian Bosphorus. The light in each was obtained by fires.

During the Saxon rule in England, beacons were erected to direct navigation, and persons were appointed to keep them in order. The expense was defrayed by the county. Pitch boxes were made use of in the reign of Edward III.

The Eddystone lighthouse (*b*) is erected upon a rock of that name ten miles from shore, off Plymouth, England. A lighthouse was built on the spot, 1696–99, by Winstanley, who perished with it in a storm, November 27, 1703. Rebuilt of wood in a different form by Rudyard, 1706, and burnt 1755. Rebuilt by Smeaton of dovetailed and metal-bound granite blocks, 1757.

Fig. 2947.



Lighthouses

a, the Egyptian *Pthah*. *c*, the Bell Rock Lighthouse.
b, the Eddystone Lighthouse. *d*, the Skerryvore Lighthouse.

The surface of the rock was irregular and inclined. It was cut into steps, the risers of which were notched so as to form dovetailed mortises for the similarly shaped blocks of the stones in the course which interlocked with it. Each block had a level bearing, and the outside pieces were guarded by a border of rock which rose around them. The stones in a course were dovetailed together and additionally secured by cramps. The respective courses were secured to those above and below by dowel-pins consisting of tree-nails.

Six courses (8 ft. 4 in.) brought the structure to a level surface, eight other courses are solid, and from this point the structure is made hollow. The hight of the tower and lantern is 85 feet 7 inches. It was built in 421 working-days, being finished October 16, 1757.

The light was originally a chandelier with twenty-four candles. It is now a catoptric light, — an Argand lamp and parabolic reflectors. The change was made in 1807.

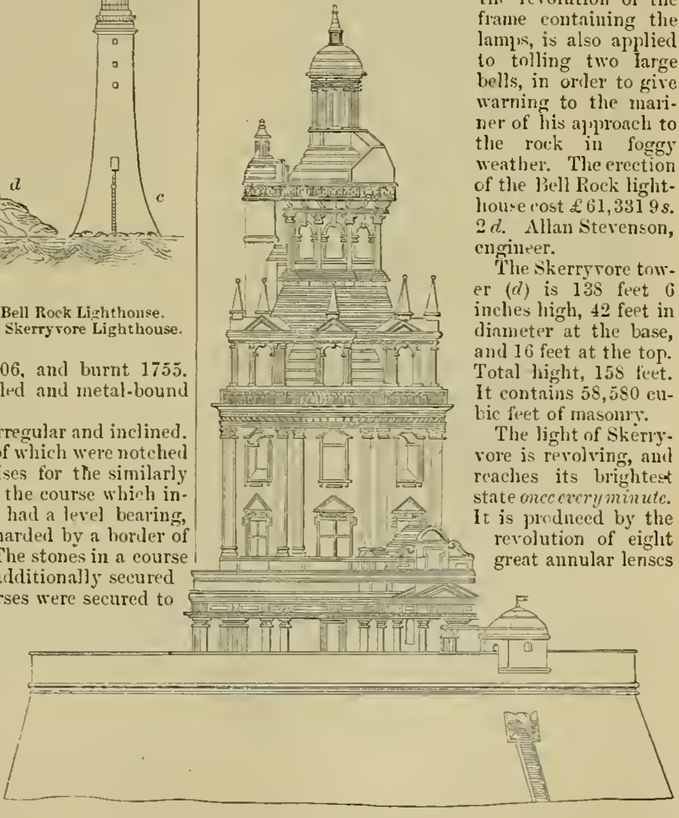
The Bell Rock lighthouse (*c*), on the rock once called the Inch-Cape and celebrated in a ditty by Southey, was erected 1807–10. The rock is off the Frith of Forth, and is 230 × 427 feet, eleven miles from land. The surface is bare at low water. The lighthouse is built in the manner of the Eddystone, the stones being joggled together, and the layers doweled together by tree-nails. Holes were bored in a circle of 36 feet diameter, and pieces of timber 50 feet in length inserted to support a temporary shelter for 30 workmen during the summer months. The structure is 42 feet diameter at the base, 13 feet at the top. The lower solid portion is 30 feet; total hight, 115. The door is 30 feet from the base.

The lantern is 12 feet in diameter, 15 feet high, has a balcony around it, is framed of cast-iron, and has plate-glass sides, the panes being 27 × 30 inches.

The light is a catoptric, the parabolic reflectors being 24 inches across. It is visible 18 or 20 miles distant.

The light is a *revolving red and white light*, and is produced by the revolution of a frame containing sixteen Argand lamps placed in the foci of paraboloidal mirrors, arranged on a quadrangular frame, whose alternate faces have shades of red glass placed before the reflectors, so that a red and a white light are shown successively. The machinery, which causes the revolution of the frame containing the lamps, is also applied to tolling two large bells, in order to give warning to the mariner of his approach to the rock in foggy weather. The erection of the Bell Rock lighthouse cost £61,331 9*s.* 2*d.* Allan Stevenson, engineer.

Fig. 2948.



Tour de Corduan (Elevation).

The Skerryvore tower (*d*) is 138 feet 6 inches high, 42 feet in diameter at the base, and 16 feet at the top. Total hight, 158 feet. It contains 58,580 cubic feet of masonry.

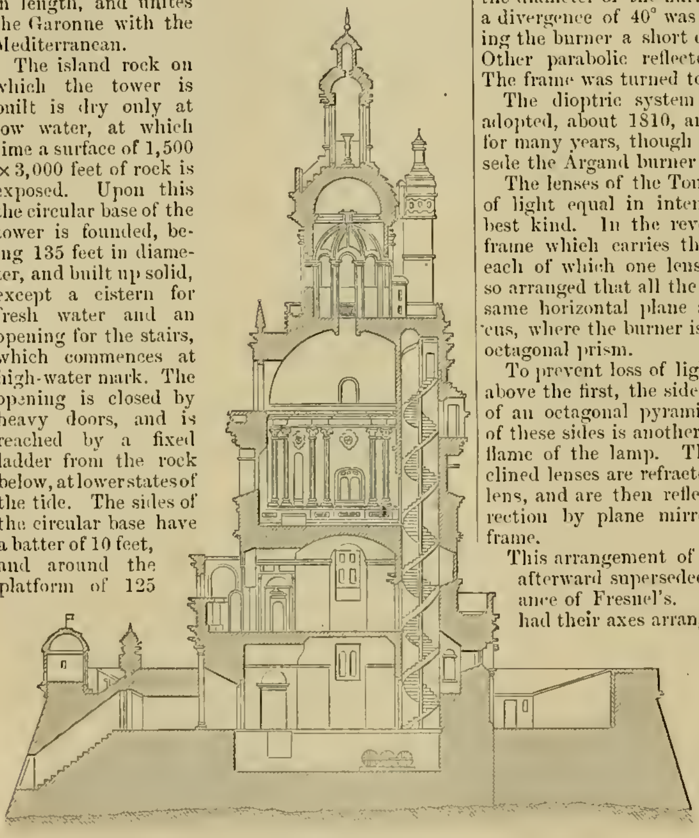
The light of Skerryvore is revolving, and reaches its brightest state *once every minute*. It is produced by the revolution of eight great annular lenses around a central lamp with four wicks, and belongs to the first order of dioptric lights in the system of

Fresnel. It may be seen from a vessel's deck at the distance of eighteen miles. The entire cost of the lighthouse, including the purchase of the steam-vessel, and the building of the harbor at Hynish for the reception of the small vessel which now attends the lighthouse, was £86,977 17 *s.* 7 *d.*

The Tour de Corduan is the most magnificent lighthouse of modern times. It is situated on a rock at the mouth of the Gironde, one of the most important rivers of France. This tower is $182\frac{1}{2}$ English feet in hight, and is built in the Ornante Renaissance style of the period. It was commenced under the reign of Henry II., in 1584, and finished in that of Henry IV., in 1610. The architect was Louis Le Foix.

The commercial city of Bordeaux is situated upon the river 70 miles from its mouth, and at the time the lighthouse was built it had another special value, as it was a part of the projected chain of water-courses connecting the Bay of Biscay with the Mediterranean. This was effected shortly afterward by the canal of Languedoc, which is 150 miles in length, and unites the Garonne with the Mediterranean.

Fig 2949.



Tour de Corduan (*Section*).

The island rock on which the tower is built is dry only at low water, at which time a surface of 1,500 × 3,000 feet of rock is exposed. Upon this the circular base of the tower is founded, being 135 feet in diameter, and built up solid, except a cistern for fresh water and an opening for the stairs, which commences at high-water mark. The opening is closed by heavy doors, and is reached by a fixed ladder from the rock below, at lower states of the tide. The sides of the circular base have a batter of 10 feet, and around the platform of 125 feet diameter thus made, is a wall 12 feet thick at its base and 12 feet high.

On the central circular area of 100 feet diameter is erected the tower, which has 50 feet diameter at the base, and has several stories diminishing towards the summit. The lower story is Doric, the 2d and 3d Ionic, the 4th Corinthian, the 5th Composite. The interior was handsomely decorated and furnished; the apartments of the 1st and 2d stories being finished for domestic use, store-rooms, etc.: the 3d was a handsome circular chapel, 31 feet in diameter, and having a dome 40 feet high. Upon this was erected the Corinthian cupola 27 feet high, which was 21 feet in diameter, had a stone balustrade around it, and supported the lantern, which formed the summit and was 5 feet internal diameter, 9 feet externally, and 17 feet high.

When this tower was erected the light was made by blazing wood, which was burnt in the lantern in a cresset. Coal was afterwards substituted. The smoke rose through an opening 18 inches in diameter in the dome of the lantern, passed into a finial chamber above, and escaped by side openings.

In 1727, the lantern was destroyed, and an iron one substituted by M. Betri.

In 1780, the catoptric system of lighting was introduced by Borda, an Argand burner being placed in the focus of a parabolic mirror formed of copper plated with silver. The focal length was about 4 inches, the diameter of the outer edge 21 inches. The beam of projected light was a cylinder equal to the diameter of the mirror. This being too partial, a divergence of 40° was given to the rays by removing the burner a short distance from the true focus. Other parabolic reflectors were afterwards added. The frame was turned to make the light revolve.

The dioptric system of Fresnel was eventually adopted, about 1810, and is likely to remain intact for many years, though the electric light may supersede the Argand burner which he used.

The lenses of the Tour de Corduan project a cone of light equal in intensity to eight mirrors of the best kind. In the revolving dioptric system, the frame which carries the lenses has eight sides, to each of which one lens is attached. The whole is so arranged that all the axes of the lenses are in the same horizontal plane and meet in the common focus, where the burner is situated, forming one large octagonal prism.

To prevent loss of light, a second frame is placed above the first, the sides of which form the frustum of an octagonal pyramid, and incline 50°; on each of these sides is another lens, having its focus in the flame of the lamp. The rays which fall on the inclined lenses are refracted parallel to the axis of the lens, and are then reflected into the horizontal direction by plane mirrors placed above the upper frame.

This arrangement of upper lenses and mirror was afterward superseded by another elegant contrivance of Fresnel's. A series of triangular prisms had their axes arranged in horizontal planes, and so adjusted that the light falling on the face next the flame was thrown upon the back of the prism, where it was totally reflected; and by a second refraction at the third side of the prism, it obtained its horizontal direction.

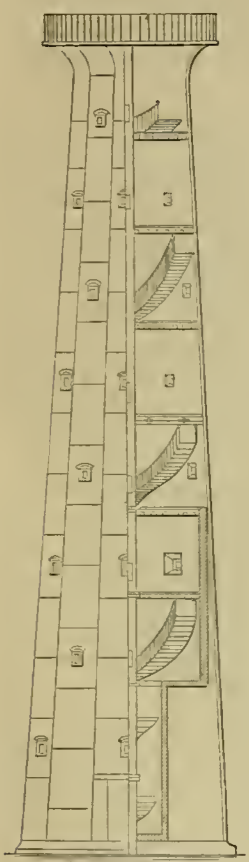
For fixed dioptric lights, the lenses are combined into a cylinder which makes an equal dispersion at all points of the horizon. The refracting apparatus of numerous lenses arranged polygonally has given way to the cylindrical lens. See Dioptric System of Lighting.

Fresnel's adaptation of the Argand lamp consists of four concentric burners protected from excessive heat by a superabundant supply of oil which is pumped into the wick-tubes, and constantly overflows.

The oil of colza (*Brassica campestris*) is used, and abundant ventilation is afforded by a lofty chimney.

The first screw-pile lighthouse actually erected prior to February, 1841, was at Port Fleetwood, near Lancaster, England. The screws which entered the bed of the river supported piles having screws at their upper ends, to which the timber columns supporting the frame of the superstructure were secured. These were united together by diagonal braces extending from the foot of one to the top of another. The first cast-iron lighthouse was put up at Point Morant, Jamaica, in 1842. The tower is formed of 9 tiers of plates, 10 feet high and $\frac{3}{4}$ inch thick, united to each other by bolts and flanges on the inside. The plates of each tier have a common radius. It was filled in with masonry and concrete to the hight of 27 feet, and rested on a granite foundation. Its total hight was 96 feet, the upper and lower diameters being respectively 18 feet 6 inches and 11 feet.

Fig. 2950

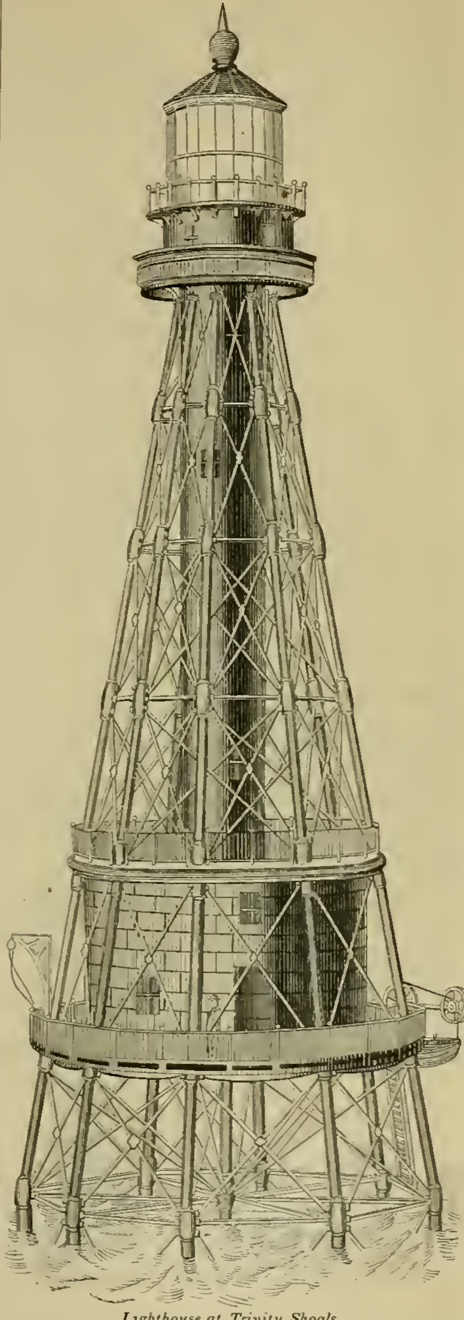


Iron Lighthouse, Bermuda.

Fig. 2950 is a cast-iron lighthouse on a plan similar to the foregoing, subsequently erected at Bermuda. It is 105 feet 9 inches in hight, the lower diameter being 24 feet in addition to the flanges by which the plates of each tier are secured to each other, and those which united the successive tiers. They are strengthened by angular feathers $\frac{1}{2}$ inch thick.

Fig. 2951 represents one of two similar lighthouses erected by the United States government at Trinity Shoals and Timbalier, in the Gulf of Mexico. It is supported upon 9 screw-piles, — a central one surrounded by 8 others at distances of somewhat less than 15 feet 4 inches, — each being 20 feet distant from the central one, and secured together at the ground by adjustable wrought-iron links, and above by diagonal braces, and by radial struts to the central pile. The summit of each pile is encased in a cast-iron socket for receiving the column and the radial and diagonal braces. The jointed columns which support the lantern have a similar provision for their diagonal braces, the arrangement of which will be understood from the illustration. The different series of columns are joined together by sleeves. The first series above the foundation is 20 feet long, the second 15 feet, the next two 18 feet, the fourth, fifth, and sixth being respectively 15 feet 6 inches, 14 feet, and 12 feet 6 inches. The columns of the first series are of wrought-iron, forged tapering; those above are of hollow cast-iron, each series successively decreasing in diameter. The lantern is supported on a cylinder of boiler-iron resting on a platform at the top of the columns.

Fig. 2951.



Lighthouse at Trinity Shoals.

The following is a list of the electric lights in England and France, with the dates at which they were erected: Dungeness, January, 1862; Cape La Heve, France, South Light, December, 1863, North

Light, November, 1866 ; Cape Grisnez, France, February, 1869 ; Souter Point, England, January, 1871 ; South Foreland, England, with two lights, January, 1872, in the first place in 1858 – 60 by Professor Holmes, and afterward England took the lead in this matter of the adaptation of electric illumination to lighthouse purposes. The Bishop rock light, Scilly Islands, the old Cassiterides of Herodotus, 145 feet high, cost £ 36,559. In the British Isles there are 357 shore lights and 47 floating lights. The French have 224 shore lights. The average annual expense in England of a shore light is £ 500 ; of a floating light, £ 1,200.

The lighthouses of the world are estimated at 2,814.

Table of the Visible Distance of Objects in Geographical or Nautical Miles.

Hight in Feet.	Distance in Miles.	Hight in Feet.	Distance in Miles.	Hight in Feet.	Distance in Miles.	Hight in Feet.	Distance in Miles.
* .663	1	11	4.08	30	6.74	150	15.07
1	1.23	12	4.26	35	7.28	200	17.4
2	1.74	13	4.43	40	7.78	300	21.32
3	2.13	14	4.6	45	8.25	400	24.64
4	2.46	15	4.77	50	8.7	500	27.52
5	2.75	16	4.92	55	9.13	1,000	38.92
6	3.01	17	5.07	60	9.53	2,000	55.04
7	3.25	18	5.22	70	10.29	3,000	67.41
8	3.48	19	5.36	80	11.01	4,000	77.84
9	3.69	20	5.5	90	11.68	5,000	87.03
10	3.89	25	6.15	100	12.31	1 mile.	89.43

* For a geographical or nautical mile, the curvature equals 7.962 inches.

Light'ing. (*Metallurgy.*) Heating metal and allowing it to cool gradually. *Annealing.* The term is especially applied to the heating after hammering or rolling, to restore ductility.

Light'ing-de-vi'ces. 1. Two pieces of wood may be rubbed together so as to char the frictional surfaces and eventually produce flame. This may be assisted by tinder, punk, etc., which readily take fire.

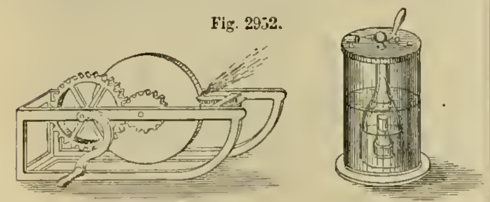
2. Iron may be hammered till it acquires a red heat, and is capable of firing combustible matters.

3. Steel struck by a flint yields sparks, which, falling upon charred linen, cause it to burn sufficiently to inflame sulphur.

This device amplified gave rise to the *miner's steel mill.*

4. The *miner's steel mill*, as it is called, has a steel wheel rapidly revolved by gearing and hand-crank, its periphery being in contact with a flint fixed to a holder on the frame. It was operated by a child, who waited upon the miner and lighted him at his work.

Fig. 2952.



Steel-Mill and Döbereiner's Lamp.

It was superseded by the safety-lamp of Sir Humphry Davy. See SAFETY-LAMP.

5. Alum, sugar, and flour, when mixed and calcined, have a tendency to take fire when exposed to the atmosphere. Hence *Homberg's pyrophorus.* See PYROPHORUS.

6. Chlorate of potash mixed with sugar kindles into flame on the contact of sulphuric acid. The matches were dipped successively in melted sulphur and then in chlorate of potash, and were ignited by pressing the prepared ends upon a sponge of asbestus saturated with sulphuric acid and placed in a bottle. This was the *Promethean.*

7. Phosphorus, placed between the folds of a piece of paper and rubbed to and fro, will heat sufficiently to kindle a sulphur match. Hence the *phosphorus light* in use in 1675.

8. The *phosphoric tapers* were of wax, having wicks coated with phosphorus. They were inclosed in glass tubes hermetically sealed. They were ignited by cutting off the end of the tube with a file, when the phosphorus became ignited by the action of the air.

9. The *phosphorus bottle* was a small vial, into which a piece of phosphorus was placed and stirred around with a hot wire. The phosphorus being partially burnt emitted fumes which coated the inside of the vial with oxide of phosphorus. The vial was then tightly corked. In use, a match dipped in sulphur was dipped into the phosphorus, and flame resulted from the energetic action of the two.

To expedite the flame, the match, after dipping, was rubbed on the cork or a piece of wood.

10. When chromic acid is brought in contact with alcohol it parts with its oxygen so rapidly as to cause ignition. Mix gently in a mortar a small portion of chromic acid and one fourth the quantity of powdered camphor ; a few drops of alcohol dropped upon it from considerable hight will cause ignition and deflagration.

11. Phosphorus and chlorate of potash rubbed together in a mortar will explode.

12. Potassium has such energetic affinity for oxygen as to decompose water when brought into contact therewith ; the oxygen combines with the metal to form potash, and the hydrogen is ignited. A parallel effect takes place in regard to sodium when the water is previously heated.

13. Ammonia added to a solution of chloride of gold produces a yellowish-brown precipitate (*aurate of ammonia*), fulminate of gold. This explodes by friction. See FULMINATE.

14. Volta's *inflammable air-lamp* was a glass reservoir charged with hydrogen gas, which could be expelled in a jet as required. Upon the pedestal was an *electrophorus*, by which a spark could be emitted in the path of the jet which was lighted thereby. This was the precursor of the *hydrogen-lamp* and of a whole train of ingenious devices, the culmination of which is found in apparatus for lighting gas by electricity, erected on a large scale in the Capitol of the United States. See LIGHTING GAS BY ELECTRICITY.

15. Döbereiner's inflammable lamp (Fig. 2952) has a flask attached to a plate and stop-cock, and suspended in a receiver containing sulphuric acid and water. A piece of zinc is suspended in the inner vessel in contact with the acid, and the evolution of gas in the upper part of the flask forces the dilute acid out at bottom into the surrounding receiver, and stops the evolution of gas. When the stop-cock is turned, a jet of gas issues and impinges upon a piece of spongy platinum, which becomes red-hot and ignites the jet. The escape of gas allows the acid to rise in the flask, and the evolution of gas is resumed.

16. In the line of the voltaic phenomena must next be cited the heating of a platinum wire by an electric current derived from a pair of voltaic plates in an acid bath. Touchwood, a match, or a jet of gas in contact with the incandescent wire become inflamed. This device and the electric spark produced at the interval of a broken circuit are the means for lighting gas by electricity.

17. Air compressed to a sufficient extent in a tube in which is a piece of German tinder becomes heated so as to kindle the tinder, which will then ignite a brimstone match. This was called the *pneumatic tinder-box* or *light-syringe*.

18. The *oxymuriate matches* were founded upon the action of a compound of chlorate of potash and sugar when exposed to sulphuric acid.

These substances made into a paste with gum and colored by vermilion were used to tip splints. These were dipped in sulphuric acid to inflame them. To these succeeded the *lucifer-match*.

19. The *lucifer-matches* were originally tipped with a paste of chlorate of potash, sulphuret of antimony, and starch, and were drawn between two sand-paper surfaces. This was the inauguration of the friction-match, and the ignition produced a detonation.

20. The *Congreve match* substituted phosphorus for sulphide of antimony, and the match ignited on any rough surface. The substitution of saltpeter for chlorate of potash produced quiet ignition. Introduced in 1834.

Then followed the substitution of saltpeter for chlorate of potash, so that both the original articles were superseded, greater safety and comfort being attained.

The chemical reactions are as follows: —

The phosphorus is ignited by frictional compression.

The heat evolved decomposes the saltpeter.

The evolution of oxygen supports the flame and enables the ignition of the sulphur.

The burning sulphur ignites the wood.

Stearine was then substituted for the sulphur, into which the match was dipped before tipping with the more inflammable compound.

Light'ing Gas by E-lec-tric'i-ty. A means of lighting gas by developing a spark or producing a red heat in a platinum coil at the jet of issuing gas.

It is used in situations difficult of access, such as the rotunda, dome, and tholus of the Capitol at Washington, and the Senate and House of Representatives, whose gas-burners are above the glass ceilings in a chamber below the roof. Gardiner's apparatus, used in the dome and tholus, was the subject of a report by a commission consisting of Messrs. Shaffner, Pike, and Knight.

From the report the following is extracted: —

"The gas-pipe connections consist of circles of burners at 45, 80, and 165 feet from the floor of the rotunda, and are furnished with 300, 325, and 425 burners respectively. In addition to these, a cluster of 90 burners is placed in the tholus at a hight of 264 feet from the floor, and, being 60 feet above the crown of the dome, is, of course, invisible from the interior, but is a beautiful object viewed from the Capitol grounds, and visible at a distance of many miles.

"The flow of gas at each tier, and in the tholus, is equalized by a regulator, and governed by a stop-cock, the latter being opened and closed by electro-magnetic engines in their immediate vicinity, worked from the battery, the central brain of the apparatus from which ramifies the nervous fluid which vitalizes the motive agents and the illuminating coil of each of the 1,130 burners.

"The battery occupies an elliptical room 45 by 36 feet, and consists of 200 glass jars of a depth and diameter of about 13 inches, containing two zinc plates 9 by 10 inches, weighing 6 pounds each, and an interposed carbon plate, all supported by suitable insulators in the acid bath. It is disposed on benches in concentric series in the room, and arranged in sections of 20 jars each, to be brought into service as required.

"The connections consist of five miles of No. 10 copper wire, doubly wrapped with linen yarn, and, when necessary, incased in india-rubber tubing: this is securely laid in protecting pipes or through passages drilled through the walls, the return circuit from the engines and the burners being made through the gas-pipes.

"The burners used have an indestructible lava tip, which acts as an insulator, and each is provided with an insulated coil of platinum wire, placed on one side of the orifice, so as not to interfere with the free exit of the gas, which is lighted by exposure to the red-hot metal when the electric connection is made.

"The tiers of burners are divided into sections of from 30 to 50 burners, each section having independent connection with the instrument, so that a tier being divided into ten sections, it is lighted by a corresponding number of pulsations following the flow of the gas, which is turned on by the electro-magnetic engine belonging to and in the vicinity of the tier. The manipulation which, by successive pulsations, operates the engines, makes the series of illuminating connections, and registers the work, is performed in a passageway leading north from the floor of the rotunda, and perhaps 50 feet from the battery.

"The electro-magnetic engines consist of a double helix, with a sliding armature, on which is a latch which operates a ratchet-wheel on the axis of the stop-cock. The operator, by a succession of electric connections, works the armature piston, and turns the plug of the stop-cock such a fraction of a revolution as is represented by a number of teeth on the ratchet-wheel.

"The dial-plate has eleven keys, with a corresponding number of verniers.

"The primary electric connection with the battery is made by a stud in the central key, which, by rotation, is made to bring such a portion of the battery into play as may be required, a vernier indicating the extent of battery connection which takes place in successive sections of 20 jars.

"The surrounding keys, ten in number, are equally divided between the duties of turning on the gas and lighting the same at the five levels for which the dial-plate and keys are adapted. But four of these are yet arranged, consisting of the tiers at the elevation of 45, 80, and 165 feet, respectively, and the tholus at 264 feet.

"The fifth may be used for a tier at the spring of the dome, or a circle to illuminate the pictures.

"Each gas-key has a dark and a light segment on its disk, which are exhibited at an opening in the dial-plate, in correspondence with the closed and open position of the stop-cock, which governs the flow of gas at the tier represented by the said key.

"Each lighting key has a pointer, which indicates on its vernier the extent to which the electric connection has been made in the sections of the tier to which it belongs."

Another form of apparatus consists of a galvanic battery, Ruhmkorff's induction coil, and conducting wires, which are broken near the gas-jets so that an electric spark is produced by a charge of electricity leaping to the "tips" of the burners, each burner being insulated, and forming a part of the circuit. The ends of the wires from which the spark proceeds are covered with platinum to prevent their corrosion.

One or the other plan is adopted in many public buildings, theaters, halls, and large stores, and it is proposed to light the street-lamps of cities by this means. A large circuit of lamps, embracing the streets of a ward or district, are connected by insulated wires proceeding from a conveniently situated battery, either magno-electric or voltaic. See also ELECTROPHORUS.

Light′ning-ar-rest′er. A device used in telegraphy for guarding against passage of atmospheric electricity through the instruments.

The line wires are attached to a plate of brass, usually serrated on the under side. This plate rests upon another plate connected with the ground, the two plates being separated by a thin layer of insulating material.

As lightning possesses enormous tension, preferring a short route even through a poor conductor to a longer one through a good conductor, it forces its passage through the layer of insulating material and thence to the ground, or *vice versa*. See LIGHTNING-DISCHARGER.

The Stoics distinguished two things in thunder, the lightning and the noise. They looked upon the first as the effect of the latter, which was properly what they termed thunder; for, according to them, thunder was occasioned by the shock of clouds, and lightning was the combustion of the volatile parts of the cloud, set on fire by the shock. Chrysippus taught that "these effects were coincident, and that our perception of the lightning before the thunder-clap is owing to our sight being quicker than our hearing."

Light′ning-con-duct′or. A metallic conductor intended to establish a definite line of least resistance between two bodies in opposite electrical states. The resistance of the line should be so small that no destructive effect shall arise from any discharge along it. Lightning-rods are included under this general definition.

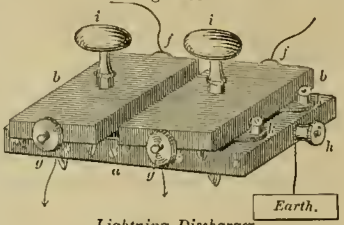
"The most important ancient notice of the relations between lightning and conducting metals appears to be that of Ctesias. He had possessed two iron swords, presents from the King Artaxerxes Mnemon and from his mother Parysatis, which, when planted in the earth, averted clouds, hail, and strokes of lightning. He had himself seen the operation, for the king had twice tried the experiment before his eyes. The exact attention paid by the Etruscans to the meteorological processes of the atmosphere in all that deviated from the ordinary course of phenomena makes it certainly to be lamented that nothing has come down to us from their Fulgural books. The epochs of the appearance of great comets, of the fall of meteoric stones, and of showers of falling stars, would no doubt have been found recorded in them, as in the more ancient Chinese annals, of which Edouard Biot has made use. Creuser has attempted to show that the natural features of Etruria may have influenced the peculiar turn of mind of its inhabitants. A 'calling forth' of the lightning, which is ascribed to Prometheus, reminds us of the pretended 'drawing down' of lightning by the Fulguratores. This operation consisted in a mere conjuration, and may have been of no more efficacy than the skinned ass's head, which, in the Etruscan rites, was considered a preservative from danger in thunder-storms.

"In the very complicated Etruscan augural theory, a distinction was made between the 'soft reminding lightnings sent by Jupiter from his own perfect power, and the violent electrical explosions or chastening thunderbolts which he might only send constitutionally after consultation with the other twelve gods.'" — HUMBOLDT.

Light′ning-dis-charg′er. (*Telegraphy.*) A device to protect telegraphic apparatus from the effects of atmospheric electricity passing over the wires.

In Fig. 2953, *a* is an iron plate called the earth-plate, over, but not in immediate contact with which are two smaller plates *b b* called conductors; each plate has two screws for attaching wires. To the screws *f f* are attached the up and down wires respectively; to the screws *g g*, the wires leading to the apparatus; and to the screw *h*, the earth-wire. The upper plates *b b* are kept in place by small knobs *i i*, attached to them and by buttons *k k* on the earth-plate. In order to prevent metallic contact, these, as well as the sides of the earth-plate, are covered with vulcanite. The atmospheric electricity, on reaching the conductors, springs over to the earth-plate, and is thus diverted from the apparatus. See also PARAGRELE.

Fig 2953.



Lightning-Discharger.

Light′ning-rod. A form of lightning conductor, attached to a structure for the purpose of protecting it from lightning.

It is preferably made of copper, that metal having a greater conducting power than any other, but iron is the material usually employed.

The alleged improvements since its invention by Dr. Franklin are innumerable; most of these are, however, worthless, or of a trifling and unimportant character.

The first lightning-rod erected with a definite purpose of protection was put up by Benjamin Franklin soon after 1752, when he brought down electricity from a thunder-cloud. The first in England was set up at Payne's Hill, by Dr. Watson. In 1766 one was placed on the tower of St. Mark at Venice; it has since escaped injury, though previously it had been frequently struck by lightning.

Great opposition was at first raised against the invention, and the charges of impiety were revived; but the centuries were exploding these notions, and Franklin held his ground. After the theory was admitted, a curious war arose. *Knobs* against *points*. Benjamin Franklin said *points*; but as he was a rebel, King George III. and his admirers of course declared for *knobs*. Franklin, who could handle a pen like a cimeter, wrote: "I enter into no controversy. I leave my philosophical opinions to take their chance in the world. If they are right, truth and experience will support them; if wrong, they ought to be refuted and rejected. Disputes are apt to sour one's temper and disturb one's quiet. I have no private interest in the reception of my inventions by the world, having never made, nor proposed to make, the least profit by any of them. The king's changing his pointed conductors for blunt ones is, therefore, a matter of small importance to me. If I had a wish about it, it is that he had rejected them altogether as ineffectual. For it is only since he thought himself and family safe from the thunder of heaven that he dared to use his own thunder in destroying his innocent subjects."

The king requested the president of the Royal Society to resign, because he could not see with royal eyes. The knob theory has long since been entirely exploded.

Sir W. Snow Harris's lightning-rod for land use consists of wide bands of copper or of copper tubing, the metal of either being $\frac{1}{5}$ inch thick. The metal is prepared in lengths of 10 feet. The sections of tubing are united by intermediate screw sections. The strip conductor is nailed to the wall; the tube is secured by coupling-pieces. The upper extremity has a bayonet-point 18 inches long, $\frac{3}{4}$ inch in diameter at the point of connection to the solid plug with which the tube terminates. The ground connection consists of a descending rod and a cross rod, giving 3 divergent branches.

Harris's lightning-conductor for vessels converts the masts into lightning-conductors by the insertion in grooves of a double set of copper plates, connecting by bands of copper leading through the side under the deck-beams, and with the large bolts leading through the keel and keelson. The system is designed to include all large metallic masses in the hull.

These plates are from 1 to 4 inches wide, curved so as to correspond to the round of the mast, into which they are inlaid longitudinally. They are from $\frac{1}{16}$ to $\frac{1}{8}$ inch thick, 4 feet in length, and are secured by copper nails at intervals of 6 inches.

According to the opinion of Sir W. Snow Harris and other eminent electricians, the insulation of a metallic conductor by inclosing it in a glass tube or by glass supports is unnecessary if the continuity of a sufficient conductor be preserved. Harris states that the electrical discharge does not quit an easy line of transit such as is furnished by a copper rod of sufficient size, to pass to other bodies out of the line. He considers it unlikely that the lightning would leave such a rod even to reach metallic clamps, but it would be unwise to put such temptation in its way, unless the clamps were so connected with the ground as to make them a part of a continuous line of descent.

It is very important to make ground connections for extensive areas of iron surfaces such as are found in the rods, iron beams and joists, copings, lintels, thresholds, stairs, chimney, window, and door caps, window-casings, pillars, etc. This matter is not much attended to, however, but iron is inserted wherever convenience dictates, regardless of all electric considerations.

The conductors should be prolonged until reaching moist soil, or if this be impracticable should be carried, at a depth of two feet or more, to a distance of some 30 feet from the building, or connected with old chain conveyed to a similar distance; the trench in which it is laid being partially filled with carbonaceous matter.

In regard to the area protected by a rod, a difference of opinion exists, and the matter cannot be considered as determined. The opinion of Leroy, 1788, was that it protected a space around equal to three times the hight of the rod. The Academy of Sciences of Paris, 1823, opined that it protected a circular space whose radius is equal to the hight of the rod. This is the general opinion, but has no sufficient data for its foundation. It is, however, the basis of the American practice in putting up lightning-rods.

Professor Henry, a high authority on the subject, recommends a rod of round iron about 1 inch in diameter, terminating in a single platinum point, and secured to the building by iron eyes. Glass insulators he considers, as do other eminent electricians, of little importance. It should preferably be placed on the west side of the building in this latitude, and especially on that chimney from which a current of air ascends during the summer season, and should be connected where practicable with the water or gas pipes of the street. Where this is impracticable, connection should be made with a well always containing water, or with an iron plate buried in the ground. This rod may be put up by an ordinary blacksmith.

The lightning-rod invented by Moses G. Farmer of Boston is formed of a core of steel, which is first carefully tinned and then covered with copper, after which the compound wire is tinned, to prevent rusting.

Lightning-rods for powder-magazines were formerly erected on a mast at a short distance from the building. It is now thought advisable to attach them directly to the building in the following manner: A strip of copper is secured to the ridge of the building, at each end of which is a lightning-rod, of $\frac{1}{2}$ inch copper, projecting about 5 feet above the highest part of the building. Copper strips pass down the hips and are secured to the eave-trough, the water-pipes being connected with the underground conductor, which is divided into two branches at about 4 feet from the building. These are about $2\frac{1}{2}$ feet below the surface, and are covered with coal-ashes and earth.

It is estimated that at least 50 persons are killed annually by lightning in the United States, 69 in France, and 22 in England, but no conductor has been contrived to be carried on the person, though it has been often suggested. The risk is so small, numerically considered, that it is not probable any great proportion of the inhabitants of any country will make special provision for avoiding the danger.

Professor Arago classed several well-known sites according to the frequency of their storms, from the best information he could obtain. His list begins as follows: —

		Days of Thunder per Year.
1.	Calcutta averages	60
2.	Patna (India) supposed to average	53
3.	Rio Janeiro averages	50.6
4.	Maryland (U. S.) supposed to average	41
5.	Martinique averages	39
6.	Abyssinia supposed to average	38
7.	Guadaloupe averages	37
8.	Viviers (France) averages	24.7
9.	Quebec averages	23.3
10.	Buenos Ayres averages	22.5
11.	Denainvilliers (France) averages	20.6

The lowest average he gives is that of Cairo in Egypt, three days of thunder per annum. That of Paris and most of the European cities is about fifteen days. He estimates the days of thunder at New York to be about the same.

Fig. 2954 exhibits some of the numerous variety of rods for which patents have been secured in the United States.

a has a series of points formed of spiral coils combined with a tubular portion, forming the tip. The conductor is a flat strip.

b, a jointed tubular conductor for vessels. It is divided at the head of the lower mast, a branch leading down the shrouds on either side to the water.

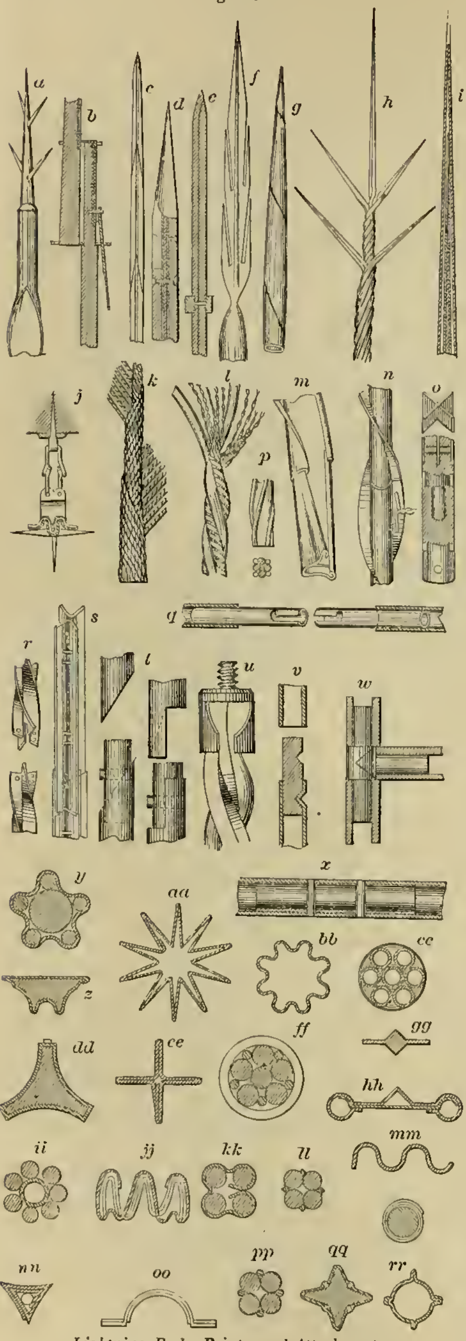
c, an iron rod tipped with copper, the point of which is gilded.

d has a central copper slip inclosed between iron side-pieces; the points of connection have interposed zinc plates.

e. The iron rod is grooved to receive a copper slip. The joints are secured by screw-threaded washers.

f. The point is formed with two opposite wings.

Fig. 2954.



Lightning Rods, Points, and Attachments.

g. The rod is composed of a single strip of copper wound spirally so as to form a tube.

h is composed of several strands of wire laid together so as to form a rope, and having several tips.

i. The point is formed of three or more metals inclosed one within the other, the most fusible outside.

j is an insulating attachment with additional conductor points at the coupling of rod-sections.

k. A copper cable, composed of a central wire rope and two exterior strands laid up in opposite directions.

l comprises two or more copper-wire ropes intertwined with an equal number of iron rods.

m. A series of metallic strips, forming a tube, are joined together.

n. A metallic strip is doubled up or corrugated, so as to form a tube with spiral flanges.

o. The joints of the rod are coupled by pieces cross-shaped in section and secured by rivets or bolts.

p has four twisted rods with wire worming.

q. The tubular sections are united by short pieces inside slotted, so as to form a species of bayonet-joint, and held by pins.

r is composed of two strips of sheet-metal, riveted together at their angles and twisted spirally.

s. The strips constituting the rod have slots through which staples are inserted to fasten them together.

t. The sections are connected by interior short pieces fastened to each by pins.

u. The exterior cable is stiffened by a spirally flanged core. The tip is fastened by a dovetailed coupling-screw.

v. The sections of the square tubular rod are secured to each other by square plugs fastened by indenting the tubes into suitable depressions formed in them, or by rivets.

w. The sections are coupled by an interior cylinder and a tapering plug projecting from each of its ends.

x. An interior tube with pins holds the ends of the tubular sections together.

y to *rr* inclusive represent sections of various kinds of patented rods.

Light-port. (*Shipbuilding.*) An opening in a ship's side provided with a glazed lid or cover. Sometimes called a *scuttle.*

Light-room. (*Nautical.*) A small chamber next to, but isolated from, the magazine. The latter receives its light through a glass partition between the two chambers.

Lights. (*Pyrotechnics.*) Pieces formed by pressing an inflammable composition, which burns with a white or colored light, into cases of large diameter or shallow vessels; such are Bengal-lights, blue-lights, etc.

Light-ship. A vessel moored in the vicinity of a dangerous shoal or headland, and carrying aloft a warning light. The first light-vessel moored on the coast of Great Britain was that at the Nore in 1734. There were, in 1850, 26 floating lights on the coast of England.

Stevenson states that the annual expense of maintaining a floating light, including the wages and victualing of the crew, who are eleven in number, is, on an average, £1,000; and the first cost of such a vessel, fitted complete with lantern and lighting apparatus, anchors, cables, etc., is nearly £5,000. The lanterns are octagonal in form, 5 feet 6 inches in diameter; and, where fixed lights are exhibited, they are fitted with eight Argand lamps, each in the focus of a parabolic reflector of twelve inches diameter; but, in the revolving lights, four lamps and reflectors only are fitted. The greatest depth of water in which any light-vessel belonging to the Corporation of Trinity House at present rides is at the station of the *Seven Stones* between the Scilly Islands and the coast of Cornwall, and is about 40 fathoms.

Light-vessels are moored with chain-cables of 1½ inch diameter, and a single mushroom anchor of 32 cwt.; the chain-cables are 200 fathoms in length. Some of the vessels are moored to *span-ground* moorings, consisting of 100 fathoms of chain to each arm, and a mushroom anchor of similar weight at the end of each; a riding-cable of 150 fathoms is in such cases attached to the center ring of the ground-chain.

Lig′num-vi′tæ. The wood of a tree of the genus *Guiacum*, a native of the warm latitudes of America. It is hard and heavy, and is used for sheaves of ship's blocks, and for ninepin balls.

Limb. 1. The graduated arc or sector of a measuring or optical instrument.

2. (*Locksmithing.*) One of the pieces which compose a lock.

Limb, Ar-ti-fi′cial. See ARM, FOOT, HAND, LEG, ARTIFICIAL.

Lim′ber. 1. (*Gun-carriage.*) The detachable part mounted on the two fore-wheels, and to which the horses are attached. The gun is *limbered up* when the trail of the gun-carriage proper is lifted up and looped over the pintle-hook of the limber, in order for marching. See GUN-CARRIAGE.

The term *limber* is also applied to the fore-carriage of the ammunition-wagon to which the caisson or tumbril is connected.

Limbers differ in construction with the purpose and positions of the guns; as, —

The *casemate*-limber; the *field-gun* limber, with an ammunition-box; the *garrison-gun* limber; the limber with shafts; the *pole*-limber; the *siege-carriage* limber; the *battery-wagon* limber.

The parts of a limber are usually —

The axle, pole, futchels, pintle, pintle-bolster, bolster yoke-hook, bolster-plate, upper and lower pintle-plates, limber-wheel, ammunition-box, trail-ring, limber-hook, limber-chain, etc.

2. (*Shipwrighting.*) A passage on each side of the keelson for bilge-water. It is covered in by a movable board called a *limber-board*, whose edges rest respectively upon the *keelson* and *limber-strake*.

3. A shaft or thill of a vehicle.

Lim′ber-board. (*Shipbuilding.*) A plank reaching from the keelson to the limber-strake, and merely butting against the bulkheads, so as to be easily taken up to expose the *limbers*.

Lim′ber-chain. 1. (*Nautical.*) A chain passing through the *limber-holes* of a vessel by which they may be cleared of dirt that chokes them.

2. (*Artillery.*) A keep-chain which goes round the pintle and confines the trail to the limber, preventing its flying off the limber-hook.

Lim′ber-chest. The ammunition or tool chest belonging to the limber of an artillery-carriage of any description. Those of the gun-carriage and caisson are fitted up as ammunition-chests, while those of the forge and battery wagon contain respectively tools and stores for blacksmiths', and for carriage-makers' and saddlers' use.

Lim′ber-holes. (*Shipwrighting.*) Holes through the floor-timbers on each side of the keelson, to allow the passage of bilge-water. The row of holes constitutes the *limber-passage*.

Lim′ber-hook. (*Artillery.*) The hook on the limber to which the trail of the gun is attached.

Lim′ber-ing-up Hoop. (*Artillery.*) A stirrup-handle on the trail of a gun by which the piece is moved in limbering and unlimbering.

Lim′ber-strake. (*Shipbuilding.*) That strake of the inner skin which is nearest to the keelson. A space between it and the latter is called the *limber*, and forms a passage for bilge-water.

Lime. (*Sugar.*) Lime-water used in clarifying coarse sugar.

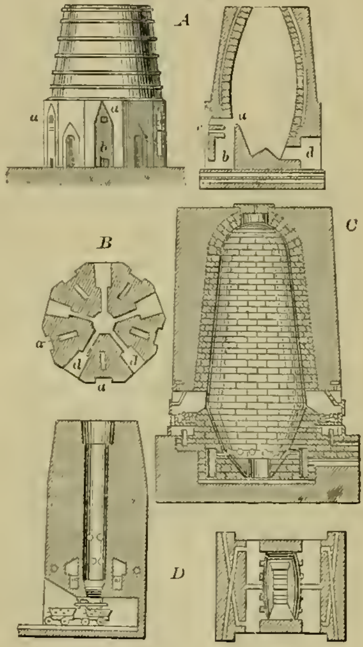
Lime-floor. A floor of lime-mortar, spread, beaten, and rubbed smooth.

Lime-kiln. Lime is derived from its carbonate, which exists in immense quantities in nature in the form of limestone, including marble. It is, where these are abundant, prepared from oyster-shells, which are also a carbonate of lime.

The process consists in calcining the carbonate in kilns, during which the carbonic acid is driven off, leaving oxide of calcium or quicklime.

The forms of kiln are various, probably the most primitive being made by excavating a hole in the earth in the shape of an inverted cone, in which alternate layers of limestone and fuel were placed, and the top covered with sods. Kilns having chambers in the form of an inverted cone are generally employed in places where materials are scarce and coal is the fuel used. The ovoidal form, truncated at its upper part, is, however, generally preferred, on account of its losing less heat by radiation, and allowing the upper portion of the lime to settle more gradually and evenly as the lower portion is withdrawn.

Fig. 2955.



Lime-Kilns.

The kiln may be built of either stone or brick, either cylindrical or rectangular, and is usually erected against the side of a natural bank, or a mound is thrown up behind it.

A B represents a kiln used at Rudersdorf, Prussia, adapted to burn one part wood and four of turf. It has five fireplaces *a a*; *b* is an ash-pit; *c c* are openings for regulating the draft; *d*, openings for withdrawing the lime.

It is lined with a double thickness of fire-bricks, the space between which and the outer masonry is filled in with well-rammed cinders to prevent loss of heat.

A continuous kiln, employed in Belgium, has eight openings for removing the lime, which is being continually withdrawn while fresh charges are added at the top. It is charged with alternate layers of coal and limestone, in the proportion of one coal to four limestone, and is allowed to cool but once a year, for inspection and repairs.

A kiln was invented by Count Rumford, having for its principal objects to consume the smoke, to bring a large surface of flame and hot vapor in contact with the limestone, to keep the latter separate from the fuel, and to allow the process to be continuous.

It consists of a truncated cone, some 15 feet high, 2 feet in diameter at base, and 9 inches at top. In order to retain the heat, the sides, which are of brick and very thin, are double and filled in with dry wood-ashes. The fuel is introduced through an opening above, which is covered by a hinged iron plate, raised and lowered by means of a chain, to regulate the draft. The opening for cleaning the fireplace is provided with a grate and ash-pit, and also, by causing a horizontal draft into the furnace, assists in consuming the smoke. The limestone is fed in at the top of the furnace. The products of combustion are directed downward before they are admitted into the body of the kiln, the unconsumed portion finally passing out at the top. The incandescent mass of lime below assists in heating the charge above. The lime is removed at an opening below, and fresh charges are added at the top as this is gradually withdrawn.

In the kiln *C*, blasts of air are forced through the burnt and cooling lime, and mingle with the caloric currents from the furnaces. The furnaces are placed around the kiln, and blasts of air forced through the fuel and through the top of the fire space.

The upper end of the kiln is arched over, and the feed-hole stopped with a removable cover having a perforation in its center.

In *D* the kiln has bottom discharge ; the furnaces are arranged on each side and discharge into the kiln. A cross-arrangement of flues counteracts inequality of draft on the windward and leeward sides.

A kiln, invented by Mr. Booker of Dublin, having the form of two truncated cones joined at their bases, where the diameter is about 7 feet, tapering to 3 feet at top and bottom, and from 25 to 30 feet in hight, is said to have produced excellent results. A pivoted plate of iron is placed over the top for regulating the draft.

Artificial hydraulic lime is now manufactured on a large scale in England and France, and has been employed in a number of important works.

Two qualities are prepared by two different processes. The first, which produces the best lime but is most expensive, consists in mixing with rich slaked lime a certain proportion of clay, and calcining the mass.

In the second, some soft calcareous material is substituted for the lime, and the materials incorporated by grinding.

In an establishment at Meudon, near Paris, the materials made use of are the chalk of the vicinity and a clay from Vaugirard, in the proportion of four chalk to one clay. These, broken into lumps, are thrown into a circular basin, around which an upright millstone, having its axis attached to a vertical shaft, is caused to travel ; this is provided with a follower, consisting of a wheel having attached toothed arrangements ; by this the mixture is, with the addition of water, ground into a pulp, and is drawn off, descending successively into a series of chambers at different levels, until it attains the proper consistency for molding. The mass is then divided into regular and equal prisms by means of a mold, and these are placed on drying-shelves until sufficiently dry for burning.

Cato (150 B. C.) gave directions for forming a lime-kiln. He preferred a truncated cone, 10 feet in diameter at the bottom, 20 feet high, and 3 feet diameter at the top. The grate covered the whole bottom ; there was a pit below for the ashes, and two furnace-doors, one for drawing out the burnt stone and the other for admitting air and fuel.

Lime-light. A light produced by projecting jets of ignited hydrogen and oxygen upon a ball of lime.

Invented by Lieutenant Drummond, who first applied it in the focus of a paraboloid for geodetic purposes. See DRUMMOND-LIGHT.

Lime-ma-chine'. (*Gas-making.*) A machine in which gas is purified by passing through lime. See GAS-PURIFIER.

Lime-paste. The cream of lime, produced by slaking with water.

Lime-pow'der. The decrepitated lime produced by air-slaking.

Lime-screen. A sifter for separating lime powdered by slaking from the lumps.

Lime-spread'er. A traveling box with perforated bottom, or other device, for distributing powdered lime over land as a manure.

Lime'stone. A rock composed of lime and carbonic acid.

The term in a geological sense includes *chalk* and *marble*, but technically these are distinct.

Limestones are often fossiliferous ; in the metamorphic limestones, such as *statuary marble*, the traces of fossils are obliterated.

Siliceous limestones are mixtures of carbonate of lime and flint.

Magnesian limestone, dolomite, is a compound of carbonates of lime and magnesia.

Chalk is an aggregation of fossils, large and small. The latter are microscopic.

Oolite is composed of small, egg-like grains, each of which has a grain of sand as a nucleus, covered by concentric layers of carbonate of lime.

Pure carbonate of lime occurs in the form of calcareous spar, but is generally associated with other minerals. According to its combinations it is known as : —

Argillaceous.
Magnesian.
Sandy.
Ferruginous.
Bituminous.
Fetid, etc.

According to its texture it is known as : —

Lamellar.
Saccharoid.
Granular.
Compact.
Oolitic.
Chalky.
Pulverulent.
Concreted, etc.

Lime'stone-me'ter. An instrument invented by Dr. Ure for ascertaining the proportion of calcareous matters in soils. See Ure's Dictionary, II. pp. 689, 690 (Am. ed.).

Lime-wa'ter. A solution of lime prepared by mixing hydrate of lime with boiling distilled water.

Lim'ing. 1. (*Leather-manufacture.*) The operation of steeping hides in lime-water or milk of lime, to remove the hair. The action of the lime is to dissolve the hair sheath and form a soap with the fat of the hide. *Unhairing.*

2. Slaked lime thinned with water, used in bleaching.

Limp. The sheet-iron scraper wherewith the top layer of poor ore is removed from the sieve.

Linch-pin. (*Vehicle.*) A pin passing vertically through a mortise near the end of the *spindle* or *arm* of an *axle*, and serving to hold the wheel on the spindle. The ring on the end of the axle is the *linch-hoop.*

With *thimble-skein* wagons, a nut takes the place of the linch-pin. See Axle.

The chariots of Egypt had two wheels, with 6 spokes each. Sometimes the wheels were fast to the axle like our railroad wheels; sometimes they ran upon the axles, like our carriages: in the latter case, they had bronze *linch-pins,* as shown at Aboosimbel and at Thebes. No screw in old Egypt.

Line. 1. (*Fiber.*) The finer and longer stapled flax separated from the shorter, *tow,* by means of the Hackle (which see).

2. (*Printing.*) An arrangement of letters and words across a page or column.

3. The twelfth of an inch.

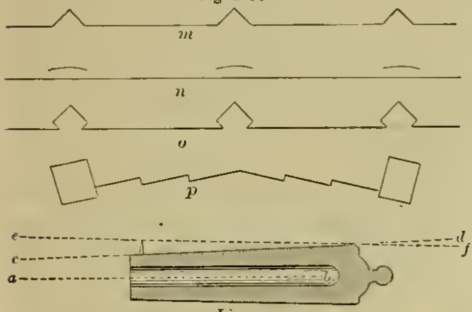
4. A measuring cord, or one for tying or suspending objects, as a *tape*-line, *clothes*-line, *chalk*-line, etc.

5. (*Machinery.*) *a.* The truth of position; as an engine *in line,* that is, the motions of the piston, pitman, and crank-wrist in the same plane, and at right angles to the axis of the fly-wheel.

b. The line of centers. The dead point of a crank, when the connecting-rod and crank are in a straight line.

6. (*Fortification.*) A rampart. Continued lines are used to inclose a front or to connect principal works with one another by a continuous parapet.

Fig. 2956.



Lines.

Redans, tenailles, or *bastions* are placed at intervals, for flank defense, and give rise to the terms, —

Redan line (*m*).

Tenaille line (*n*).

Bastion line (*o*).

Indented lines (*p*) have a succession of *faces* and flanks at right angles. The *faces* are four times the length of the *flanks;* the latter have an enfilading fire on the *faces* of the parapet.

Names defining position and relation are: —

Line of defense: extending from the projecting angle of a work to the exterior extremities of the flanks which defend it.

Line of circumvallation: a belt of field-works two or three miles from the place invested, facing the country.

Line of contravallation: a belt of field-works facing the place attacked.

Line with intervals: one having detached works which command the intervening space and enable them to support each other.

7. (*Shipbuilding.*) A delineation of the form of a vessel, representing vertical and horizontal sections.

a. Beam-line. The line indicating the intersection of the top of the beams with the frames of the ship.

b. Bearding-line. The trace of the inner surface of the ship's skin upon the *keel, stem,* and *stern-post.*

c. Boundary-line. The trace of the outside surface of the skin, corresponding to the outside edge of the rabbet.

d. Bow and *buttock* lines are the boundaries of the vertical sections of the ship, in planes parallel to the vertical longitudinal section.

e. Center-line. The central, vertical, longitudinal section.

f. The *cutting-down* line is a curve on the sheer plan, corresponding to the upper surface of the throats of the floors amidships and to the under side of the keelson.

g. Diagonal lines show the boundaries of various sections formed by planes which are oblique to the vertical, longitudinal plane, and which intersect that plane in straight lines parallel to the keel.

h. Level lines are similar to the water lines, excepting that they are parallel to the keel instead of to the surface of the water, or the *line of flotation.*

i. The *main-breadth* line is the boundary of the widest part of the ship in each of the three plans, — the *shear-plan, half-breadth plan, body-plan.*

j. Ribband-line. An oblique longitudinal section. See *Diagonal* line.

k. Sheer-line. The line of the deck at the side of the ship. The upward curvature towards the ends is called the *sheer,* and the effect is to raise the vessel to a greater hight out of the water at the stem and stern, where her motion relatively to the water is greatest.

l. Stepping-line. The *bearding*-line at the points where it curves upward towards the ends of the vessel.

m. The *top-breadth* or *top-timber* line is a line drawn to the sheer of the ship, fore and aft, at the hight of the under side of the gunwale amidships.

n. The *top-side* line is a sheer-line drawn above the *top-timber* line at the upper side of the gunwale.

o. Water-lines are straight and horizontal in the *sheer-plan* and curved in the *half-breadth plan.* They show the form of the ship at successive depths, as would appear by so many horizontal sections.

8. (*Nautical.*) *a.* A running cord or rope; as, *bowline, bunt* line, *clew* line, *spilling* line, etc.

b. A cord for a specific purpose; as, a *hand*-line, a 20-fathom sounding-line having a lead of from 7 to 14 pounds (see Hand-line). A *deep-sea* line, one of say 200 fathoms, and having a lead of 28 pounds weight (see Deep-sea Line). A *fishing*-line.

c. A grade of rope, such as *marline, white* line, *tarred* line, etc.

9. (*Mining.*) *a. Line of bearing.* The strike of a stratum, or its direction at right angles to the *dip.*

b. Synclinal line. The axis of the valley curvature of strata, opposed to *anticlinal.*

c. Anticlinal line. The axis of the ridge or saddle curvature of strata, opposed to *synclinal.*

d. Line of least resistance. The *line of mine* or *axis of explosion.* A line drawn from the focus of a mine to that point in the direction of which the charge meets with the least resistance.

10. (*Architecture.*) *Springing* line. The line from which an arch rises, and from which the versed sine is calculated.

11. (*Masonry.*) The bricklayer's cord, which is his guide for level and direction. It is stretched between *line-pins.*

12. (*Railway-engineering.*) A railway-track, as

the *main* line or trunk. A *loop*-line, a *connecting* line, a *crossing* line, a *side* line or switch.

13. (*Telegraphy.*) The wire connecting one station with another.

The part of an instrument to which the *line* is connected is known as its *terminal.*

The wires and instruments form the *circuit.* See CIRCUIT; WIRE.

14. (*Surveying.*) *a. Base-line.* A carefully measured line which extends between two stations and forms the basis of triangulation.

b. Line of direction. The *bearing.* The line laid down or protracted in a survey.

15. (*Drafting* and *Perspective.*) *a.* The *ground* line or *fundamental* line. The common section of the ground plane and the base of the picture. The *terrestrial* line.

b. The *horizontal* line. The common section of the horizontal and that of the draft of representation, passing through the principal points.

c. The *visual* line. The line conceived to proceed from the object to the eye.

d. The *principal* line. A line drawn from the eye perpendicular to the picture. The *line of distance.*

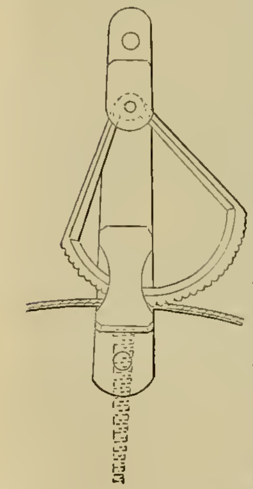
16. (*Carpentry.*) To strike a straight line on timber or boards; usually a chalk line between points determined by measurement.

Lin'e-ar Mi-crom'e-ter. (*Optics.*) A graduated scale placed in the field of a telescope, and used to measure distances between objects.

Line-clamp. A device to hold a clothes or other line.

In the example, the line is clamped between the hook and the serrated swinging segment.

Fig 2957.



Clothes-Line Holder.

Lined-gold. Gold backed by a leaf of baser metal.

Line-en-grav'ing. This term is used to distinguish it from *aquatint*, *mezzotint*, and *stipple* or *chalk* engraving. It was originally entirely executed with the graver and *dry point.* The latter term is to distinguish it from the *etching point*, which makes a mark through a *ground* upon the plate, which is afterwards *bit in* with acid.

Latterly, the subject is first *etched* and then *finished* with the graver. Certain parts are left to be entirely executed by the graver and dry point, while other parts are deepened and made more effective by the application of the graver to the etched lines. Smooth portions are laid in by the *ruling-machine*, which has a *diamond-point* working through a ground upon the plate, and so arranged as to make a series of parallel marks at regulated distances. After *ruling*, the plate is *bit in* with acid, as described under ETCHING. (See RULING-MACHINE, ENGRAVER'S.) Line-engraving is generally admitted to be the highest style of the art.

Lin'en. (*Fabric.*) A cloth made of flax and having many grades of fineness, and several forms distinguished by their figures or surfaces; as *damask*, *diaper*, *cambric*, *huckaback*, etc.

The earliest notice of linen — cloth of flax — is in Egypt. In the time of Moses, the Pharaoh was arrayed in vestures of fine linen; and on the tomb of Beni Hassan are shown the pulling of the flax and the ridding of the seeds by means of the ripple. It was the only material allowed for the garments of the priests and the bandaging of the dead. The ceremonial law of the Hebrews also prescribes linen for the priests. Cotton was then unknown, except as a curiosity. Wool was regarded as foul. We read of the Egyptian linen in Genesis, Chronicles, Proverbs, and Ezekiel. Pharaoh arrayed Joseph in vestures of fine linen, 1716 B. C. The mixture of flax and wool in a fabric was forbidden (Lev. xix. 19). Solomon had linen yarn brought out of Egypt (1 Kings x. 28).

"He [Aaron] shall put on the holy linen coat, and he shall have the linen breeches upon his flesh, and shall be girded with a linen girdle, and with the linen miter shall he be attired; these are holy garments."

Wilkinson states that the ancient Egyptian linen is far superior to the finest modern in general quality and the evenness of the threads. One specimen has 540 threads or 270 double threads in the warp, and 110 in the woof.

In the linen corselet given by Amasis of Egypt to the Lacedemonians, each thread, though fine, was composed of 360 other threads, all distinct. It was handsomely embroidered. The tomb of Rameses III. at Thebes showed a similar corselet, worked with figures of animals. Pliny notices the corselet of Amasis, shown in the temple of Minerva at Rhodes. See FLAX.

It was first manufactured in England by Flemish weavers, under the protection of Henry III., 1253. Before this, woolen shirts were generally worn. A company of linen-weavers was established in London, 1368.

The Presbyterians, who left persecution in Scotland in the time of the Stuarts, planted the linen manufacture in the North of Ireland, and were encouraged by William III. and succeeding governments.

Lin'en Pa'per. As with paper of cotton, bamboo, morus bark, and silk, it appears that the first manufacture of linen paper was in China. The Egyptians excelled in fine linen in very early times. About 1500 B. C., the Israelites left Egypt with stores of linen; and five hundred years afterward, Solomon imported linen yarn from thence. Yet, with all this, it does not appear that the people of any country bordering on the Mediterranean had conceived the idea of tearing these rags to pieces, making them into pulp, and then into a sheet. See PAPER.

The use of papyrus itself, though it so much preceded any true paper, is by many persons supposed not to have antedated the expedition of Alexander. Without the papyrus, which so long gave the Egyptians precedence in the matter of written records, they must have been reduced to the same straits as their neighbors, and have written on waxed tablets, linen cloth, palm leaves, bark, etc. The use of parchment was not yet, if we may credit the assertion that it was invented by the king of Pergamus as a substitute for the papyrus, on which an embargo was laid by the reigning Ptolemy, whoever he was.

The use of linen paper in Europe appears to have originated in Germany, about the eleventh or twelfth century, the exact date being undeterminable. We read of a German paper-mill at Nuremberg in 1390, one in England in 1343, in France, 1314, Italy, 1367. Linen paper, however, is yet preserved, containing documents of much older date.

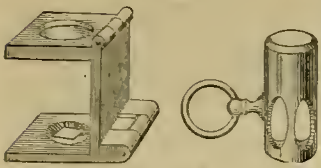
John Tate had a mill at Stevenage, England, in 1496, but the manufacture was much increased by

Spielman in 1588. This person was a German jeweler, and established a paper-mill at Deptford during the reign of Queen Elizabeth.

Whatman's mill was established at Maidstone in 1770. The name is yet a famous brand.

Lin'en-prov'er. A small microscope for counting the threads in linen fabrics. Its base has a square opening, which exposes a certain area of linen, and the glass above enables the number of threads to be counted.

Fig. 2958.



Linen-Prover.

Some linen-provers are provided with four perforations, which are respectively, —

$\frac{1}{4}$ of 1 inch. $\frac{1}{703}$ of 37 inches.
$\frac{1}{200}$ of 40 inches. $\frac{1}{200}$ of 34 inches.

See Reed.

Line-of-bat'tle Ship. In England, a ship of not less than 64 guns.

Line of Cen'ters. (*Machinery.*) *a.* A straight line joining the centers of two wheels in gear.

b. The line when the crank and the connecting-rod are in a straight line. The *dead-point* of the crank.

Line of De-fense'. (*Fortification.*) A line joining a salient angle with the opposite flank. See Line, 6.

Line of Fire. (*Ordnance.*) The line formed by the axis of the piece produced. When the gun is laid point-blank, the *line of fire* is parallel to the *line of sight*, and not otherwise. See Fig. 2956.

a b, line of fire.

c d, line of metal.

e f, line of sight (point-blank).

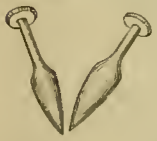
Line of Met'al. (*Ordnance.*) A line joining the notches on the breech and muzzle, and forming an angle with the axis of the bore, in consequence of the taper form of the piece. See Fig. 2956.

Line of Met'al-el-e-va'tion. (*Ordnance.*) The elevation due to the conical form of the gun when the line of metal is laid horizontal.

Line of Sight. (*Ordnance.*) The line passing through the breech and muzzle sights of a gun at any elevation and the object. See Fig. 2956.

Line-pin. (*Bricklaying.*) A pin used by bricklayers to hold the line by which the bricks are laid. Its pointed end is forced into a mortar-joint of the building.

Fig. 2959.



Line-Pins.

Lin'er. 1. (*Marble-working.*) A long slab of stone to which pieces of marble are secured in order to be ground or polished. The pieces of marble — for a tesselated pavement, for instance — are placed face downward on a flat stone; plaster of paris is poured on their upper surfaces, and the *liner* is laid upon them so as to be cemented to each, though they may vary in thickness. They are then ready for grinding by being drawn back and forth over a large slab of marble, sand and water being supplied between the surfaces, which act by mutual attrition.

2. (*Machinery.*) A thin piece placed between parts to adjust them. A *shim*.

3. (*Nautical.*) *a.* A line-of-battle ship. One large enough to occupy a position in the main line.

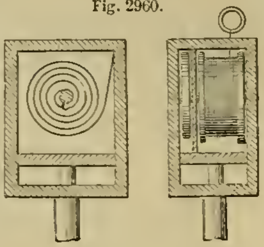
b. One of a regular line of vessels or packets sailing or steaming between ports.

Line-rock'et. (*Pyrotechnics.*) A small rocket made to run along an extended wire or line.

Lines. (*Saddlery.*) Another name for driving-reins.

Line-wind'er. A reel for a clothes-line, a fishing-line, a chalk-line, a log-line, etc. In the example, the line, after being withdrawn for use, is re-wound on the reel by a spring upon the reel-shaft.

Fig. 2960.



Chalk-Line Reel

Line-wire. (*Telegraphy.*) The wire connecting stations. They are usually of iron, on account of its comparative cheapness, and its tenacity, which allows a long reach between posts. See Insulator; Telegraph; and, for a specific index of related subjects, see Electrical Apparatus and Appliances.

Lin'gel. A small thong of leather for sewing or lacing bands. *Lingle.*

Lin'got. An iron mold for casting metals.

Lin'guet. 1. A tongue; as in some organ-pipes. A *languet*.

2. The piece of a sword-hilt which turns down over the mouth-piece of a scabbard.

Lin'ing. 1. (*Joinery.*) Inside boarding; in contradistinction to outside *sheathing* or *boxing*, called *casing*. A covering of an interior surface, such as—

The *boxing* of window-shutters which form the backs of the recesses into which the shutters are folded.

The *facings* on each side of a doorway.

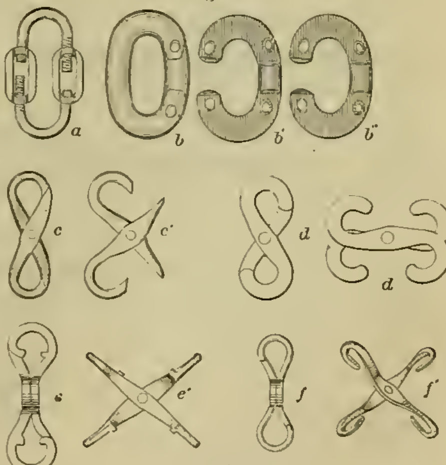
The vertical pieces of a window-way parallel with the surface of the wall.

2. (*Metallurgy.*) The *fixing* or protecting stuff on the boshes of a puddling-furnace. The inside surface material of a Blast-furnace (which see).

3. (*Steam-engine.*) A non-radiating covering of felt, etc., for a steam-boiler. The term is hardly correct here, for the covering is exterior, and is properly known as *cleading*, *lagging*, or *jacket*.

4. (*Hydraulic Engineering.*) Puddle laid on the sides of a canal, to prevent the percolation of water.

Fig. 2961.



Connecting Links.

Link. 1. A short connecting piece of circular or other equivalent shape, as one of the oval rings or divisions of a chain.

The illustration shows several links capable of being taken apart, and thus becoming a means of uniting the broken ends of a chain. Each half of the link *a* has a swivel to which it is connected by a head, the swivel of each part forming a nut for the threaded leg of the other portion. The link *b* is made of two sections, *b′ b″*, laid upon each other and riveted. The illustrations (*c c′*, *d d*, *e e′*, *f f*) are forms of connecting link whose twin swiveling portions form a mousing for each other.

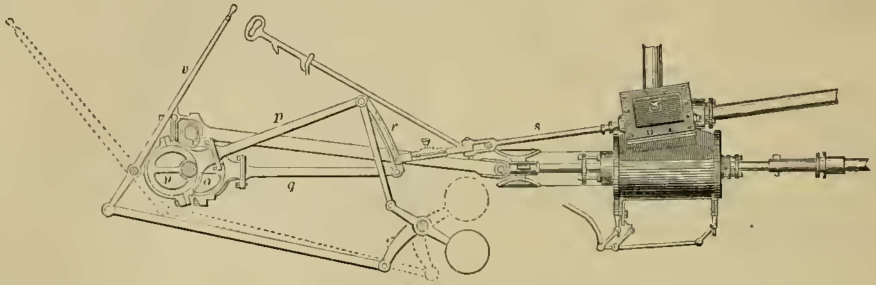
2. A short connecting bar with a bearing in each end, for transmitting motion from one rod or lever to another.

3. The length of one section of Gunter's chain, 7.92 inches, the 100th part of 66 feet.

4. A torch. It is made of tow and pitch, or of combustible splinters, such as of pitch-pine.

Link-mo′tion. A gear by which the valve is operated in locomotives and similar engines. It acts as a variable cut-off, or reverses the steam, or renders the valve inactive, as may be required.

Fig. 2962.



Link-Motion.

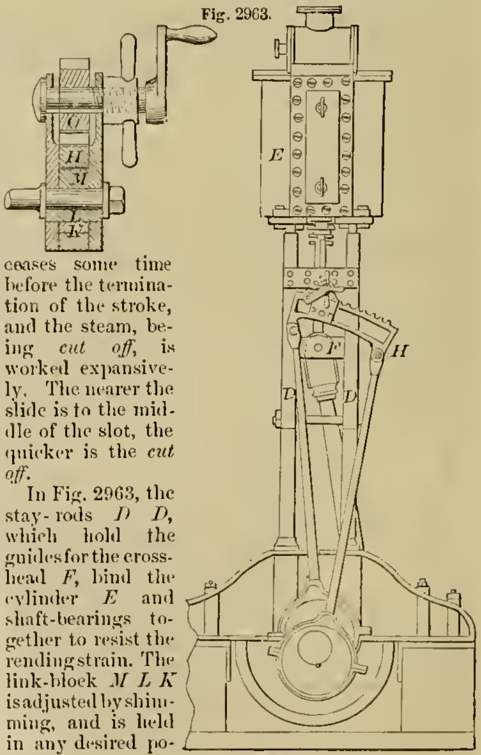
It consists of two eccentrics *n o* and their rods *p q*, one for the forward and the other for the backward movement of the engine. The rods are connected to the respective ends of a slotted bar *r* called the *link*, which is vertically adjusted by an arrangement of levers terminating in a handle *v*, as shown. The valve-rod *s* is connected to a sliding pin which moves up and down in the slot of the *link* as the latter is adjusted vertically by the handle and connecting-levers previously referred to. The handle is retained at any *set* which may be given to it, by engagement with a notched segment-bar.

The motions of the valve are produced by an impulse imparted to the pin in the slot of the link ; as the pin moves, a longitudinal reciprocation is imparted to the valve-rod. The motion of the pin — which is furnished with a slide to adapt it to move in the slot of the link — is made up of the motions imparted to it by the two eccentrics ; and when the pin-slide is in the middle of the link, it is not moved at all, as the actions of the eccentrics just balance each other, and the link simply oscillates on the slide-pin as a center. When the link is thus adjusted, the handle being at the middle notch of the segment, the valve is inactive and the engine at rest.

When the slide-pin occupies a position either way from the said middle position in the link, it is thereby brought under the domination of the eccentric-rod, whose end of the link it occupies. The other eccentric-rod then forms a fulcrum, on which the link oscillates, carrying with it the slide-pin, and thereby operating the valve-rod and valve at a *full* stroke. By shifting the link *r* downward from the position shown in the figure, the eccentric *n* and its rod *p* are brought into activity, the rod *q* attaining a *nearly* absolute position, reversing the motion of the slide, and consequently of the engine.

When the slide-pin occupies a position in the link at any point between the middle and either end, it receives a motion therefrom great in proportion to its proximity to the end, and conversely. In such position, the motion of the valve is distinctly made up of the motions of the two eccentrics, as the fulcrum-point of the link is itself shifting, and the effect is to give the valve only a part of the throw of the eccentric. The steam-valves are partially opened, quickly closed again, so that the admission of steam ceases some time before the termination of the stroke, and the steam, being *cut off*, is worked expansively. The nearer the slide is to the middle of the slot, the quicker is the *cut off*.

Fig. 2963.



Link-Motion for Steam-Engine

In Fig. 2963, the stay-rods *D D*, which hold the guides for the cross-head *F*, bind the cylinder *E* and shaft-bearings together to resist the rending strain. The link-block *M L K* is adjusted by shimming, and is held in any desired position by the toothed link *H* and the pinion *O*. See Burgh's "Link-Motion and Expansion-Gear." London, 1871.

Link-worm′ing. (*Nautical.*) Worming a cable by chains inserted in the interstices of the strands.

Link-le′ver. (*Railroad-engine.*) The reversing lever of a locomotive.

Link-work. Work in which motion is communicated by connecting pieces.

Lin′net-hole. (*Glass.*) (Fr. *lunette.*) A hole connecting the glass-melting furnace with the arch.

Lin′seed-mill. (*Lint*, Flax.) A mill for grinding flax-seed for oil. See OIL-MILL.

Lin′seed-oil. Oil expressed from flax (*lint*) seed.

Lin′sey. (*Fabric.*) A country-made fabric, of linen warp and worsted filling, undressed; hence the name *linsey-wool′sey*.

Lin′stock. A *lint-s′ock*. A gunner's forked staff, to hold a match of lint dipped in a solution of saltpeter. It is referred to by Shakespeare: —

> "And the nimble gunner
> With *linstock* now the devilish cannon touches."
> *Henry V.*

Lint. Raveled or scraped linen reduced to a soft state and used for dressing wounds or ulcers. As formerly prepared, it consisted of scrapings from the surface of old linen cloth, which was drawn beneath a knife, the weft-threads being pushed back from time to time, and the scrapings being obtained from the threads of the warp.

A machine has been used for the purpose, the straight, blunt knife-blade being brought down by a pedal upon the frayed edges of the linen, which lies upon a little leather covered ledge beneath it. The linen is rolled upon a round stick whose length is in the direction of the weft-threads, and the edge of the piece, being pushed under the descending knife, receives a pull after the knife has supplied it, thereby raveling off the weft-threads and scraping the warp-threads. The art of using the machine consists in causing the knife to descend on the warp between the weft-threads at each descent.

Lint made up into a flat, oval form is termed a *pledget;* into a cylindrical form, or resembling a date-stone, it is a *dossil*.

A substitute for lint consists of carded or scribbed fiber, impregnated with vegetable tar to render it antiseptic and disinfectant.

Lint-doc′tor. A sharp-edged ruler on the delivery side of the calico-printing cylinder, to detain any lint or fibers which may come off the cotton cloth. The *color-doctor* on the other side of the roller acts as a wiper to remove superfluous color. See CALICO-PRINTING.

Lin′tel. (*Carpentry.*) A piece of timber laid horizontally over a doorway or window. An arch above to bear the superincumbent load is called a *discharging*-arch.

Lip. 1. A projecting flange, as on the edge of a kettle.

A narrow surface around an opening, as the *lip* of a bottle.

2. (*Music.*) In organ-pipes, the edge against which the sheet of air impinges. The vibration acquired thereby is communicated to the column of air in the pipe, and produces a musical note. See MOUTH-PIPE; PIPE.

3. (*Water-wheel.*) A rim closing the joint between the barrel and curb of a turbine.

4. (*Vehicles.*) A *cuttoo* plate. A projecting part of the bolster.

Lip-bit. A boring-tool adapted to be used in a brace, and having a cutting lip projecting beyond the end of the barrel. See BIT.

Lip-head Bolt. A bolt with a head projecting sideways.

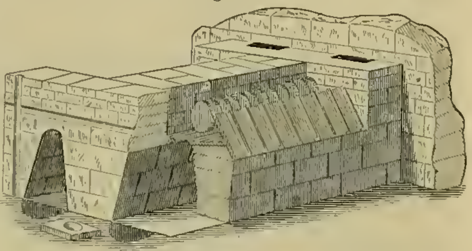
Li-qua′tion. Silver is separated from copper by melting the alloy with the addition of lead, and cooling the triple alloy suddenly in the form of cakes. These cakes are heated to such a degree on an inclined hearth as to cause the alloy of lead and silver to run off, and allow the copper to remain.

The lead and silver may be separated by cupellation or by Pattinson's process, in which the alloy is allowed to cool slowly and the crystals removed as they form, leaving the alloy relatively richer in silver. By a repetition of the process an alloy of great richness is procured, and the operation may be followed by cupellation, in which the lead is oxidized, melts, and runs off. See LEAD-FURNACE.

Li-qua′tion Hearth or Fur′nace. A hearth or furnace in which metals are separated by exposure to a heat which melts one or more of them, but leaves the other or others unmelted.

The disks of alloy — say, copper, lead, and silver — are set on edge in a slanting position on two iron plates, between which is an interval. Wedges are placed between the disks until the furnace is charged, and the space around the disks is then filled in with charcoal, the top of the furnace restored, and heat applied to the kindling in the chamber below. As the temperature increases, the alloy of lead and silver, whose union is more intimate than that of either with the copper, becomes fused and runs down to a conductor on the bottom of the fire-chamber, and is led to the cistern in front, from whence it is ladled, the lead and silver being afterward separated by cupellation.

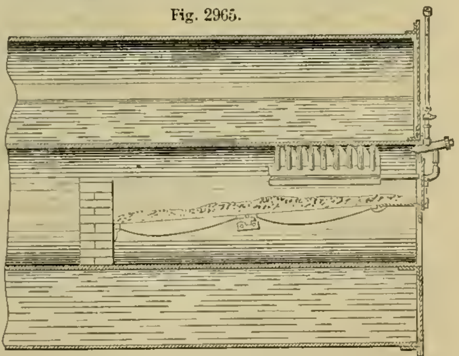
Fig. 2964.



Liquation-Furnace.

Liq′uid-car′bon Fur′nace. A furnace in which liquid fuel, such as petroleum, is introduced into the fire-chamber and burnt in contact with air and sometimes with steam. The example has an injector above the fire-door, for the introduction of the liquid hydrocarbon; the supply is regulated by a cock, and

Fig. 2965.



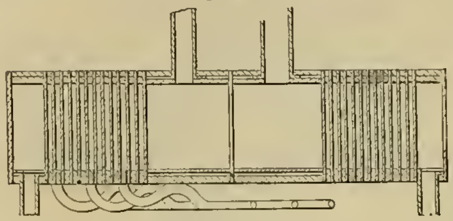
Liquid-Carbon Furnace.

at the point of ejection it is associated with superheated steam at a temperature of about 600° Fah. The combined spray thus injected comes in contact with the hot ashes on the grate-bars, by which it is ignited.

In raising steam, fire is first made on the grate-bars in the ordinary way, and the injector is brought into action when the required pressure is obtained in the boiler.

Liq′uid-cool′er. An apparatus for cooling wort, beer, wine, water, etc. On a small scale, as the wine-cooler at the sideboard, it is a tub in which bottles are stood with broken ice around them. For soda-water and other liquids on draft, it is a coil of pipe which passes through a chamber, and is covered with pounded ice. For milk, it is a pan which has a false bottom, through which cold water circulates. For beer on draft, it is a chamber in which the keg is set with blocks of ice about it and the faucet projecting. See Fig. 632.

Fig. 2966.

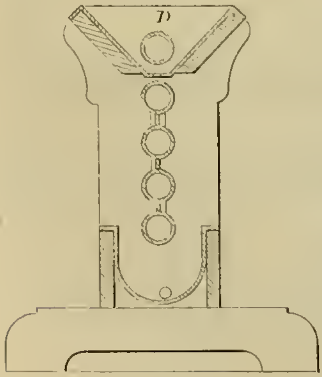


Volute-Cooler.

On a larger scale, used in breweries for cooling wort or beer, it has many forms. It is usually a very large shallow vat. One is shown in Fig. 2966. It is a volute, formed by a wide strip of metal set on edge between upper and lower heads. A long sheet-metal plate is folded and then convolved, so as to form a helix with two distinct spaces; the edges of the plate are attached to the top and bottom disks, which form heads, and one space in the convolution is for the refrigerating liquid, the other for the vapor or fluid to be condensed; induction and eduction passages admit and discharge the respective fluids.

In Fig. 2967, the beer, on its way from the *cool-beds* to the fermenting-tun, flows into the trough *D*, and thence trickles over the vertical series of horizontal pipes, through which cold water passes. Similar to this in construction is the Degrand condenser, except that the latter is for heating cane juice, and the pipes are filled with steam. See Fig. 1421.

Fig 2967.

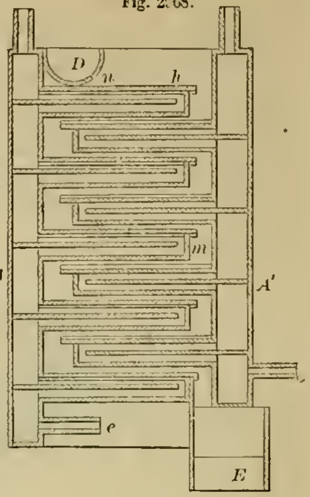


Liquid-Cooler.

The cooler in which the wort passes through a coil of pipe in a vat which is filled with ice, or through which flows a stream of cold water, is also like the coil-condenser in the arrangement of its parts. See Fig. 631.

Another form is that in which an outer and an inner vessel are filled with ice and communicate by short tubes which cross the intervening space; over these tubes the beer descends in a shower from a pan above.

Fig. 2968.



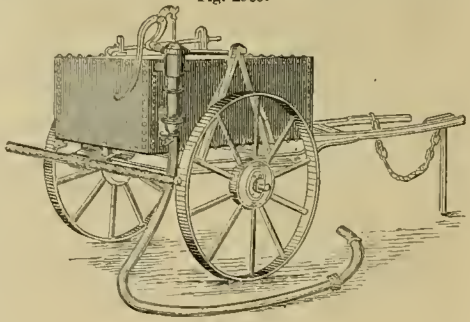
Liquid-Cooler.

Fig. 2968 has two vertical cases *A A′* in which wort circulates, discharging at *e* and *e′*. From each of these cases project boxes *h m*, which lap past each other in the intervening space through which water flows from *D* to *E*. In the cases are also plates which extend into the boxes, so as to form a sinuous channel through which the wort passes in a sheet against the outer walls of the box, which are cooled by the water.

Another form is a series of inclined troughs through which the wort passes to be cooled by exposure to the air.

Liq′uid-ma-nure′ Cart. A tank on wheels for conveyance of liquid manure to a field and distributing it there. As shown, it is made of boiler-iron riveted, and is filled by means of a portable pump and hose, shown in position. The tank is hung upon centers, so as to remain level on inclined ground.

Fig. 2969.



Liquid-Manure Cart.

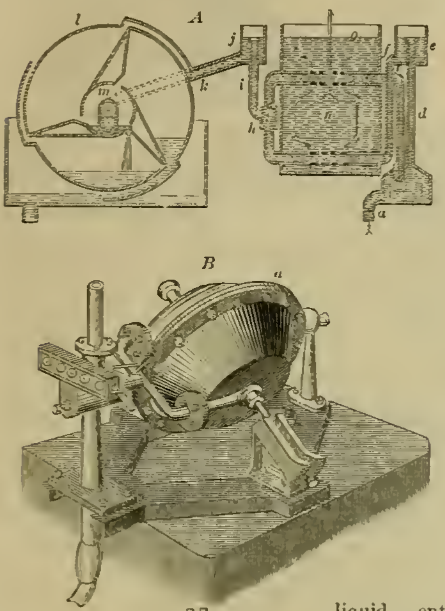
Liq′uid-me′ter. A device for ascertaining the quantity of liquid received or discharged through an orifice. See METER, WATER.

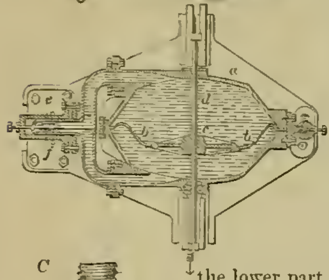
It does not appear to have been in use prior to 1824, when William Pontifex of London, England, patented a new mode of adjusting or equalizing the pressure of fluids or liquids in pipes or tubes, and also an improved mode of measuring said fluids or liquids. This consisted in forming a chamber over the supply-pipe and near its end, in which was a leathern cup secured to the top of the chamber. A series of weights, one above the other, was also suspended from the top of the chamber, which were successively raised as the pressure of the liquid increased. An arm connected with the bottom of the cup operated a valve, which gradually closed the discharge orifice as the weights were lifted.

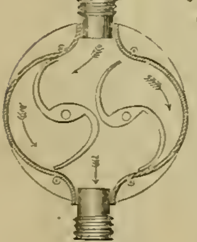
William Brunton, near the same time, invented a meter in which the reciprocating motion of a piston in a cylinder was caused to measure the amount of water discharged, the valve arrangements, etc., being similar to those of the steam-engine.

The forms of meter are various, the principal being known as the *diaphragm*, the *balanced*, in which compressed air is employed, the *piston*, the *propeller*, and the *flexible tube and roller* meter.

Fig. 2970.







Liquid-Meters.

The spirit-meter of Siemens and Halske is shown in Fig. 2970 (*A*). This instrument is designed to register the quantity of spirit discharged, and also the amount of absolute alcohol contained therein. The liquid enters through the pipe *a* into the chamber, whence it passes through two pipes *c d*, one of which terminates in a chamber *e*, whence it is carried by the pipe *f* through the lower part of the vessel *g*. The other conducts it directly to the upper part of *g*.

The parts of the pipes which pass through *g* are perforated respectively on the upper and lower sides, causing upward and downward currents therein, thoroughly mingling the spirit, so as to insure that the quantity of alcohol contained in the spirit does not vary. The two meet in the chamber *h*, passing through a pipe *i* into a chamber *j*, from which it flows into the *volumeter* through the pipe *k*. The volumeter is a hollow drum *l*, having a concentric cylinder *m*, the space between the two being divided into three compartments. Three slits in the central cylinder permit the liquid to flow successively into each compartment, as it in turn occupies the lowest position. The openings are so arranged that while the lower chamber is filling the level is too low to permit an escape into either of the others, and the apparatus remains stationary until the lower chamber is full. The discharge of this then commences, while the aperture through which it received its supply is carried by the rotation above the liquid in the central chamber. To prevent overflow until this change of position has occurred, the discharge-channels are carried spirally from each chamber round the exterior of the one next following. The registering dials are actuated in the usual manner. The amount of pure spirit is determined by the indications of a hydrometer *n* in the tank *g*, having a curved lever, the shorter arm of which is connected with its stem. The hydrometer is filled with alcohol, and rises and falls according to the density of the surrounding spirit, causing the lever to vibrate each time that a chamber of the volumeter is emptied, to an extent indicating the quantity of pure spirit contained therein. A three-leaved cam, attached to the axis of the volumeter, is connected with the long arm of the lever, and is provided with a ratchet-wheel of large diameter with fine teeth. This is placed on the axis of the first register-wheel, and causes it to turn an amount equal to the movement of the curved lever.

The water-meter of Duboys of Paris (*B*) consists of a casing *a*, in the interior of which is a diaphragm *b*, carrying in its center a metallic disk *c*, the convex edges of which accurately fit the sides of the casing. The diaphragm and disk are kept in position by the rod *d*, which passes through water-tight orifices. *e* and *f* are apertures for receiving and discharging the water.

As the water enters through either duct, as *e*, it raises the diaphragm, forcing out the water on the upper side until the vessel is full, when the diaphragm fits closely against that side. During the process of filling, the vessel is inclined; but when the weight rises to the top, it gives that side the preponderance, causing the vessel to turn on its pivots until it becomes the bottom side. At the same time, the supply-opening is closed and that for discharge opened, while on the opposite side a contrary effect is produced. Arrangements are provided to prevent the vessel from tilting until it is entirely filled.

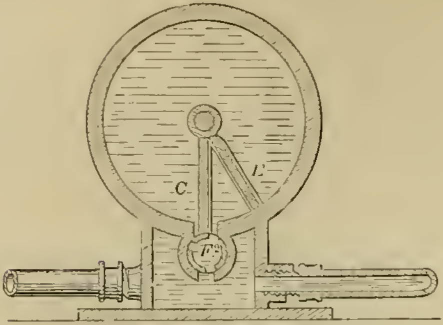
The meter of M. Clement of Orleans consists of an upright cylinder divided into five compartments, each of which is caused to actuate a crank on a vertical axis common to all. This carries a compound stop-cock, which admits the water to and discharges it from each compartment when filled.

Payton's meter (*C*, Fig. 2970) contains two S-shaped arms, whose extremities during rotation are in close contact with each other and with the sides of the box. The arrows indicate the direction of the current. Similar devices are shown under Rotary Blower; Rotary Pump.

In Cochrane's meter for measuring liquids under pressure, the measurement is effected by a pivoted vessel resembling a double scoop, which tilts and discharges when either side is full. A bent lever below this is tilted back and forth at each movement of the scoop, actuating the registering mechanism.

Atwell's cylindrical case has a piston *E* which turns on an axial shaft communicating motion to the register, and carrying an arm which, at the end of each stroke, changes a cylindrical valve F^2 so as to cause the water to alternately enter and discharge from the measuring-chamber at opposite sides of the internal partition C.

Fig. 2971.

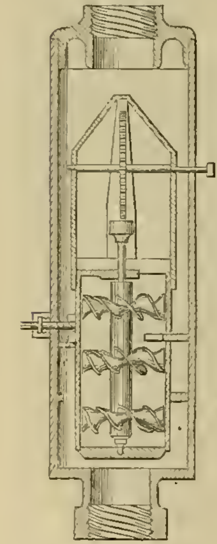


Pulsating-Piston Meter

In Fig. 2972, a water-wheel within a pipe is connected to a register to indicate the flow of water. The flow is regulated by a sliding-valve.

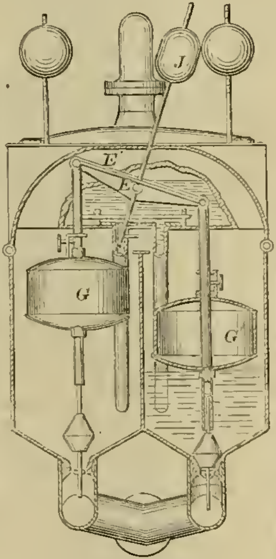
In Young's spirit-meter, floats G in the measuring-chambers are attached to each end of a pivoted beam. The alternate downward motion of the floats, as the chambers are discharged, diverts the induction flow from one to the other. The floats G and their valves occupy two chambers, and are suspended to opposite ends of the oscillating beam E. The valve-stems have a limited sliding motion in the floats, so that the float will rise to a sufficient hight without raising the valve to permit the emptying of the chamber. At the point of discharge the weighted rod J is thrown past the vertical, and, closing the valve to this chamber, opens the induction-pipe to the other chamber, depressing that float sufficiently to close the escape-valve.

Fig 2972.



Spiral-Vane Meter.

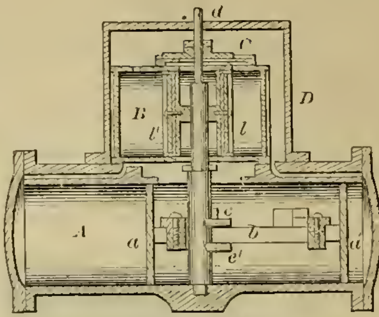
Fig. 2973.



Young's Spirit-Meter.

In Sickles's meter (Fig. 2974) the liquid, flowing into the chamber D, is by means of the valve C admitted alternately to each end of the hollow valve B, which is divided into compartments by the partitions l l'. From these the fluid flows alternately through appropriate ports behind the pistons a a on the rod b, which has tappets that strike the pins c c' on the upright shaft d, causing its partial rotation and operating the slide-valve C, which admits the fluid into the compartments of the valve B.

Fig. 2974.



Sickles's Liquid-Meter.

Liq'uor. 1. A term applied to a prepared solution, as, —

(*Sugar.*) A solution of sugar, used in claying the loaves.

(*Dyeing.*) A dye or mordant in solution, as *tin-liquor.*

Liquor of flints, liquor silicum; soluble glass.

Liquor of libavius; bichloride of tin.

2. A dilution; as *liquor ammonia*, etc.

Liq'uor-gage. A measuring-rod for determining the depth of the liquid in a cask or tank. A part of the gager's equipment.

Liq'uor-pump. A portable pump for emptying casks, etc. See Burr-pump.

Liq'uor-thief. A tube which is let down through the bung-hole of a cask and then closed, so as to withdraw liquid therefrom. It is usually closed at top by the finger, but, in the illustration, the tube is closed by a plug. A *sampling-tube.* A *velinche.*

Lisle-lace. A light, fine, transparent, white-thread, hand-made lace, so called from Lisle in France. It has a diamond-shaped mesh, formed by 2 threads plaited to a perpendicular line. Also known as *clear-foundation.*

Lis'sens. (*Rope-making.*) The ultimate strands of a rope.

List. 1. To chop a block or stave to an approximate shape; e. g. the balk or *codling* from which staves are to be rived is chopped to give a taper towards each end, before being cleft into staves by the *frow* and mallet.

2. (*Carpentry.*) *a.* The upper rail of a railing.

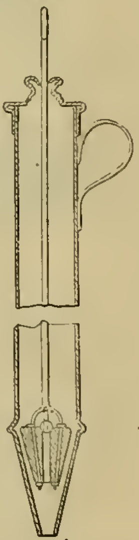
b. A narrow strip from the edge of a plank.

c. A small, square molding. A *fillet.*

3. A selvage (*self-edge*) strip on the edge of broadcloth.

4. (*Rope-making.*) A woolen flap in the hands of a rope-maker, through which the yarn goes.

Fig. 2975



Liquor-Thief.

5. *a.* A thin coat of tin preparatory to the thicker coat, in tinning iron plates.

b. A selvage or wire of tin formed on the under edge of plates in tinning.

6. (*Nautical.*) An inclination of a ship to one side. A *heel.*

List′el. (*Joinery.*) A narrow, slightly projecting ledge. A *reglet.*

List′er. A three-pronged fish-spear. See Leister.

List′ing. 1. Cutting away the sappy edge of a board.

2. The narrow edge of a board.

List-pan. (*Tin-plate manufacture.*) A perforated skimmer.

List-pot. A heated pan with a small quantity of tin at the bottom, and the last of the series of five pans used in the manufacture of tin-plate. *Tin-pot, wash-pot, grease-pot, pan, list-pot.* See Tin-plate.

Lith′arge. Semi-crystalline or fused protoxide of lead, obtained in separating silver from lead ore, and used in the composition of flint-glass.

Lith′ic Paint. A mastic of petalite (which contains an alkali known as lithia), sand, and litharge, used as a coating for walls.

Lith′i-um. A metal, the base of lithia.

Equivalent, 6.9; symbol, *Li.* This rare metal somewhat resembles sodium, and has no special interest in a mechanical point of view. Specific gravity, 0.59; fusing-point, 356° Fah.

Lith′o-clast. (*Surgery.*) A powerful forceps-like instrument, with two blades having concealed chisel or wedge shaped projections to cut the stone in the bladder into pieces, if found to be too large to extract by means of the lithotomy-forceps after the operation of lithotomy.

Lith′o-col′la. A cement for uniting stones. See Cement.

Lith′o-frac′teur. Composed of nitro-glycerine, 52 per cent; infusorial silica and sand, 30 per cent; carbon, 12 per cent; $NaO\ NO^5$, 4 per cent; sulphur, 2 per cent.

Its characteristics, as compared with dynamite, are: (1) greater sensitiveness to temperature, exploding at 120°, while dynamite explodes at 190°; (2) greater sensitiveness to moisture from the presence of the hygroscopic nitrate of soda; (3) the gases from the explosion always contain carbonic oxide from the carbon in the compound; (4) for equal volumes it has the less explosive power. — *Journal of Applied Chemistry.*

Lith′o-glyph. An engraving on a gem.

Lith′o-graph′ic Cray′on. In drawing on stone for the purposes of lithographic printing, crayons are used. They are composed essentially of soap, wax, fat, and lampblack, and are cast in the form of little cylindrical sticks. These are fastened in a porte-crayon or quill in the ordinary way. The above constituents, with various additions of shellac, mastic, etc., are fused together and finally set on fire. The longer the mixture burns, the harder the product becomes; three or four grades are usually made.

A grained lithographic stone is always required for a crayon-drawing; that is, a stone to which an evenly roughened surface has been given by grinding it carefully with sharp sand of a uniform character. The asperities upon the surface of such a stone remove the substance of the crayon in quantity proportionate to the pressure employed by the artist. When finished, such a drawing appears to the eye exactly as the impressions on paper printed from the same stone are intended to look. The printing capability is possessed by a crayon-drawing only after it has been etched with a very weak acid and gum-water. See Lithography.

Lithographic crayon or chalk (Engelmann): —

Yellow wax, 32 parts; Marseilles soap, 24 parts; tallow, 4 parts; saltpeter, 1 part; lampblack, 7 parts.

Melt the wax and tallow first; add the soap gradually, and heat till the mixture catches fire of itself. Remove the vessel from the fire, and let its contents burn for about two minutes for soft, and three minutes for hard, crayons. Extinguish the flame, and add very gradually and carefully the saltpeter dissolved in 7 parts of water. Heat is now to be applied with constant agitation, till the mass again takes fire, when it is to be instantly extinguished and the lampblack added. Mix very thoroughly, and heat till combustion once more takes place, which is to be instantly checked as before. It now remains to test the quality of the crayon as to hardness, and the quality of the point which can be given to it. A sample is poured out for this purpose, cooled, cut into strips, and left standing a day. If soft, farther burning will harden the product; but it can only be softened by adding an extra soft quality of crayon. When satisfactory, the mass is melted and poured into suitable molds. There are many other recipes for making crayons, involving the use of resins, etc., but the above is the simplest, and without doubt one of the best. Lemercier's formula is but a rehash of the foregoing, and the same may be said of Korn's, save that he does not set fire to his mixture, but prolongs the time of melting immensely, to attain the hardening of the mass.

Lith′o-graph′ic Ink. Lithographic ink, adapted for drawing on stone, is a compound similar to that used for Lithographic Crayons (which see), save that soap enough is present to render it quite soluble in water. It is rubbed up like india-ink, and used with a pen or very small hair-pencil, mostly on smooth stones. The usual preparation with acid and gum-water fits the work done with it for printing.

The same, or an ink quite like this, is also used for writing on *autographic transfer-paper.*

Transfer-ink is used for transferring from one stone to another, or from an engraved plate to stone, also for photo-lithographic transfers. It is composed of fatty and resinous bodies fused together, and often burned. Soap is frequently added in small quantity, and it is always colored with lampblack. Transfer-ink is used with a roller, like printing-ink, or with a *tampon* or pad, when transfers are made from engraved stones. This ink is sometimes called re-transfer-ink, in allusion to the fact that the printing surface is sometimes formed by a second transfer.

Printing-ink for lithographic purposes is very similar to that used by the type or woodcut printer. In the latter, boiled oil, resin-oil, and similar adhesive fluids serve as a vehicle for the carbonaceous or mineral matter which gives the color. In lithographic printing, the nature of the oily substance ground with the lampblack, or color, is all important; for upon its affinity for the design upon the stone, and its repulsion for the damp portions, depends the possibility of printing. Experience has shown that *burned linseed-oil,* technically known as Lithographic Varnish (which see), is admirably adapted for the manufacture and thinning of lithographic ink. The treatment such varnish has been subjected to, while it does not seriously lower its affinity for the lithographic picture, or its repulsion for the gummed and damp parts of the stone, will be found to have deprived it completely of its greasy character, which would gradually tend to smear and cloud the work.

In the manufacture of black ink, the quality depends a good deal upon that of the lampblack used; but chiefly upon the thoroughness of the mechanical process by which it is ground. It comes into the market as an exceedingly tough paste, made up in closed cans. The lithographic printer thins this with varnish of appropriate consistence, to suit his requirements, using the muller and pallet-knife to make the mixture thorough and uniform.

Recipes for a variety of lithographic inks are appended hereto.

Lithographic ink for drawing and writing on stone with the pen (Desmadryll, Sr.): White wax, 40 parts; mastic, 10 parts; shellac, 28 parts; white soap, 22 parts; lampblack, 9 parts.

The wax is heated in a suitable vessel till it continues to burn when set fire to. It is then removed from the fire, and the soap, shellac, and mastic added in small quantities at a time, but not fast enough to extinguish the flame. When all the ingredients are mixed, the cover is put on the pan, so as to stop farther combustion; the lampblack is now added, and the whole heated once more till it catches fire; the flame is extinguished at once, and the ink is examined after cooling. If it gives a solution which too soon becomes gelatinous or sticky, it must be burned more.

Another recipe, which gives a softer ink, is the following (Desmadryll, Sr.): Tallow, 10 parts; wax, 10 parts; soap, 16 parts; shellac, 14 parts; lampblack, 5 parts.

Fuse together and treat exactly as above.

The following is Lemercier's recipe for a similar ink: —

Yellow wax, 4 parts; tallow, 3 parts; white Marseilles soap, 13 parts, shellac, 6 parts; lampblack, 3 parts. Melt the wax and tallow, and add the soap in small quantities, then the shellac, and stir till all is evenly blended. Raise the temperature till the vapors take fire, burn cautiously for from one to two minutes; the lampblack is to be added next, and well mixed, and heat continued for a quarter of an hour. The ink is then poured out on a slab, cooled, and again melted with moderate heat, and constant stirring. The second melting is supposed to effect a more thorough blending of the constituents.

Ink for working on stone with the hair-pencil (Engelmann): —

Wax, 6 parts; soap, 6 parts; tallow, 3 parts; lampblack, 2 parts. Melt together and burn for a short time.

Ink for autographic transfer (Engelmann): —

Shellac, 16 parts; white wax, 10 parts; soap, 8 parts; dragon's blood, 8 parts; tallow, 5 parts. Melt the wax and tallow till ready to take fire; add the soap gradually in small pieces, and let the heat rise to the point of combustion. Add, while burning, the shellac and dragon's blood, and continue the burning for about five minutes. One part of this mixture dissolved in eight parts of hot water gives a good ink.

Another recipe (Cruzel) is as follows: —

White wax, 8 parts; white soap, 2 parts; shellac, 2 parts; lampblack, quantity sufficient. Melt the soap and wax together, then add the lampblack, of which there should be no more than will just color the ink when dissolved. Burn for about half a minute, put out the flame, and add the shellac with constant stirring. Heat is again applied till the mixture takes fire, after which it is cooled.

Mantoux obtained the gold medal from the *Société d'Encouragement*, for the following autographic ink: —

Gum-copal, 6 parts; wax, 10 parts; tallow, 10 parts; soap, 8 parts; shellac, 10 parts; gum-mastic, 10 parts; sulphur, 1 part. Heat the copal till it begins to crackle; then, to facilitate its fusion, add a small quantity of olive-oil. When melted add the tallow and wax. Heat and ignite, and add the soap quite dry and in little pieces. When melted and while still burning, throw in the mastic and shellac. The sulphur is now stirred in, whereby the heat will be increased, and the union of the copal with the other ingredients accomplished thoroughly. The flame at this stage of the process is to be extinguished, but after cooling a little the whole is again heated, and set fire to, and let burn moderately till the volume of the whole is reduced to one fourth of what it was. This ink is to be dissolved in ten parts of hot water; it is difficult to make, but is said to be one of the very best.

Ink for transfer from stone to stone: —

Wax, 1 part; soap, 1 part; tallow, 1 part; varnish, 4 parts; Venice turpentine, 6 parts; stiff printing-ink, quantity sufficient.

These substances are melted, and thoroughly mixed with the muller on a slab slightly warmed, the proportion of printing-ink being kept as small as possible. If too thick for use, more varnish is added by the printer, according to his judgment, at the time of pulling the transfer-sheet.

The above recipe can only be regarded as typical of and one of the simplest of the infinite variety of compounds for transfer from pen and crayon drawings on stone, and also from engraved stones and plates. It may almost be maintained that there are as many formulas for transfer-inks of this kind as there are transferrers, each making his own favorite compound, often with imposing secrecy. As in many other cases, marked success in transferring depends more upon the man than upon any other single circumstance.

Lith'o-graph'ic Pa'per. For transfer purposes, Chinese paper (India proof) is much used. It is cut into large sheets, and prepared by coating one side evenly with starch-paste, applied with a sponge. When dry, a second coat is sometimes given. Such paper is used for transferring from stone to stone.

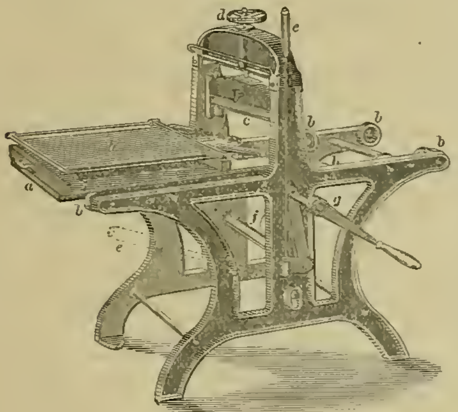
For autographic transfers, any good book or writing paper may be employed. The sizing on the latter is often considered sufficient, but for first-class work a coating of a solution of isinglass or gelatine, with an addition of gamboge, is generally used. For photo-lithographic transfers, *Saxe* paper is required to attain superior results.

For printing from lithographic stones, almost any paper is suitable which is fitted for type and wood-cut work. This is not so when a soluble chemical substance is present in the paper, such as chlorine, alum, etc. The fact that the stone is constantly wet causes such re-agents as the above to act upon it, and upon the drawing which takes the ink, even when the paper itself is not dampened, and a gradual but certain deterioration of the work necessarily follows. In the early days of lithography, when paper was made for mechanical printing processes only, difficulties were experienced in procuring it of suitable quality for lithographic printing. These difficulties no longer exist, manufacturers having much improved the bleaching and sizing of stock. Unsized paper, such as India proof and plate paper, usually printed damp, generally give the clearest and blackest impressions from stone. For crayon and close artistic work, one or the other is indispensable; but they are expensive and will not stand wear and tear, therefore sized papers of various kinds and qualities, as book, map, bond, are largely employed for commercial and professional work. On the lithographic power-press, paper more or less sized works better than that in which the fibers are easily disintegrated. On such presses dry paper is very desirable, therefore much attention is now being paid to smoothness and regularity of surface, which should lift the ink thoroughly without injuring the work, even on editions of many thousands from the same stone. Such papers are now manufactured, although greater perfection in this respect is still desirable, the power-press having created a demand for quality as well as quantity not dreamed of ten years ago.

Lith'o-graph'ic Pen. (*Lithography.*) Lithographic pens for writing on stone are now made by the best steel-pen makers, and are used to a limited extent. Such pens are exceedingly small and fine, even finer than a crow-quill, but the best lithographic pens are yet made by the artists themselves. They are made of thin steel ribbon, very slightly hollow, shaped and slit by a fine pair of scissors made specially for the purpose. These pens are not fitted for working on paper, but on the surface of the stone they give lines of extreme fineness unattainable in any other way.

Lith'o-graph'ic Press. The manner of applying pressure to a lithographic stone for the purposes of printing or transferring differs essentially from that employed for analogous work in the type and copperplate hand-presses. In the latter two, up and down pressure of the platen, or the progressive rolling pressure of the cylinder, is employed; in the former, a scraper is used. In power-press printing, however, it will be seen that these distinctions do not hold good.

Fig. 2976.



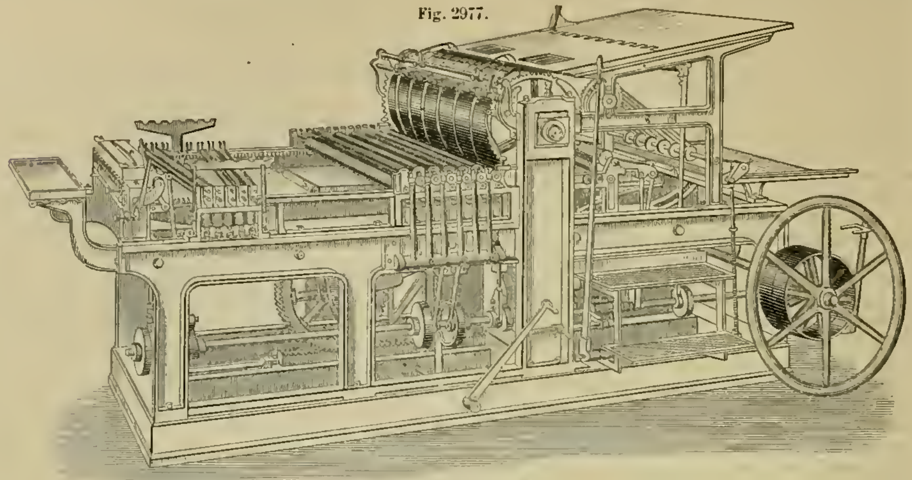
Lithographic Hand-Press.

The lithographic hand-press consists of a frame provided with rollers *b b b*, on which the carriage *a* runs to and fro. The scraper *c* consists of a flat piece of boxwood, beveled from both sides to about a quarter-inch edge, and firmly clamped in the sliding iron piece above. The hight of the scraper above the carriage can be adjusted by the screw *d* to suit the varying thickness of the stones. The manner of printing is as follows: The stone *i*, with the design upon it, is placed face up upon the carriage; it is damped and inked, and the sheet of paper which is to receive the impression is laid thereon. The tympan *h* of leather, stretched in an iron frame, is then lowered upon it, as in the figure, and the carriage pushed under the scraper. By depressing the lever *e* to the position indicated by the dotted lines, the toggles at each end of the shaft *f* raise the bearings of the winch *g*, upon the axle of which a strong iron roller is made fast. This roller, or cylinder, is the full width of the press, and the depression of the lever brings it into contact with the under side of the carriage, lifting the latter at the same time off the rollers *b b b*, and pressing the forward end of the stone against the edge of the scraper. By revolving the winch-handle, the stone is slowly dragged under this stationary edge, which applies its pressure progressively through the leather of the tympan, to a narrow strip of the work, the result being equivalent to a very much greater crushing force applied over a larger surface. When the whole of the design has passed under the scraper, the lever *e* at the side is restored to its upright position, the carriage falls upon the rollers *b b b*, it is brought back by hand, the tympan lifted, and the printed sheet removed.

This, with unimportant modifications, is the form given to the lithographic hand-press in England and America. In Germany, Belgium, and France, presses of this construction are rarely seen. In Prussia, for instance, a press is used, occupying nearly double the space, but admirably constructed and well adapted for the execution of first-class work. In this machine, the scraper and its holder swing from the side across the carriage, the holder or *head* is then locked, and the pressure applied by a compound lever with the foot. The carriage is then drawn through by a broad girth or belt, one end of which is made fast to it and the other wound about an axle of small diameter at the extreme end of the frame, rotated by a *star* similar to that of a copperplate-press. The result is an exceedingly steady and uniform motion, but the loss of time as compared with the English press is considerable.

In the construction of lithographic power-presses, the scraper principle has been tried without success; power has long been and is still applied to the ordinary hand-presses, to relieve the workmen from the labor of pulling the carriage through; but for all automatic presses driven by steam, a cylinder of large diameter is now employed to apply the pressure. Since 1865, many press-builders in Europe and America have turned their attention actively to this subject, and produced serviceable machines. One of the most satisfactory presses of the kind, though not the earliest, is that now well known as Hoe's Steam Lithographic Machine. It is a stop-cylinder press, or one in which the cylinder comes to rest pending the adjustment of the sheet. The paper is fed to grippers on the cylinder from the inclined table above. The traveling-bed, on which the stone rests, is drawn under the cylinder by a crank and connecting-rod from the end of the frame below, and the cylinder, after being thrown into gear, is rotated at the same time (carrying the sheet with it) by a rack attached to the side of the bed. At the end of the stroke the cylinder goes out of gear, and remains stationary and locked during the return of the bed and stone; the latter passing under a cut-away part of the cylinder, so as not to come in contact with it. In place of a tympan, the cylinder is covered with a thin rubber blanket. The inking of the stone is effected by parallel rollers (from three to six) in front of the cylinder, upon which are heavy riding rollers of iron; the latter being made to vibrate laterally to aid the distribution of the ink. These inking-rollers are covered with leather, like the ordinary hand-rollers for lithographic printing; they receive their ink from a table which travels with the bed, and are driven by a rack or friction-pieces on the sides of the bed. The ink is fed to said table from a fountain at the end of the press, and distributed by a number of oblique-lying rollers, also covered with leather.

Fig. 2977.



Lithographic Printing-Machine.

The automatic damping arrangement is at the back of the cylinder. It consists of a shallow trough containing water, partially immersed in which a cylinder of wood is made slowly to revolve. An absorbent roller is held in contact with the wet surface of this cylinder for a longer or shorter time, according to the amount of water required upon the stone, after which it carries its increase of moisture over to a heavy riding-roller, which again gives it up to two damping-rollers covered with linen, which traverse the stone as it passes beneath them, just before it meets the inking-rollers at the other side of the cylinder; the feed of water admits of adjustment as to quantity, while the press is in motion.

The pressure in this press is adjusted by means of butting-screws, which lift or lower the bed in the traveling-carriage; these screws are turned by a key from above.

When the sheet is printed it is conveyed by an intermediate cylinder provided with grippers to the fly at the end of the press, and there deposited, face up, on the pile of printed work.

This press, though by no means identical with European machines of the same class, may be regarded as furnishing an illustration of the essential features of them all.

The introduction of the lithographic power-press has totally remodeled the lithographic trade throughout the world within the short period of four years (from 1868–72), increasing the possible production about tenfold. It has lowered the cost of, and, in fact, rendered possible, large editions from stone, which, in former times, found their way to the type-press with very inferior results. By this change the general public have profited largely.

Lith′o-graph′ic Roll′er. (*Lithography.*) Made of a stock of wood or metal, covered with a fold or two of woolen cloth, over which a *skin* of leather is drawn. The leather is of fine quality and shaved to an even thickness. The seam is made by turning the leather edge to edge and sewing it with silk, it being afterwards turned inside out. The *grain* or *hair* side of the leather is generally used for color-rollers, for the reason that it can be washed with turpentine, and for no other reason. Where a roller is kept for each individual color, as at Prang's chromo establishment, the flesh side is used for this as well as for black printing.

Hand-rollers are from 11 to 14 inches in length and 3½ inches in diameter. They have timber stocks for lightness, and the handles at the end are laid hold of by loose leather sleeves, in which the handles turn, and by compressing which, the printer, without blistering his hands, can produce a variety of effects. By a slow motion, with considerable pressure, the roller drags over the stone, depositing ink; by a quick motion and light pressure the tendency is to lift ink. In like manner the roller of close-grained leather deposits ink, while the tendency of a coarser grain of leather is to lift it. These considerations are of the greatest importance in developing the resources of the art of printing, for in this case it is an art.

Machine-rollers have a metallic stock, but in other respects are made as the hand-rollers. The expense of making them is much increased by the great length, which is sometimes as much as 50 inches. The improved method is now to drive them by friction disks running with the bed, whereby the speed of the rollers is rendered equal to that of the surface of the stone, preventing wiping action.

The capacity of a lithographic-printing roller depends upon the relative adhesion of the ink to the leather surface of the roller, and to the inked surface of the stone.

Lith′o-graph′ic Stone. A sedimentary limestone from the upper beds of the Jurassic formation. Lithographic stones of various sizes and weights are now articles of commerce all over the world. They are obtained almost solely from the extensive quarries of Solenhofen, in Bavaria. France furnishes a very hard and dark blue stone, which is but little used. In Canada stone of good quality is said to exist, as also in Missouri; but little is known of either. The Bavarian stone occurs in nearly horizontal layers. When these are of suitable quality and thickness (from two to five inches), they are squared and trimmed for exportation, the slabs varying in size from 6 × 8 to 40 × 60 inches. Two qualities are recognized: the yellow, and the blue or gray (though the difference in color is not much). The latter are harder and more generally serviceable, and cost ten to fifteen per cent more than the yellow.

Lithographic stone is a very homogeneous substance, free from sand or grit, and possessed also of strength sufficient to stand the wear and tear of the press. Besides carbonate of lime, it contains small quantities of magnesia and alumina, and traces of silica and iron. Its serviceableness for lithographic purposes depends chiefly upon its chemical constitution, in which respect it may be regarded as carbonate of lime only.

In this country, lithographic stones are sold by the pound, and the ratio increases rapidly with the size, varying from five to twenty-five cents. Zinc plates are used successfully as a substitute for stone, but they are by no means so generally useful. See LITHOGRAPHY and ZINCOGRAPHY. See also list of processes under FINE ARTS; ENGRAVING; 'GRAPH.

Lith'o-graph'ic Var'nish. An oily varnish used for the manufacture of lithographic ink, and by printers for thinning the same. It is made by heating linseed-oil very strongly in a suitable pan, and finally setting fire to it. When sufficiently changed in its nature, and sufficiently concentrated, the flame is extinguished by a cover, and the varnish let cool. The changes which take place during this treatment of the oil are not well understood. All the older recipes insist on the introduction of several slices of stale bread, and some peeled onions, into the oil when it gets hot. Their effect has been variously stated; but, beyond a great commotion and consequent exposure of the surface to the air, their beneficial action is more than problematical. When the oil has become hot enough to take fire, it is let burn under proper control, by which treatment a considerable diminution of its bulk is caused and an increase of its viscidity. The longer it burns the stiffer and more sticky it becomes, drawing out into threads between the finger and thumb. In this respect, there are three or four grades known to the trade, as Nos. 1, 2, 3, 4.

Lithographic varnish is not to be confounded with *boiled linseed-oil*, in the preparation of which oxide of lead is used. It retains enough of the greasy character to impart to the ink the qualities requisite for lithographic printing, but not enough to smear the stone or grease the printing-paper. It may tend to elucidate the changes which fatty bodies undergo when strongly heated and burned, if it is remembered that previous to combustion the oxygen of the air comes in contact with the hot surface; but that after the fused contents of a pan are covered with a flame, there can be no more oxidizing action, only a species of concentration or elimination of the more volatile constituents. See LITHOGRAPHY and LITHOGRAPHIC INK.

Li-thog'ra-phy. The process of engraving or drawing on stone, in such a way as to produce a surface from which printed copies can be multiplied in the press.

This great art, now an all-important industry throughout the world, has come into existence and attained its wonderful development within the present century. Until the discovery of lithography by Alois Senefelder, only two methods of printing were known and practiced: that from engraved metallic plates, and that from raised type or wooden blocks. Both of these were essentially mechanical in their nature, mechanical means were used to produce the engraved surfaces, and in printing, the simple adhesiveness of the ink was the one essential condition.

Senefelder discovered and developed to perfection a totally new method, in which the chemical constitution of the materials employed plays a vital part. The history of this invention, which occupied him three or four years, viz. from 1796 to about 1800, is interesting and instructive, but too lengthy for our space. It will be found fully given in his own work upon this subject, which has been translated into English.

The invention was the result of earnest, persistent, and highly intelligent work, tending towards a distinct object which Senefelder kept all the time before his mind, namely, the discovery of a new printing process which would adapt itself to his wants as an author. Much has been said by writers anxious to glorify the mere circumstance at the cost of the mind which grasps and utilizes it, of an accident which helped this great inventor on his way; but it will be found to have had no direct bearing on lithography, which was not invented until three years later, and that the credit of possessing creative genius of the highest order is Senefelder's indisputable right.

Almost the only stone suitable for lithographic work is a compact, sedimentary limestone of a yellowish or bluish-gray color, which comes from the now celebrated Solenhofen quarries in Bavaria. Such stratified slabs of stone as separate naturally into layers of from two to five inches in thickness are fit for lithographic use. They are trimmed on the edges so as to give them a rectangular form, are ground by moving one upon another, with sand and water between, and finally polished with pumice-stone. See LITHOGRAPHIC STONE.

Upon such a surface the artist produces the design to be printed from. This is done by one of four distinct methods: —

1. He draws it with a fluid, watery ink.
2. With a solid crayon.
3. He obtains it by transfer from an inky design produced on paper by various means.
4. He engraves it on a prepared stone.

1. In the first case, the lithographer uses an *ink* which, though it contains other substances, may be regarded as consisting essentially of a soluble soap (stearate or oleate of soda or potash) colored with lampblack sufficient to render it visible upon the gray surface of the stone. (See LITHOGRAPHIC INK.) The design is drawn with a watery solution of such an ink, using a pen or fine hair-pencil, exactly as it is required to appear when printed, and left to dry upon the clean stone. Such a drawing cannot be printed from until subjected to an *etching* process, the object of which is not to elevate or depress the work, but to act upon it chemically. The application of an exceedingly weak acid (nitric or hydrochloric) over the whole surface does not wash away or blur the image as water would; it decomposes the soap contained in the ink, combining with its alkali, and sets free, in intimate contact with the particles of carbonate of lime, of which the stone consists, the insoluble fatty acids contained in the soap. As far as the design is concerned, it is now fit for printing; that is, it would take printing-ink from the roller, but the other parts of the stone would not remain clean. To enable them to do so, the whole surface is flooded over with a solution of gum-arabic in water, the action of which is to incapacitate the clean places for receiving grease of any kind while wet. After a few minutes the excess of gum is washed away, the stone is dried, and placed in the hands of the printer. In appearance no change has taken place; the acid, although it necessarily dissolves part of the stone, does so to an imperceptible extent.

It should be remarked here, that at the present day the practice of applying the dilute acid and gum at the same time is almost invariably followed. The results, in both cases, are identical, but the older method is described above, as better calculated to segregate the changes which take place.

The operation of printing may now be proceeded with. For this purpose the workman places the stone in the press, and adjusts the pressure. He then carefully washes off, with a sponge and abundance of clean water, any excess of gum, and while still wet he *washes out* the remains of the drawing with turpentine, in which it is soluble, using a piece of rag to rub the surface with. This procedure would smear the whole stone and utterly ruin the work, were it not for the protective action of the gum. When wiped clean, the surface at first glance appears to be perfectly blank ; but a closer inspection shows the work as a *white* design, *in* the face of the stone.

The printer now passes the roller, charged with printing-ink, to and fro over the stone, which is still damp. The white image instantly takes the greasy ink, and holds it with a strong affinity. (See LITHOGRAPHIC INK.) The film first held by its adhesion accumulates more from the roller, and so on till the workman thinks the design is sufficiently *rolled up*. During this operation the rest of the stone has been kept damp ; it will be found to have taken no ink from the roller. A sheet of printing-paper is next laid down upon it, the tympan is closed, and the stone *pulled through*. When again released, and the sheet lifted, the ink will be found to have divided itself between the stone and the paper. In this way lithographic impressions are *pulled ;* the operations of *damping, rolling in,* and *printing* following each other in constant succession. Should the stone get dry, its surface will immediately take ink indiscriminately ; but will part with it on being damped again, if the rolling be continued, without injury to the work. Only after *washing out* with turpentine does the *true white lithographic picture in* the stone become visible, its affinity for the black printing-ink causing it to remain covered all the time.

Such are the facts, without theory, upon which Senefelder's invention is based, and such the phenomena with which every good lithographer ought to be familiar. They repeat themselves, in modified form, in the other three methods, which it will not be necessary to describe at such length. The probable scientific explanation — though it involves the assumption of chemical reactions which many would dispute, and which are by no means demonstrated — is, that it is not simply a greasing of the particles of limestone which enables them to take ink and resist water while thousands of impressions are printing ; but the formation of an actual chemical compound, more or less definite in its constitution. In fact, there are many reasons for believing that at the moment when the mineral acid sets the fatty and resinous acids free, they combine with the lime, displacing the carbonic acid, and forming insoluble lime soaps. In like manner it must also be assumed that the gum enters into a more or less perfect union with the substance of the stone, depositing at least an insoluble coating on the particles, which no amount of washing, or even continuous rubbing, can remove ; and through which, though infinitely thin, no fatty matter can penetrate. Whatever the nature of this union may be, it is quite as essential to the successful prosecution of lithographic printing, as that produced by the fatty and resinous constituents of the ink, although the vital importance of the function performed by the gum has been almost universally ignored by the few persons who have written on the subject of lithography. It is also highly probable that the change which the gum effects is facilitated and perfected by the slight solvent action of the weak mineral acid on the stone, in consequence of which its surface is rendered chemically clean.

It will be readily understood that want of space, and the chemical character of the subject, make it inexpedient to do more than simply sketch out the above theory, without advancing arguments in its favor.

2. In the second method which the lithographic artist employs to produce his design, he avails himself of the lithographic *crayon* on a *grained* stone, — a stone the surface of which is evenly roughened by grinding it in a peculiar manner with very sharp and even sand. The crayon is composed of soap, wax, tallow, and sometimes resinous substances with lamp-black, and it is used on stone as an ordinary chalk is on rough paper. In the hands of an experienced and capable artist, this modification of the lithographic art offers many advantages ; great freedom in execution with delicacy in the lighter shades, as well as vigor, depth, and transparency in the shadows. To accomplish these results, genuine artistic capacity is of more importance than technical training ; lithography differing essentially in this respect from the arts of copperplate and wood engraving. The drawing being finished exactly as it is to appear on paper when printed, the stone is acidulated or etched in the manner above explained as applicable to ink employed in the liquid state, and the result is the formation of the same white lithographic picture, capable of taking printing-ink. The effect of the grain of the stone, in giving character to this method, does not require lengthy explanation. It prevents the continuity of the stroke, the particles of chalk closing in round the asperities, and producing deeper tones in proportion as the artist leans more heavily, but rarely or never bridging them over so as to produce perfect blackness, with opacity as a consequence.

A modification of crayon-drawing is the production of *rubbed tints* on stone, chiefly for chromo-lithographic work. The material used as crayon for this purpose is not cast into cylindrical sticks, but applied in larger masses. It is rubbed upon the grained surface pretty freely, and then rubbed off or distributed in accordance with the lights and shades of the design, a small piece of woolen cloth or a *stump* being used for this purpose ; afterwards the stone is strongly etched. For soft, undulating surfaces rubbed tints are unsurpassed, and their use does not hinder that of crayon for portions of the work requiring more force and detail than can be readily given by *rubbing*. See LITHOGRAPHIC CRAYON.

3. The third lithographic method is by *transfer*. Of this there are several varieties, but they all resemble each other in the fact that the work is not drawn or engraved upon the stone direct, but is placed there in a completed condition from some source furnishing it, and that paper is invariably used at the medium, by the intervention of which it is carried over.

Autographic transferring, in this country, is almost solely confined to the reproduction of manuscript matter for business purposes. The writing is often done on ordinary, well-sized writing-paper ; but better on paper prepared with a thin coating of gelatine, flour-paste, or starch, which may be colored by gamboge. Such a sheet, after being written on, is damped (sometimes with an exceedingly weak acid) and then laid face downward on a clean stone in the press, and *pulled through*. If the paper was well prepared, it will adhere to the stone. It is then damped on the back, and pressure again applied. When, at last, the sheet is carefully lifted, the ink will be left behind in contact with the stone. It is then etched with acidulated gum-water in the usual way, and then printed.

All transferring is done in this manner, save that the ink differs according to the nature of the work.

Autographic transfers, of a very superior character, are quite common in Great Britain. Much of the map-work, ornamental designs, and lettering is done on transfer-paper by persons who make this branch of the art a specialty.

Transferring from stone to stone constitutes at the present day one of the most important and difficult of the processes practiced by the lithographer, and every large establishment has two or three, or more, men who do nothing else.

When a design has been engraved or drawn upon stone — often at considerable expense — it is almost the rule in this country not to print from it direct. It is found safer, quicker, and more economical to preserve the original stone carefully, making as many transfers for the press as the size of the work and that of the edition will warrant. In this way small work, such as labels, show-cards, etc., can be multiplied upon a stone, and the expense of printing proportionately reduced, with a facility which often gives lithography the advantage over typography, even in cost. Very valuable original stones also are saved from the wear and tear of the press, and from accidents; and the artist's work, in place of furnishing but two or three thousand impressions, may yield indirectly many times that number. It is true a transfer is not always equal to the original in quality, but the difference is very slight, and such work is for many purposes quite satisfactory.

Impressions for transfer from stone to stone are pulled or printed very carefully on India proof-paper with a starched surface; but an ink differing from printing-ink is used, the constitution of which makes it very effective when transferred to the clean stone. See LITHOGRAPHIC INK.

Transfers from engraved stones and plates are pulled in the same way as ordinary impressions from such are printed (an operation to be presently described), but with stiff transfer-ink.

Photo-lithographic transfers will be found described under PHOTO-LITHOGRAPHY.

4. Engraving on stone — the fourth subdivision of the art — is essentially different from the preceding methods of producing a printing-surface. It is very largely practiced, however, especially in the United States, and is of much importance.

For this purpose, after a stone of suitable size is polished, its whole surface is etched or prepared with gum-water and an exceedingly dilute acid, and its face is then colored black with a trace of lampblack, or red with a little powdered red chalk, and let dry. The coloration is simply to enable the engraver to see his work as it progresses. Upon this surface the design is now engraved, or rather scratched; sharp-pointed steel needles and the diamond being almost the only tools used. When the design is finished, oil is poured over the whole, and some time is allowed for its absorption by the stone where the needle has laid it bare. The coloring matter, and any excess of gum upon the surface, is next washed off, and ink is rubbed into the lines with a *tampon* or pad, made of some folds of woolen cloth fastened to the face of a small piece of flat wood. As the treatment with gum protects the rest of the stone, it will remain clean as long as damp. If an impression be now pulled, the sheet will lift the ink out of the lines, which are very shallow, as in copperplate printing. From the foregoing it will be seen that printing from an engraved stone is an interesting and complex operation. The ink is held not only by the peculiar nature of the lithographic picture, which forms the bottom of the lines, but also mechanically by reason of their depression and depth; and the rest of the surface is clean, not because it is wiped off mechanically as in copperplate printing, but because it is damp and does not take ink. Lithographic engraving, however, differs considerably from engraving on copper or steel. As it is done in a friable substance with the needle, the boundaries of the lines never attain the smoothness and clearness which are given by the graver, though the approximation is much closer than would be supposed possible, the dexterous use of the diamond giving wonderful perfection in this respect. The ponderousness of the stones, and the *drawing* character of the method, take also from the freedom and sweep which the experienced copperplate engraver imparts so readily to his work; lastly, the depth of the line cannot be proportioned to its width, as is the case on steel or copper. At the present day very little printing is done from engraved stones, — almost none in this country, — but they are constantly used, nevertheless, in consequence of the great facility with which transfers of the finest and most delicate designs can be made from them, and from them only.

Printing from engraved work is slow, and therefore costly, but after transfer it is done with the roller and without unusual expense. In this way it is possible to supply work (so fine that it can only be produced with the needle and diamond) at a very moderate cost.

A most striking elaboration of this system is to be found in the commercial lithography of the United States, especially bonds, checks, certificates of stocks, etc., which, in redundancy of ornament (excellent as to quality), are not equalled by that of any other country. The vignettes, borders, etc., for such documents are all transferred from separate engraved stones, which are retained on hand in great variety as an important part of the lithographer's stock in trade, and from them any particular design can be compiled or built up and transferred to a smooth stone.

Analogous to lithographic engraving is the process of etching on stone, so as to produce a similar result. This is sometimes used very successfully on ruled shades and tints. For this purpose, the stone is protected by a shellac ground, which is cut through by the steel-point or diamond, generally the latter. A wall of wax is then raised round the edge of the stone, and dilute nitric or hydrochloric acid poured on. When bitten deep enough, the lines are filled with thick lithographic writing-ink, and let dry. The ground is then removed and the surface etched strongly with acid and gum. This modification is generally used in combination with engraving to produce certain effects.

In addition to the foregoing four great subdivisions of the lithographic art, various expedients are used to produce certain results which hardly deserve mention here. One exception, perhaps, is to be found in a method, very commonly followed, of obtaining graduated tints for color-printing. For this purpose, a solution of asphalt and crayon in turpentine is applied to a grain stone, let dry, and then scraped more or less with a scraper or knife, according to the tint required. The stone is then etched, washed out, and printed. This method is now superseded in many establishments by the rubbed tint already described.

Chromo-lithography is doubtless the highest development of the lithographic art. For it all the foregoing methods are put in requisition, but it does not itself constitute an essentially distinct method in a technical sense. In the imitation and reproduction of oil and water-color paintings, much knowledge and experience not possessed by the ordinary lithographer are required; still the novel and difficult part of the art of making first-class chromos lies in the appreciation and selection of colors, their judicious superimposing and blending, and above all things in a cultivated estimation of the true value of a picture and of pictorial effects generally. See CHROMO-LITHOGRAPH.

Senefelder died in 1834. Every phase of the lithographic art described in the preceding sketch was indicated, originated, or practiced by him. Even chromo-lithography was suggested and anticipated by him. The development and perfection of the present day, in every branch of his great invention, would gratify and astonish him infinitely; he would gaze in amazement at the lithographic power-press, printing thousands of sheets daily; and his philanthropic mind would be lost in admiration at the sight of a chromo, which he would confound with the original painting, and which his art has placed within the reach of every one. All this he would readily comprehend; *photo*-lithography alone would be to him a mystery and a revelation. — *Contributed to this work by Mr. J. W. Osborne.*

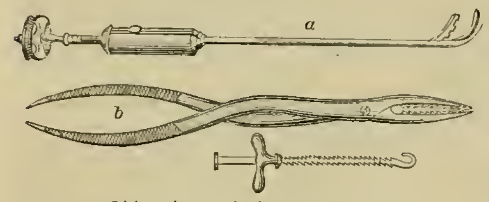
Lith′o-labe. (*Surgical.*) An instrument for grasping a stone in the bladder, and holding it while it is being acted upon by a lithotritic instrument. The *lithoprione* is a form of litholabe.

Lith′o-lyte. (*Surgical.*) A form of catheter for conveying solvents of calculi into the bladder.

Lith′on-trip tor. An instrument for crushing the stone in the bladder into minute fragments, that they may pass out with the urine.

The instrument *a* is made of two halves, one sliding within the other, and is of the size and shape of an ordinary catheter when closed. It is introduced into the bladder by the urethra; then, by means of a screw or rack and pinion worked on the outer extremity, the movable part is made to slide back within the bladder, now forming two jaws by which the stone is seized; by turning the screw or handle, the blade is propelled onward again by short jerks, thus breaking the stone into fragments so minute that they may pass the urethra.

Fig. 2978.



Lithontriptor and Lithotomy-Forceps.

This is followed by the use of the lithotriptic instrument, the *evacuating catheter* or *double-current catheter*, which is a catheter of moderate size, having a wall along its center, dividing it into two canals. By means of the upper one the bladder is filled with tepid water, which finds its exit through the lower one, carrying with it all particles of stone remaining after the operation of lithotrity.

The temple of Serapis in Alexandria was used as a hospital in the time of the Ptolemies, and here were performed operations in lithotomy, crushing the stone, reducing dislocations, etc.

Ammenius of Alexandria, the first century B. C., proposed and performed the operation of lithotrity, or breaking a calculus in the bladder, when too large for extraction by lithotomy. The Romans seem to have been much subject to the stone in the bladder.

The lithotritor of Celsus (first century A. D.) was a hook inserted behind the stone while it was cleft by the end of a blunt instrument, struck by a hammer. This instrument was similar to some of the modern.

Lith′o-pho-tog′ra-phy. A process by which a photographic picture is developed on stone, so as to admit of impressions being taken therefrom. See PHOTO-LITHOGRAPHY.

Li-thor′i-neur. An instrument invented by Meirieu and Tanchou for filing down a calculus in the bladder.

Lith′o-tint. A process of drawing upon stone, in which the ink is applied to the stone by a camel's-hair pencil.

Lith′o-tome. (*Surgical.*) A bistoury or scalpel for making the incision in lithotomy. This knife is of various sizes and shapes, blunt, probe, or sharp pointed. It is inserted through the groove of the lithotomy-*staff*, through a small opening previously made in the urethra, and carried along into the bladder, making an opening just large enough to allow the extraction of the stone by means of the forceps. The *gorget*, *bisector*, and *bistouri caché* are varieties of *lithotomes*. Hippocrates, d. 357 B. C., treats of the operation of lithotomy, which seems in his time to have been practiced as a specialty by certain chirurgeons. Five methods of operating are enumerated by Dunglison, in some cases requiring special instruments. As it is the neck or body of the bladder that is cut, the instrument might more properly be called a *cystotome*.

Li-thot′o-mé-cache. (*Surgical.*) An instrument used in lithotomy. It is introduced with blades concealed in a sheath, from which they are protruded, by pressing upon a lever, on reaching the place of operation. The incision is made by withdrawing the instrument. It is made single or double bladed. Called also a *bistouri-caché*.

This instrument is specifically recommended by Sabatier, 1797, in an article read before the National Institute of France, October 6, 1797.

Li-thot′o-my-bi-sect′or. (*Surgical.*) An instrument for making the bilateral incisions in lithotomy.

Li-thot′o-my-for′ceps. An instrument (*b*, Fig. 2978) for extracting stone from the bladder through the opening previously made by lithotomy. Its blades are concave, with rasp teeth cut in to take a firm hold on the stone, the outer surface well rounded to admit of easy introduction, with crossed shanks so that the blades may be fully opened within the bladder without expanding the wound.

Li-thot′o-my-gor′get. (*Surgical.*) A lithotome with one or two concealed blades which are exposed by pressure when required.

Li-thot′o-my-scoop. (*Surgical.*) A small, spoon-like instrument for removing calculi or fragments of stone from the bladder, after the operation of lithotomy or lithontripsy.

Li-thot′o-my-search′er. (*Surgical.*) See LITHOTOMY-SOUND.

Li-thot′o-my-sound. (*Surgical.*) A steel, catheter-shaped instrument introduced into the bladder by the urethra. It indicates the presence of stone by a peculiar click when it comes in contact with it.

Li-thot′o-my-staff. (*Surgical.*) An instrument curved like a catheter and with a deep groove on the convex side of its curved portion, introduced into the bladder by the urethra, for the purpose of guiding the cutting-instrument in lithotomy.

Lith'o-trip tor. See LITHONTRIPTOR.

Lith'o-tri ter. See LITHONTRIPTOR.

Lith'o-type. 1. A stereotype in which the surface is composed of gum-shellac, fine sand, and a little tar and linseed-oil.

2. A name signifying printing from stone. The lithographic design on the stone is deeply etched, giving a sufficient relief for the type-press.

Lit'mus. A coloring matter produced from the lichen *Rocella tinctoria*.

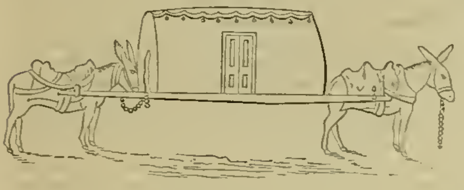
Li-tram'e-ter. An instrument for ascertaining the specific gravity of liquids, invented by Dr. Hare of Philadelphia.

It is founded upon the principle that, when columns of different liquids are elevated by the same pressure, their hights must be inversely as their gravities. It consists of two tubes, their lower ends open and submerged in two liquids whose specific gravity is to be compared, say one vessel of water and the other of an oil or spirit. The tubes connect above with a horizontal pipe, from which the air is exhausted by an air-pump. Atmospheric pressure causes the liquids to rise in the tubes to a hight according to their gravity.

Lit'ter. A *stretcher* with a bed, and in many cases a canopy; used, not as the stretcher ordinarily is, in emergency and haste, but provided for the use of the civil sick, during necessary transportation home or hospital-ward.

Another form of litter is adapted to be carried by two animals. This approaches or reaches the palanquin, and there is probably no absolute dividing-line between the two.

Fig. 2979.



Litter.

The litter (*lectica*) on which the body of Augustus was carried to the grave was made of ivory and gold, and covered with costly purple drapery worked with gold.

Stretchers were used in the Roman army to carry wounded officers.

The Asiatic litter was introduced into Greece, having four posts, canopy, and curtains. They were carried by four bearers, and used in traveling. When standing, it rested on four feet. The *lectica* of the Empire was closed with panels of *lapis specularis*, — talc. The poles were removable. It was a palanquin, carried on the shoulders of the bearers.

Companies were formed, and lecticæ were placed in public places for hire.

The lectica was adapted for a person lying down; the *sella*, or sedan-chair, for the sitting posture.

Lit'tress. A smooth kind of cartridge-paper, used in the manufacture of cards.

Live-ax'le. One communicating power; in contradistinction to a *dead* or *blind axle*.

Live-box. A cell in which living microscopic objects are confined for observation. It has a tubular piece with a glass top, upon which slips an upper ring having also a glass top. The object is confined between the glasses.

Live-gang. (*Saw.*) A gang-saw mill, so arranged as to cut through and through the logs without previous slabbing. The bark and wany edge are afterward removed from each board by a *double edger*. The lumber goes to market of the full width.

Live-head. (*Lathe.*) The *head-stock* of a lathe, which contains the *live-spindle*; in contradistinction to the *dead-head* or *tail-stock*, which contains the *dead-spindle*.

Live-mat'ter. (*Printing.*) Type in page or column ready for printing.

Liv'er of An'ti-mo-ny. A sulphuret of antimony and potassa.

Liv'er of Sul'phur. Fused sulphuret of potassa.

Live-spin'dle. (*Lathe.*) The rotating effective spindle in the *head-stock* of a lathe; in contradistinction to the *dead-spindle* in the *dead-head* or *tail-stock*.

Live-steam. (*Steam-engine.*) 1. Steam from the boiler at its full pressure; in contradistinction to *dead*-steam.

2. Steam from the boiler; in contradistinction to *exhaust-steam*.

Live-trap. A device for imprisoning living microscopic objects. It consists of three parallel glass slips; the middle one has a circular perforation forming the cell, while the other one constitutes the sides.

Lix-iv'i-al Salt. One obtained by leaching.

Lix-iv-i-a'tion. The process of separating a soluble from an insoluble material by a washing or filtering action. *Leaching*.

Lixiviation removes a soluble material, which is the valuable portion, as in discharging a certain amount of syrup from a bone-black filter, by passing water therethrough. The *leaching* of ashes is a familiar instance of lixiviation.

Elutriation is the separation of more soluble and comparatively useless portions from one less soluble, by allowing the latter to settle and decanting the supernatant liquor, as in the case of removing the saccharine and coloring matter from starch in the starch manufacture.

Liz'ard. 1. (*Nautical.*) *a.* A piece of rope having one or more legs with thimbles acting as *fair-leaders* or for other purposes.

b. The *top-gallant lizard* is a rope with one end hitched to a hole in the *royal-pole* and the other spliced round a thimble on the hauling part of the mast-rope. It keeps the mast from turning over when its head comes below the topmast crosstrees.

2. A crotch of timber or a forked limb, used as a sled to support a stone being hauled off a field. A *stone-boat*.

Li-ziere'. (*Fortification.*) A *berme*. A small coping or space between the foot of the parapet and the scarp.

Load. The amount of work done by an engine working up to its capacity. Not to be confounded with *duty*.

Load'er. A machine attached to a wagon, as a *hay-loader* or *stone-loader*. In the former case, it is an endless traveling apron on a truck, trailing behind the wagon and carrying up the hay collected by a rake. See HAY-LOADER.

Load'ing-fun'nel. One for charging mortars with loose powder.

Load'ing-ham'mer. One for loading rifles.

Load'stone. A natural magnet. An ore of iron; the protoxide and peroxide of iron in combination. See MAGNET.

Load Wa'ter-line. (*Nautical.*) The line of flotation of a ship when she has her full cargo on board.

Loaf. 1. The conical mass of molded sugar.

2. A shaped mass of light bread in the dough state, or baked.

Loam. (*Founding.*) A mixture which essentially consists of sand and clay, the former largely predominating, with a certain quantity of horse-dung added, or some equivalent for the same, such as chopped straw, sawdust, cow-hair, etc. Beds of loam are sometimes found of nearly suitable composition, but it is more commonly made up by blending different sorts of sand, clay, etc., in a mill resembling a pug-mill. In molding, it is always used quite wet, like plaster, but is dried perfectly before pouring. Its characteristics must be plasticity while wet, strength and solidity when dry, perviousness to the *air* from the mold, and the power to resist the high temperature of the metal. It is employed for large work in both brass and iron, obviating the use of a pattern, as already explained. See MOLD.

Loam-beat′er. (*Founding.*) The rammer of a molder, used in compacting the loam around the pattern.

Loam-board. (*Founding.*) Cores which are struck up upon a spindle or barrel are supplied with loam from a board placed across the trestles on which the barrel revolves, which is hence called a *loam-board.* This is cut to the shape of the core. It is also used after the latter is dry, as a rest on which to place the tool (a very broad chisel with a short handle at each end) used to turn it down to the exact size and shape, before black-washing.

Loam-cake. A disk of loam which covers in the mold in *loam-work* casting, and which is perforated with holes for the entry of the metal and the escape of the air.

Loam-mold′ing. Making a mold by templets. See MOLDING.

Loam-plate. (*Founding.*) One of the flat cast-iron rings or plates used in loam-molding, upon which the nowel or the cope rests, as the case may be.

Loam-work. A method of making molds for large hollow castings, such as cisterns, tanks, steam-engine cylinders, and kettles of large size, etc.

Instead of making a pattern of the object, the *nowel* and *cope* are built up of bricks and covered with loam, which is shaped by a templet. The parts are afterward brought into the required juxtaposition in a pit, surrounded by packed sand, and then the metal is run in.

Lob′bing. (*Metallurgy.*) Breaking blocks of ore into pieces with the hammer, for assortment as to quality with such ores as copper, and for more effectual treatment in the preparatory roasting or calcining processes. Otherwise called *cobbing.*

Lobe-plate. A strong piece of cast-iron laid upon the keelson, etc., to support the parts of a marine steam-engine. A *sole-plate.* A *foundation-plate.*

Lo′cal. (*Telegraphy.*) The battery of a *local circuit.* The latter is one which includes only the apparatus in an office, and is closed by a relay.

Loch′a-ber-axe. The battle-axe of the Highlanders.

Lock. (Anglo-Saxon, *loc,* an inclosure or fastening.) 1. A device having a bolt moved by a key, and serving to secure a door, lid, or other object.

The ancients, though possessing many valuable arts and great skill, do not seem to have been successful in locks. Those of the Egyptians, Greeks, and Romans were clumsy contrivances. Denon has an engraving of an Egyptian lock of wood, which is similar to the one shown at *A,* Fig. 2980.

The locks used to the present day in Syria are much like those used over 2,000 years ago in Palestine and in Egypt. Thompson mentions that the steward of the Carmelite Convent, on Mt. Carmel, opened his magazine with a key as large as a club; reminding him of the passage, "And the key of the house of David will I lay upon his shoulder." — Isaiah xxii. 22.

The strongholds of the castles of Syria yet have enormous locks and keys. They are placed on the inside of the doors, and have a number of metallic wards which are adjusted by the pins on the key. A hole is cut through the door, and the hand and arm thrust through to insert the key. "My beloved put in his hand by the hole of the door, and my bowels were moved for him." (Canticles v. 4.) That is the way "the beloved" let himself into the chamber.

In the Book of Judges, chapter iii. verses 23 – 25, it is stated that Ehud, going forth, locked the doors, and his servants took a key and opened them. This was 1336 B. C., and is the first mention of a key which could be taken out of the lock.

A, Fig. 2980, shows one of these Oriental locks. The following is the description given in Eton's "Survey of the Turkish Empire," published towards the close of the last century. It will answer as well for the present time: —

"The key goes into the back part of the bolt, and is composed of a square stick with five or six iron or wooden pins, about half an inch long, towards the end of it, placed at irregular distances, and answering to holes in the upper part of the bolt, which is pierced with a square hole to receive the key. The key, being put in as far as it will go, is then lifted up; and the pins, entering the corresponding holes, raise other pins which had dropped into these holes from the part of the lock immediately above, and which have heads to prevent them falling lower than is necessary. The bolt, being thus freed from the upper pins, is drawn back by means of the key; the key is then lowered, and may be drawn out of the bolt. To lock it again, the bolt is only pushed in, and the upper pins fall into the holes in the bolt by their own weight."

Locks of this kind are supposed to have been exchanged by the Phœnician navigators with the people of Cornwall for tin, and locks of this pattern, but home-made, still exist in that queer old prong of Britain.

Occasional notices are found among the Greek and Roman writers of the keys of their times; as when Aratus compares the constellation of Cassiopeia to a Roman key, "having a curved stem" and a handle "shaped like the south stars" of the group. Ariston also refers to their "deeply bent" stems, and Eustathius compares them to sickles; and indeed some were so large that they might fairly be carried over the shoulders, as described by Callimachus in his "Hymn to Ceres," where he represents the priestess of Nicippe carrying her key in that manner.

Homer's allusion to the lock on the wardrobe of Penelope is thus rendered by Pope: —

> "A brazen key she held, the handle turned,
> With steel and polished ivory adorned.
> The bolt, obedient to the silken string,
> Forsakes the staple as she pulls the ring;
> The wards, respondent to the key, turn round,
> The bars fly back, the flying valves resound;
> Loud as a bull makes hill and valley ring,
> So roared the lock when it released the spring."

It is said that locks with sliders and tumblers have for centuries been made in China.

Tradition says that locks were made in England in the reign of Alfred, but it was not till the fourteenth century that the craft was recognized as a distinct one. In the reign of Elizabeth, locks with bells or chimes attached were so constructed as to ring an alarm or play a tune when tampered with. The medieval locks were often highly ornamented and artistic pieces of workmanship, constituting quite an important part of the church-door or cabinet to which they were attached. A number yet survive on the cathedrals and churches of Europe, and on the plate and muniment chests of the old families.

The letter-lock is a Dutch invention, but is ascribed, in the "Memorabilia" of Vanhagen von Ense, written about 1650, to Regnier, Director of the Musée d'Artillerie at Paris. Regnier's locks were much esteemed, and the courier's dispatch-boxes were fastened with them. They are, however, alluded to in Beaumont and Fletcher's "The Noble Gentleman," printed in 1615. See LETTER-LOCK, p. 1292. Carew, in some verses written five years later, has this reference: —

> "As doeth a lock that goes
> With letters; for, till every one be known,
> The lock 's as fast as though you had found none."

The letters of the alphabet were engraved on four parallel revolving rings, which by prearrangement on the part of the owner were made to spell a certain word, or number of words, before the lock could be opened.

A French treatise, *L'Art de Serrurier*, published in 1767, contains many examples of the locks of that and former periods. It appears that, though the art had advanced as far as the invention of the single tumbler, yet the main dependence was placed on the complexity of the wards. Multiple bolts, shot simultaneously by a single key, were much in vogue. One lock, figuring in this work as attached to a large coffer or chest, has as many as twelve of these bolts.

The simplest modern form of lock is the common spring-lock, the interior arrangement of which is shown at *B*. In the cut, the bolt is represented half shot. At *a a* are two notches on the under side of the bolt, connected by a curved part; *b* is the back spring, which becomes compressed by the passage of the curve through a limited aperture in the rim *c c* of the lock. When the bolt is wholly withdrawn, one of the notches *a* rests upon the rim *c c*, and the force with which the notch falls into this position, urged by the spring *b*, gives rise to the snapping or clicking noise. When the bolt is wholly shot, the other notch rests in like manner upon the edge of the aperture in the rim.

Wards, or *wheels*, were among the most important improvements in locks, and when sufficiently complicated were considered, especially when the lock was provided with numerous and strong bolts, as affording nearly perfect security.

Wards, shown at *B* and *C*, are pieces of metal having a circular curvature, and are affixed to the interior of the lock. They may be in cross-section of any shape, affording sufficient strength to resist the usual wear and tear occasioned by the motion of the key, which is very slight. They fit into clefts or grooves in the key, which turns around upon them, and prevent the lock from being opened except by its own proper key, or by a key so constructed as to avoid them altogether.

G is a ward-lock key and its keyhole. The various parts are, —

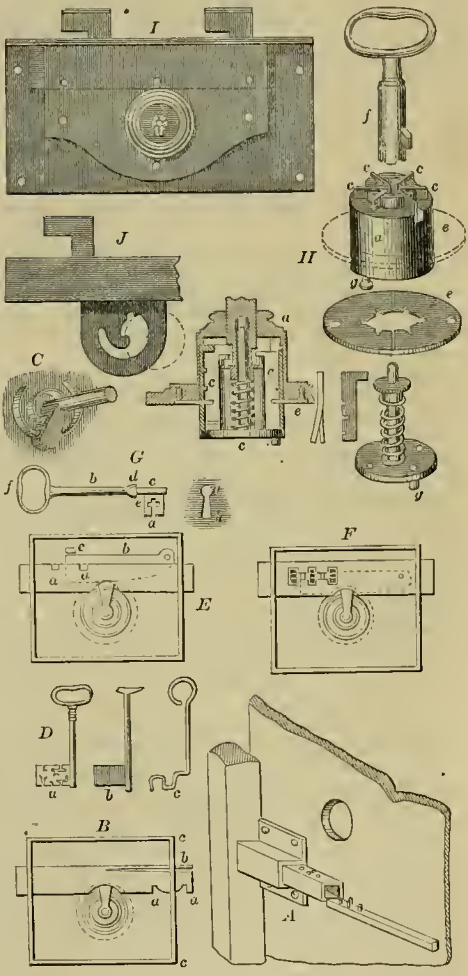
a, the *main*-ward, or *bridge*-ward.
b, *stem*, or *body*.
c, *pin*.
d, *collar*.
e, *bit*, or *web*.
f, *bow*.
g, *eye*.
h, *slot*.

D shows the manner of opening a warded lock by means of a false key. *a* is the true key, the wards of which are somewhat complex. An instrument *b*, covered with wax or soap on one side, is inserted in the keyhole and turned, receiving a perfect impression of the wards. A piece of wire *c* is then bent into such a shape as to avoid contact with these when turned in the lock, withdrawing the bolt with as much facility as the proper key would do.

This is a *skeleton*-key. A *master*-key is similar in principle, being so constructed as to avoid the wards of a set of locks. Such keys are adapted to locks having wards of the same general form.

The period of the invention of tumbler-locks (*E*) is unknown. Some elaborate examples are exhibited in the French treatise before referred to, published in 1767.

Fig. 2980.



Locks.

The *tumbler* is a lever or latch which falls into a notch of the bolt, and prevents it from being shot until the tumbler has been raised or released by the action of the key. A simple form is shown at *E*. The bolt has two square notches *a a* in its upper edge. Behind the bolt is the tumbler *b*, pivoted at one end, and having a projecting stump *c* at the other, which, in either position, locked or unlocked, falls into one of the notches of the bolt. The tumbler must first be lifted by the key, releasing the stump from the notch in the bolt before the key can act on the latter to turn it either way.

Barron's tumbler-lock was patented in 1778. Its principle consisted in an arrangement "to allow a stump on the tumbler to pass through an opening in the bolt, or a stump on the bolt to pass through an opening in the tumbler."

The former arrangement is shown at *F*. This lock has two tumblers of unequal width, each having a stump or stud which, when the lock is in either a locked or unlocked position, rests in one of the notches represented in the bottom of the gating of the bolt. The web of the key has two unequal steps which, when the key is turned in the lock, elevate the tumblers equally and to a sufficient hight to lift the stumps clear of the lower notches in the bolt and bring them exactly on a level with the gating or slot in the bolt, permitting the latter to slide freely; whereas, if an improper key be used, they will be either lifted too high or too low, so that it cannot pass.

The patents granted for locks, both in England and this country, since Barron's time, have been very numerous. Brahmah's, patented in England, 1784, is shown at *H*. It has a central barrel *a*, having grooves in which are a number of sliders *c c*, whose ends rest against the spring. Each of these is notched at a different part of its length, so that they must be unequally depressed before the plate *c* can enter all the notches simultaneously, and allow the barrel *a* to turn so as to actuate the bolt. This is effected by a stud *g* working in the slot on the bolt shown at *J*. The sliders are provided with false notches to increase the difficulty which a burglar would experience in finding the position of the true ones. The key *f* has longitudinal slots corresponding in length to the distance which each slider must be depressed.

I is an exterior view of the lock, and *J* shows the form of the bolt and the manner in which the rotation of the barrel is made effective in throwing the bolt.

The patent of Mitchell and Lawton, 1815, embraced, among other devices, a revolving curtain for closing the keyhole.

A detector which indicated if any of the tumblers had been overlifted was patented by Ruxton in 1816.

In the same year, Kemp devised a lock whose sliders were operated by a set of small concentric tubes in the barrel of the key.

Paper secured over the keyhole to indicate tampering was patented by Gottlieb, 1829.

At the present day, the aid of photography has been called into requisition as a detector.

Two photographs are made from an irregular pattern, one of which is placed over the keyhole, and the other is retained. The American Seal-Lock Company employs sheets of variegated glass, cut into strips, for this purpose. Access to the keyhole can only be obtained by breaking the glass, which of course cannot be replaced. See SEAL-LOCK.

Chubb's lock, 1818, has six or more tumblers turning on a pin common to all. Each of these must be lifted to a different hight before a stud on the bolt can pass through a continuous aperture formed by a slot in each tumbler when all are in their proper position. Should either of the tumblers be overlifted by the introduction of a false key, it is held in that position by a spring, thus indicating that the lock has been tampered with.

In Newell's American lock (exhibited in England in 1851) the bits are interchangeable on the stem of the key, so that an indefinite number of combinations may be formed, each of which so alters the relative position of the tumblers at the moment of locking that they can only be brought into position to allow the bolt to be withdrawn by the same arrangement of the bits. There are three sets of bits, the two nearest the keyhole falling to a common level when the key is withdrawn, while those of the third, which are inaccessible to the "feeling" devices of the burglar, remain at the different hights to which they were lifted by the key through the medium of the other two. See PERMUTATION-LOCK.

It has been proposed to construct locks with clock-work attachments, so that they cannot be opened, even with their proper key, until a regulated interval of time has elapsed. Mr. Rutherford of Jedburg, Scotland, patented a lock of this description in 1831.

A circular stop-plate is placed against the end of the bolt of the lock, and so adjusted that the bolt cannot be withdrawn until a particular notch in the rim of the circular plate is, by means of clock-work, brought opposite the end of the bolt.

Locks having pins or pipe-shafts fitting in the pipe or barrel of a key can only be opened from one side, but those adapted for keys with a solid stem can be opened from either side. In the latter case, only one half the key acts at once.

The variety, both in the form and nomenclature of locks, is very great. Not all of the English trade terms for locks obtain with us. The following is a summary; some of the distinctions are evident, others will be explained: —

A *bolt-lock* is one the bolt of which can only be driven or withdrawn by the action of a key.

A *latch-lock* can be opened by a knob on the inside, but requires the use of a key on the outside.

In-door and *out-door* locks, on the respective sides of a door.

Door-locks are known as *iron-rim*, *brass-case*, or *mortise*, according to the quality or mode of fitting. The *draw-back* has a bolt capable of three positions, *locked*, *latched*, or *open*. The *spring-stock* is a wooden door-lock of inferior quality.

The *dead-lock* or *closet-lock* has a single bolt.

The *two-bolt* has a latch and bolt.

The *three-bolt* has the addition of an interior bolt, not operatable from the outside by any means.

The *knob-lock* and *ring-lock* are so named from the forms of their handles.

The *right-hand* and *left-hand* locks are for door to swing to the right or to the left.

A *dormant-lock* is one having a bolt that will not close of itself.

A *spring-lock* is one whose bolt is protracted by a spring.

A *rim-lock* is named from its shape.

Ward-locks are so called from having *wards* corresponding to clefts in the key, into which they must enter before the key can be turned. They are known as *one-ward*, *two-ward*, etc., according to number; the round wards being sometimes called *wheels*, as *one-wheel*, *two-wheel*. The shape of the ward sometimes gives a name, as L-*ward*, T-*ward*, Z-*ward*. If the ward be cast solid instead of being made of a bent strip, the lock is termed *solid-ward*.

A lock without wards is a *plain-lock*.

Straight-locks have a plate screwed flat against the woodwork; *cut-locks* are inserted into the woodwork, so as to lie flush therewith. *Mortise-locks* are slipped into a mortise cut into the *edge* of the door.

Tumbler-locks have one or more pivoted pieces, called *tumblers*, provided with a lug or dog fitting a notch in the bolt, from which the dog must be released before the bolt can be thrown.

The *letter*, *puzzle*, *permutation*, or *combination* lock has usually a series of notched rings, which must be turned until all the notches are in line in order to enter or withdraw the bolt.

Wheel-locks are those in which one or more wheels form a part of the interior mechanism.

Detector, protector, paranoptic, vibrating-guard, compound-lever, defiance, duplex, detent, holdfast, drill-proof, are among the names given by inventors to various descriptions of patented locks.

The *stock-lock* is an outside wooden lock for stables, gates, etc.

D-locks and P-locks are gate-locks of forms resembling those letters.

Many locks are known by their adaptation to specific uses; as, *cabinet, cupboard, bookcase, desk, portable desk, table, drawer, box, cuddy, chest, carpet-bag, valise, trunk,* etc., locks. See list, p. 1342.

2. (*Hydraulic Engineering.*) *a.* An inclosure in a canal between gates, where boats are raised and lowered. See CANAL.

The parts of a canal-lock are, —

The *head-gate* and *tail-gate*, which, with the *side-walls*, inclose the lock-*chamber*. They are made of *framing* with *leaf-planking* nailed and bolted thereto.

The *clap-sill* or *miter-sill*, with two *branches*, is the framing against which the lower edge of the gate shuts.

The *hollow-quoin* is the recess in the masonry occupied by the *heel-post* of the gate.

The *head-bay* or *head-crown* is the canal above the lock.

The *tail-bay* or *aft-bay*, below the lock-chamber.

The *lift* is the amount of fall overcome by the lock.

The *lift-wall* is the wall at the foot of the head-gate.

A canal-lock is a device by which boats are passed from one level to another. It consists of a basin between the levels, having a pair of gates at each end communicating with the respective level. Fig. 2981 shows a vertical, longitudinal section *a*, a plan *b*, and views of the upper and lower gate *c d*.

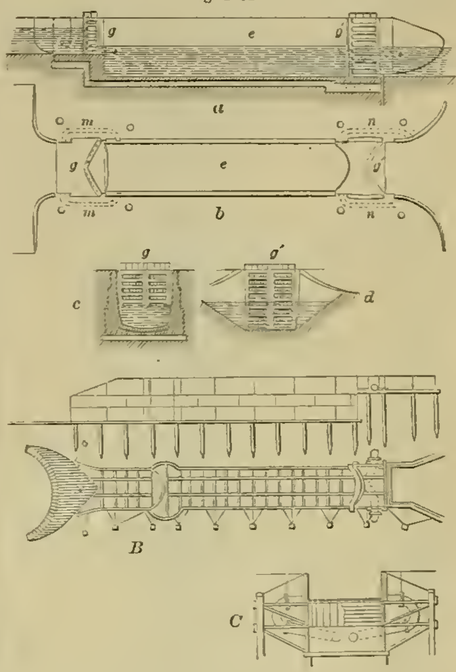
e is the lock-chamber; the floor is called the *invert*, and is lined with masonry. The floor of the upper end is even with the upper level, and the lower floor with the lower level. The gates are shown at *g g′*; they turn upon their hingeing ends; when shut, they close against each other, presenting an angle up hill against the force of the water. When a boat is to ascend, the lower gates are opened, the boat floated into the chamber, and the gates closed. Water is then allowed to pass by underground conduits *m m* to the chamber, until it is even with the water of the upper level; the upper gates are then opened and the boat floated out. In descending, the boat is floated into the full chamber, the upper gates closed; the water in the chamber allowed to pass from the latter by the conduits *n n* to the lower level, until the level of the water on each side of the lower gates is even, when they are opened and the boat floated out.

The Ellesmere and Chester Canal, England, crosses a quicksand in Cheshire, at which place cast-iron locks and lock-gates were made. The locks (*B C*) rise 17 feet, are founded upon piles, and formed of cast-iron plates and girders. The leaves of the gates have cast-iron heads, heels, and ribs, in separate pieces with flanges, which are fastened together with nuts and screws; the whole is covered with wooden planking. The docks and gates are stated to have given good satisfaction.

The complete canal-lock was invented by Dionisio and Pietro Domenico in 1481, consisting, as it did, of a lock-chamber inclosed by a double pair of gates. This invention soon spread throughout Europe, and Leonardo da Vinci erected six of them at the junction of the two canals of Milan, 1497. The fall was 17 Milan brasso. (*Milan brasso = 1.725 English feet.*

In 1188, Alberto Pitentino converted the Mincio into a canal and restored it to its ancient course, from whence it had been diverted by the Romans in the time of Quintus Curtius Hostilius. Cresy dates the introduction of locks from the period of the building of this canal. It was a curious contrivance called a conch, with a balance-lever and hanging gate, which somehow opened to allow the boats to pass. This was used at Governolo, to dam up the waters of the Mincio on the side of Mantua. It was probably a kind of sluice. See Cresy's "Ency. Civil Engineering," pp. 185–188.

Fig. 2981.



Canal-Lock.

The first canal-lock in England was constructed by John Trew of Glamorganshire for the Exeter Canal. The lock-chambers were 300 feet in length, 80 in breadth at top, 50 at the bottom. The gates were in pairs, at each end, 25 feet high, and each leaf 20 feet wide, furnished with iron and brass work that they might be moved with facility. Sluices were made to admit and remove the water in locking. The object was to ascend to a level in the river Ex, above a weir constructed across the river.

This account disproves the statement that locks were introduced into England by Vermuyden, a Dutch engineer, in the time of Charles I.

A substitute for the lock is found in the *canal-lift*, which is used in some cases, but not with boats of large capacity. See LIFT, CANAL.

b. An embankment or structure confining the waters of a canal or race. A *weir* or *guard-lock*.

3. (*Printing.*) To wedge up a form in a chase by means of *sticks* and *quoins*.

4. A cotter or key; as the one which fastens the

cap-square over the trunnion of a mounted cannon. A *forelock*.

5. (*Fire-arms.*) The firing apparatus of a gun, usually consisting of a trigger, sear, hammer, and mainspring. See GUN-LOCK.

6. A fastening for the ends of a hoop which incloses a bale. See BALE-TIE.

7. (*Vehicle.*) *a.* A device to keep a wheel from turning in descending a hill. See WAGON-LOCK; CARRIAGE-LOCK; CAR-BRAKE, etc.

b. The swerving to the right or left of the fore carriage of a vehicle, deviating from the line of direction of the hind wheels and the trend of the carriage proper. It is called the *haw* or the *gee* lock respectively, according as it is to the left or the right of the driver.

8. (*Plastering.*) The projection of the plaster or cement behind the lath, which keeps it from falling or scaling off.

See under the following heads: —

Air-lock.
Alarm-lock for tills.
Bag lock.
Bolt.
Book-edge lock.
Box-lock
Broach
Burglar-alarm lock.
Canal-lock
Cannon lock.
Car-door lock
Carriage-lock.
Car-seat lock.
Case-lock.
Cell-door lock.
Check-lock.
Chest-lock.
Clasp-lock.
Dead-lock.
Detector-lock.
Dial-lock.
Dog.
Door-lock.
Double lock.
Drawer-lock.
Fence.
Firelock.
Flint-lock.
Forelock.
Fuse lock.
Guard-lock.
Gun-lock.
Hasp
Hasp-lock.
Keeper.
Key.
Key-fastener.
Keyhole protector.
Latch.
Latch-key.
Letter-lock.
Lift-chain.
Lift-chamber.
Lift-latch.
Lift-lock
Locker.
Lock-file.
Lock-gate.
Locking-forceps.
Lock-nut.
Lock-paddle.
Lock-piece.
Lock-pulley.
Lock-rail.
Lock-saw.
Lock-sill.
Lock-stitch.
Lock-up valve.
Lock-weir.
Matchlock.
Mortise-lock.
Multiple bolt.
Night-latch.
Nut-lock.
Oar-lock.
Padlock.
Percussion-lock.
Permutation-lock.
Piano-lock.
Pick-lock.
Puzzle-lock.
Rabbeted lock.
Reversible lock.
Rim-lock.
Ring lock.
Rose-lock.
Rowlock.
Rural lock.
Safe-lock.
Sash-lock.
Screw-lock.
Seal-lock.
Shutter-lock.
Spindle.
Spring-lock.
Staple-lock.
Stump-lock.
Tentation-lock.
Tide-lock.
Till-lock.
Time-lock.
Trunk-lock.
Tumbler.
Tumbler-lock.
Tusk.
Valise-lock.
Wagon-lock.
Ward-lock.
Wheel-lock.
Window-lock.

Lock-bay. (*Hydraulic Engineering.*) The pond or space of water between the gates of a canal-lock.

Lock-chain. (*Vehicle.*) A chain employed to lock the wheels by attaching a part of the rim to some non-rotating part of the vehicle. Or a chain by which is secured to the vehicle a *skid-plate*, on which the wheel rides in descending a hill. A *skid-chain*.

Lock-cham′ber. (*Hydraulic Engineering.*) That part of a canal-lock, between the gates, in which a boat rises or sinks to the level above or below. See CANAL-LOCK.

Lock-cramp. An implement used to restrain the spring in putting the parts of a gun-lock together.

Lock′er. (*Nautical.*) A compartment in a ship for stowing away things.

The chain-lockers are centered around the foot of the main-mast.

Shot-lockers are recesses and shelves for shot.

Lockers in the cabin are for various articles, answering to closets, and may be fastened by a lock.

Lock′et. 1. (*Arms.*) That part of a leathern sword-scabbard where the lock is fastened.

2. (*Jewelry.*) *a.* The fastening of a necklace, etc.

b. A gold case with a snapping cover, and adapted to contain hair or a miniature.

Lock-file. A slitting file, knife-shaped, for cutting out the wards in the bit of the key. See FILE.

Lock-fil′ers' Cramp. A pair of leaden or brazen cheeks for a vise.

Lock-gate. (*Hydraulic Engineering.*) A pair of closed doors at one end of a canal-lock, to confine the water in the chamber. The gates at the end of the lock-chamber are respectively the *head-gates* and *tail-gates*. See CANAL-LOCK, p. 440.

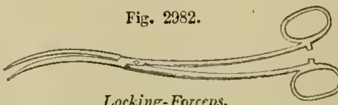
The lock-gate consists of two *leaves*, each having a top and bottom cross-piece, diagonal brace, *quoin-post*, also known as a *heel-post;* and *miter-post*, also known as a *meeting-post*. One pair of gates constitute the *head-gate;* the lower pair form the *tail-gate;* the two, with the *side-walls*, inclose the *lock-chamber*.

Lock-hatch. (*Hydraulic Engineering.*) The sluice-board or sliding-gate in a sluiceway.

Lock-hole. The recess in a musket-stock to receive the lock.

Lock′ing-for′ceps. A light forceps whose arms are automatically locked when closed; used for various purposes, such as holding a sponge tent in uterine operations, for carrying lint, etc.

Fig. 2982.



Locking-Forceps.

Lock′ing-plate. 1. (*Horology.*) Or *count-wheel*. A notched circular plate on the great wheel, whose notches receive the end of a lever attached to the *lifting* piece, and by which the number of strokes is governed.

2. (*Vehicle.*) A plate on a vehicle to take the wear of the fore-wheel when the vehicle is turning short. A *rub-plate*.

Lock-nail. One of the pins by which the parts of a gun-lock are secured to the *lock-plate*. In the old form of lock, they are the *tumbler-pin*, *mainspring-screw*, *sear-pin*, *bridle-screw pin*, *hammer-nail*, *hammer-spring screw*.

Lock-nut. A supplementary nut screwed down upon a primary one, to prevent its shaking loose. A *jam-nut*, *check-nut*, or *pinching-nut*.

A *nut-lock* is a means for preventing a nut from turning. See NUT-LOCK.

Lock-pad′dle. (*Hydraulic Engineering.*) A sluice for filling an empty lock-chamber.

Lock-piece. In guns of the old construction, a lug cast just alongside of the vent for the attachment of the lock.

Lock-plate. That plate on which the parts of a gun-lock are fastened, and which is screwed to the stock.

Lock-pul′ley. (*Machinery.*) Two pulleys formed to rotate together or separately, at will. One of them slips on a *spline*, and has a pin which locks into a hole in the face of the other pulley. See PULLEY.

Lock-rail. (*Carpentry.*) Of a door-frame, the transverse piece which separates the main doorway from the open space above it, which is usually occupied by a glazed sash. A *transom*.

Lock'ram. (*Fabric.*) (Fr. *Locronan*, a town of Bretagne.) A hempen cloth.

Lock'rand. (*Masonry.*) A course of bond-stones.

Lock-saw. A *compass-saw* used in cutting seats for locks in doors. It has a fine, taper, flexible blade. See COMPASS-SAW.

Lock-screw. The screw which fastens the gun-lock to the stock.

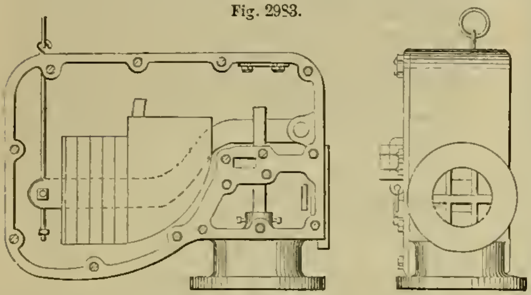
Lock-sill. (*Hydraulic Engineering.*) A piece of timber at the threshold of a canal-lock, with a chamfered edge, against which the gates shut.

Lock-stitch. A sewing-machine stitch in which the lower thread is made to pass over the upper one, simply interlocking therewith. See STITCH.

Lock-tool. A cramp used in putting the parts of a gun-lock together.

Lock-up Safe'ty-valve. A safety-valve which is so inclosed that weight cannot be surreptitiously added to the lever; as in the example, in which the lever and weights are inclosed in a lock-up chamber which the steam does not enter, so that they are secure from access by any not possessed of the key, and can be inspected at any time. A rod passing through the chamber-top enables the engineer to blow off, but affords no facility for holding down the valve.

Fig. 2983.



Lock-up Safety-Valve.

The lock-up valve was a feature in the specification of a locomotive, for which a prize was offered in 1829, and won by Stephenson's "Rocket."

Lock-wag'on. A device to impede or arrest the motion of one or more wheels of a vehicle when descending a hill, or when it is desired to prevent its being moved. See WAGON-LOCK.

Lock-weir. A weir having a lock-chamber and gates.

Lo'co-mo'tive. A self-moving, traveling steam-engine.

Watt's patents of 1769 and 1784 included the uses of steam-engines for running carriages on land, but he never made any such.

A locomotive was made by Cugnot, a Frenchman, in 1769. It is still preserved in the museum of the Conservatoire des Arts et Métiers at Paris, and is described as having a copper boiler, much like a common kettle, and a pair of 13-inch single-acting cylinders, which operated a single driving-wheel roughened on its periphery. Hornblower's steam-carriage had the same date, 1769.

Symington showed a model of a steam-carriage in Edinburgh in 1770. It was a long-coupled, four-wheeled carriage, the boiler and engine behind, a coach-body on the usual springs, and in front the guard, who governed the fore-wheels by a lever. To the piston-rod was attached a rack gearing into a pinion on the driving-wheel axle. The writer cannot state whether the said pinion was a ratchet, and allowed the rack to *slip* back on its return stroke, or whether it was thrown out of gear in returning while the cylinder on the other side became effective. Its mode of coupling the power to the running-gear resembled, in some respects, his steamboat.

In 1784, William Murdoch of Redruth, Cornwall, England, while in charge of the Boulton and Watt pumping-engine, made a locomotive wherein a lamp supplied the heat. Determining to give it a trial on a road, he lit the lamp beneath the boiler, and as soon as the working parts were thrown into gear, the thing started and got away from him, he following it along the lane at full speed. The night was dark, and the locomotive met and scared the clergyman of the parish, who raised a cry of distress, thinking he had met the Evil One. This locomotive was exhibited before the Institution of Mechanical Engineers in 1850, 66 years after its construction.

Oliver Evans of Philadelphia obtained a patent in Maryland in 1787 for the exclusive right to make steam-wagons for roads and railways. The details of the invention are not known to the writer. His descendants in the third generation are yet inventing. He is entitled to the credit of first making the double-acting high-pressure steam-engine a success. In 1801, he built a floating dredging-machine, to which he fitted wheels connected with the engine, and conveyed it 1½ miles to the place of launching. See HIGH-PRESSURE STEAM-ENGINE.

It is stated that about 1803, a Mr. Fredericks made a locomotive for a silver-mine in Hanover. The principles of construction are unknown.

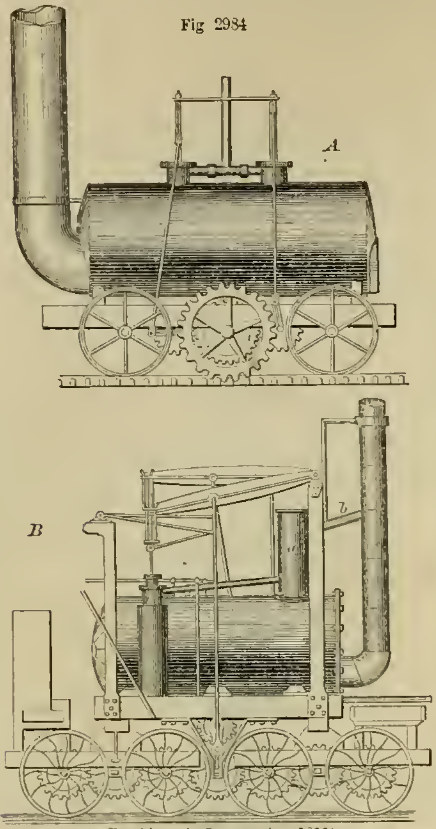
In 1806, a locomotive to be driven by hot air was constructed by Niepce at Chalons, France.

Trevethick's locomotive had a single cylinder, laid horizontally below the bottom or front part of the boiler, its reciprocating piston-rod being connected by another rod with a crank, at the midlength of an axle which carried a fly-wheel and a pair of cog-wheels, which geared into other spur-wheels on the axle of the driving-wheels. The engine was run upon a railway at Merthyr-Tydvil, in 1802, and drew ten tons in addition to its own load at the rate of five miles per hour. Vivian was associated with Trevethick in the patent. It was high-pressure, non-condensing, and exhausted into the chimney. It may be considered the first locomotive to run on rails or trams.

Blenkinsop's locomotive, in 1811, gave still better satisfaction to its owners, and it was usefully employed at the Middleton Colliery in hauling coals on a tramway, the engine having spur-wheels working into a rack on one side of the track. The engine (*A*, Fig. 2984) was otherwise supported on four wheels. The fire was built in a large tube passing through the boiler, and the tube was bent up at the end to form a chimney. Two vertical cylinders were placed above the boiler, and the pistons were connected by cross-heads and connecting-rods to cranks on the axles of spur-pinions, which geared into the main spur-wheel, which formed the driver. It was long used on a colliery railway between Leeds and Middletown, 3½ miles distant, and perhaps was the first successful locomotive in regular use. It drew trains of 30 tons weight 3¾ miles per hour.

In 1812, Blackett made a series of experiments which proved that the expedient of a pinion and rack-rail was unnecessary; and Chapman patented a locomotive with eight wheels driven by gearing, for the purpose of increasing the tractive adhesion. In the same year, Brunton invented a means of driving a locomotive by two propellers consisting of jointed rods intended to imitate the action of the hind legs of a horse. Analogous contrivances were adopted by Gordon and Gurney.

Fig 2984



A, *Blenkinsop's Locomotive* (1811).
B, *Hedley's Locomotive* (1813).

In the spring of 1813, William Hedley built a locomotive with four smooth drive-wheels, to run on a smooth rail. The machine failed to accomplish much, on account of its small boiler. Hedley thereupon the same year built another engine (shown at *B*, Fig. 2984), having a return-flue boiler, and mounted on eight driving-wheels, which were coupled together by intermediate gear-wheels on the axles, and all propelled by a gear in the center, driven by a pitman from the walking-beam. See "Who Invented the Locomotive-Engine?" London, 1858, written by O. D. Hedley, the son of the inventor.

Hedley's locomotive was objected to by residents of Newcastle, on account of the smoke. He therefore passed the smoke into a large receiver (*a*), and turned the exhaust-steam upon it. From the receiver the steam and smoke were conveyed by a pipe (*b*) to the chimney, which device soon developed into the steam-blast.

"Puffing Billy" was at work more or less until 1862, when it was laid up as a memorial in the British Patent Office Museum. Hedley died in 1842.

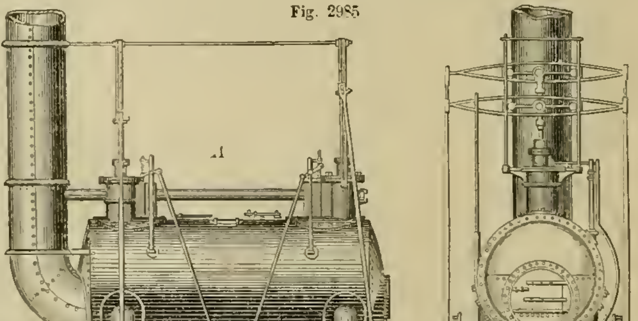
In 1815, Dodds and Stephenson patented an engine (shown by side and end views, Fig. 2985), in which the power might be applied either through wrists, at angles of 90° to each other on the driving-wheel, or an endless chain working in gearing on the axles. A patent was taken out in the succeeding year by Losh and Stephenson, embracing, among other features, a series of cylinders communicating with the water in the boiler, and having pistons with rods at their lower ends, which were caused to press upon axles having vertically movable bearings, so as to keep the wheels down when running on an uneven track. Their first engine is stated to have been made for the Killingworth Railway, and their engines were employed on iron tracks by the Stockton and Darlington Railway in 1825, and, later, at the Newcastle collieries. The locomotive in the Stockton and Darlington Railway had two vertical cylinders, and the driving-shaft had cranks at an angle of 90°. The axles of the wheels were coupled by an endless chain passing around both axles.

In 1829, the Liverpool and Manchester Railway, then the most extensive and finished work of the kind ever undertaken, was completed, and the directors offered a reward of £500 for the best locomotive, which should fulfill certain imposed conditions. Among these were, that it was to consume its own smoke, draw three times its own weight at a rate of not less than 10 miles an hour, and the boiler-pressure was not to exceed 50 pounds per square inch. The weight was not to exceed six tons, nor the cost £550.

Three engines competed for the prize: the "Rocket," constructed by George Stephenson; the "Sanspareil, by Timothy Hackworth; the "Novelty," by Messrs. Braithewaite and Ericsson.

The "Rocket" weighed 4 tons 5 cwt., and its tender, with water and coke, 3 tons 4 cwt. It had two loaded carriages attached, weighing a little over 9 tons 10 cwt. The greatest velocity attained was $24\frac{1}{6}$ miles per hour, and the average consumption of coke per hour 217 pounds. See *A*, Fig 2986.

Fig. 2985



Dodds and Stephenson Locomotive (1815).

The "Sanspariel" attained a speed of 22⅔ miles per hour, but with an expenditure of fuel per hour of 692 pounds.

The "Novelty" carried its own water and fuel. In consequence of successive accidents to the working arrangements, this engine was withdrawn from competition. A fourth engine, the "Perseverance," by Burstall, not being adapted to the track, was withdrawn.

The opening of the Liverpool and Manchester Railroad, September 15, 1829, was an era in civilization, and perhaps the first victim to the iron horse was slain on that day, — Mr. Huskisson, Home Secretary in the British Cabinet. Eight locomotives were used on that day, and while the engines were watering at the Parkside station some of the guests descended to the road. While Mr. Huskisson was talking to the Duke of Wellington, the famous "Rocket" came by, knocked down Mr. Huskisson, and the wheels passed over his left leg. He was placed on board the "Northumbrian," driven by George Stephenson, who conveyed him 15 miles in 25 minutes, at the rate of 36 miles an hour, the most marvelous achievement yet. Mr. Huskisson died the same night at Eccles.

The "Rocket" engine was superseded in 1837, being condemned for life to the collieries. Here it proved itself capable of a rate of 60 miles an hour; but being again convicted of levity while on duty, it was cashiered and its place filled by heavier machines of 12 tons. After a few years of inglorious retirement, some one, not totally oblivious of how it would look in history, recalled the old soldier from his limbo, and now he enjoys the company of his elder brother, Hedley's "Puffing Billy," in the English Patent Museum.

In Fig. 2986, *A* is an elevation of the "Rocket." The boiler *a* is a cylinder 6 feet long, and has 25 tubes. This feature was due to Mr. Henry Booth, though a tubular boiler had been patented by M. Seguin in France, in 1828. The fire-box *b* has two tubes, communicating with the boiler below and above, and is surrounded by an exterior casing, into which the water from the boiler flows and is maintained at the same level as that in the boiler.

B is a longitudinal vertical section of a modern English locomotive. The boiler is surrounded by two casings, one within the other, united by stays. The tubes *a* are of brass, 124 in number, and the boiler has longitudinal stays connecting the ends. *b* is the smoke-box, into which the blast-pipe *c* discharges. *d* is the steam-dome, into which the steam from the upper part of the boiler enters, its amount being governed by a regulator controlled by a winch. This serves to obviate in great degree the effects of priming. The steam-pipe *e* has two branches, each entering one of the boxes containing the valves by which the flow of steam to the cylinders is controlled.

C is an express-engine designed by Gooch for the Great Western Railway, where an unusual rate of speed is maintained. The boiler has 305 tubes, 2 inches in diameter. The cylinders are 18 inches diameter and 24 inches stroke, the driving-wheels 8 feet in diameter, the heating surface of the fire-box 153 square feet.

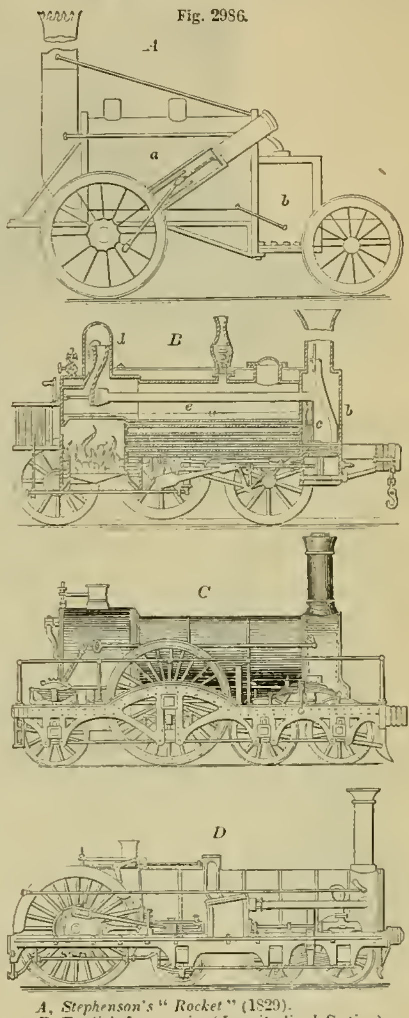
D is an express-engine designed by Crampton for the same road. It is adapted for the usual gage.

For details of English locomotives, which differ considerably in construction from those used in the United States, the reader is referred to Colburn's "Locomotive Engineering."

The engines employed on the Irish mail-trains between London and Holyhead weigh 27 tons; the tenders 17 tons, carrying 2 tons of coke and 1,500 gallons of water. The cylinders are of 16 inches diameter and 24-inch stroke. The apparatus for feeding the fuel also provides for the combustion of the smoke. The engine is supplied with water while running, from a trough beneath the rails, from which the water is scooped up by the tank. The cost of a locomotive of this description is nearly £3,000. It is said that one of them has been known to run 130 miles in 144 minutes.

Faulding's locomotive (English) is designed to avoid the inertia of its working parts. It has an oscillating cylinder on each side, which is, by a partition at its midlength, divided into two cylinders, each of whose pistons, coupled directly to the crank-pins, propels one of the four driving-wheels, and is simultaneously driven outward and inward. The crank-axles are at right angles with each other, so that each wheel is driven alternately. The cylinders are carried on a frame supported by the journals of the driving-wheels, so as not to be affected by the motion of the springs.

Fig. 2986.



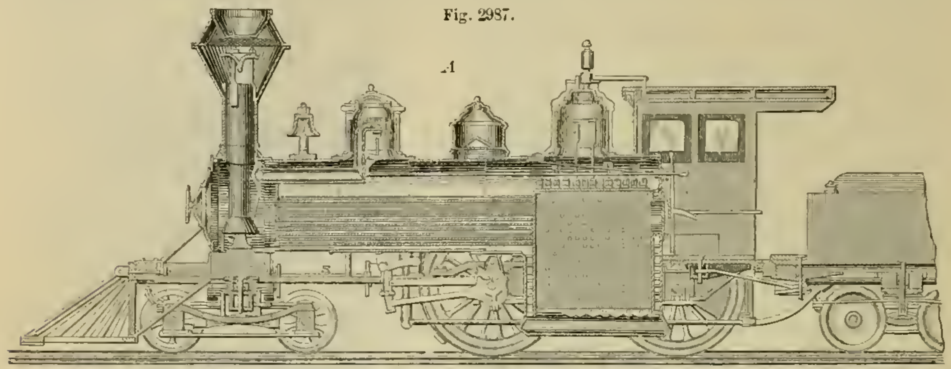
A, *Stephenson's "Rocket"* (1829).
B, *English Locomotive* (*Longitudinal Section*).
C, *Gooch's Express Engine* (*English*).
D, *Crampton's Express Engine* (*English*).

The first locomotive run on rails outside of England was the "Stourbridge Lion," made by Stephenson and brought from England for the Delaware and Hudson Canal and Railroad Company by Horatio Allen. This was in August, 1829. It was soon found that English locomotives, adapted for gentle curves, were ill suited for the exigencies of American railroads, where curves of as small a radius as 200 feet were sometimes employed. Mr. Peter Cooper, since so well and widely known, devised an engine which solved the difficulty. This was in 1829.

The second locomotive built in the United States for actual service was for the South Carolina Railroad, and made its first regular trip in March, 1831. See RAILWAY.

The London "Engineer" describes an engine built for the Mt. Cenis Railway as having four drivers and four horizontal wheels, which latter grasp between them a central rail with an amount of pressure regulated by springs, which are controlled by bars bearing upon them, and adjusted by means of a shaft extending across the engine and furnished with right and left handed screws. This shaft carries on its end a worm-wheel, gearing into a worm connected with a hand-wheel on the foot-plate, by which the pressure is regulated. This may be increased to 24 tons, 6 on each wheel.

Fig. 2987.

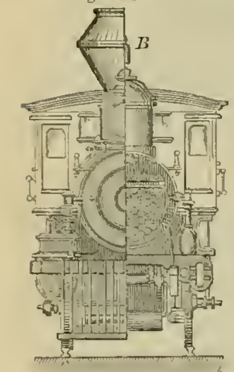


Baldwin Locomotive (*Central Longitudinal Section*).

Fig. 2987 is a central longitudinal section of an approved form of American locomotive as made at the Baldwin Locomotive Works, Philadelphia.

Fig. 2988 is a front elevation, one half of which shows a transverse section through the boiler. The engine has four drivers, 60¾ inches in diameter, and a four-wheeled swing bolster truck, and weighs, with water and fuel, about 65,000 pounds. The flues, 144 in number, are 2 inches in diameter, and 11 feet 5 inches in length. The fire-box, of cast-steel, is 66 inches long, 34½ inches wide, and 63 inches deep. Water-space 3 inches sides and back, 4 inches front. Grates, cast-iron. The cylinders are horizontal. Valve-motion graduated to cut off at any point of the stroke. The tires of cast-steel, and the wheel-centers of cast-iron with hollow spokes and rims; the wrist-pins of cast-steel, the connecting-rods of hammered iron. The truck-wheels are 28 inches in diameter. All the principal parts of the engine are interchangeable.

Fig. 2988.



Baldwin Locomotive (*End Elevation and Transverse Section*).

Attempts are being made, by adaptation of the furnace and boiler, to run locomotives by means of liquid fuel. Differences also occur in the construction of the heating parts, according to the character of the fuel, — coal, coke, wood, peat, etc.

The ordinary speed attained on English railways is greater than that usual in this country. The Great Western express from London to Exeter travels at the rate of 43 miles an hour including stoppages, or 51 miles an hour while actually running. Midway between some of the stations a speed of 60 miles is attained, and on experimental trips 70 miles an hour has been reached. A speed of 75 miles is equivalent to 35 yards per second, so that if a row of stakes one yard apart were driven at the side of the road, they would at this velocity appear undistinguishable one from another. Were the driving-wheels of the locomotive 7 feet in diameter, they would revolve 5 times in a second, each piston would traverse the cylinder 10 times per second, while there would be 20 discharges of waste-steam per second, causing a continuous sound instead of the "cough" which is heard when the engine is moving slowly.

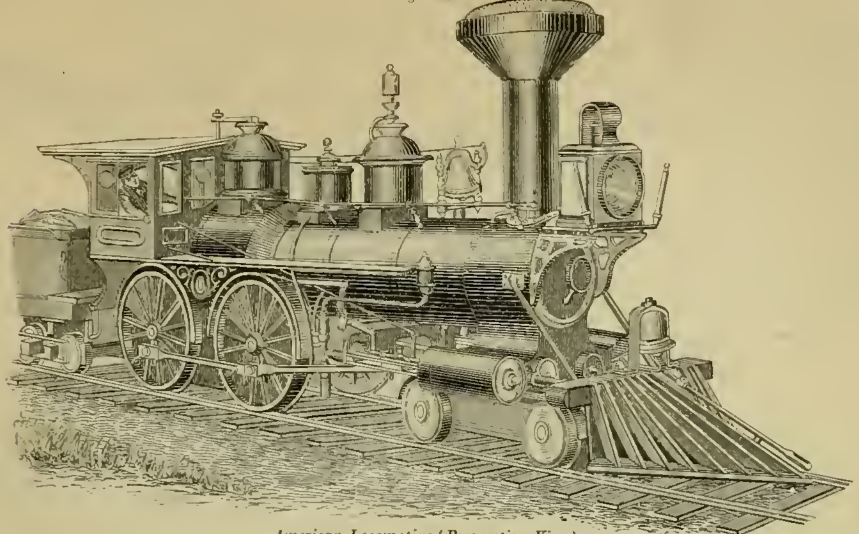
Very high speeds have been attained, on special occasions, on American roads, probably fully equaling any time ever made in England. For instance, it is stated that a train conveying some officials of the New York Central Railroad made the distance from Rochester to Syracuse, 81 miles, in 61 minutes, said to be the fastest time ever made in America.

The life of a locomotive-engine is stated in a paper read before the British Association at thirty years. Some of the small parts require renewal every six months. The boiler-tubes last five years, and the crank-axles six years; tires, boilers, and fire-boxes, seven to ten years. The side-frames, axles, and other parts, 30 years. During this period, the total cost of repairs is estimated at $24,450 in American money, the original cost of the engine being $8,490. It therefore requires for repairs in eleven years a sum equal to its original cost. In this time it is estimated that an engine in average use has run 220,000 miles.

See Clark's "Recent Practice on the Locomotive"; Tredgold on "Locomotive-Engines," London, 1851; Hensinger and Clauss's "Locomotive Maschine," Wiesbaden, 1858; Weissenborn's "American Engineering," New York, 1861; "The Student's Guide to the Locomotive," London, 1849.

The following figures, from the *Railway Times*, show the result of locomotive performance on the Cleveland, Columbus, Cincinnati, and Indianapolis Railway, 397 miles, for the month of March, 1872, and may be interesting in this connection: —

Fig 2989



American Locomotive (Perspective View).

Miles run by passenger trains	53,222
Miles run by freight trains	201,346
Miles run by other trains	67,446
Total mileage	322,014
No. of miles run to 1 pint of oil	23.23
No. of miles run to 1 ton of coal	40 52
(Miles run with coal, 158,018.)	
Cost per mile run for repairs	4.15 cents.
Cost per mile run for stores	55 "
Cost per mile run for fuel	7.40 "
Cost per mile run for E., F., and W.	7 10 "
Total cost per mile run	19.20 cents.
Total pints of engine-oil used	8,027
Total pounds of tallow used	3,693¼
Total pounds of waste used	1,951
Total quarts of oil used	1,928½
Total tons of coal used	2,451

The principal parts of a locomotive are, —

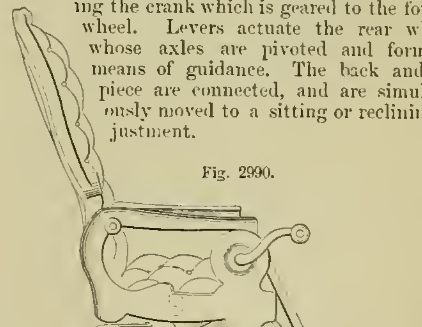
Air-brake.
Air-brake cylinder.
Air-pipe.
Air-pump.
Air-valve.
Ash-box.
Axle-boxes.
Bell.
Bell-cord.
Bell-crank.
Bell-standards.
Blow-off cock.
Boiler.
Braces.
Cab.
Center-casting.
Check-valve.
Chimney.
Clock.
Cone.
Convey-pipe.
Coupling bar.
Coupling-pin.
Counterbalance.
Cross-head.
Crown-bars.
Crown-sheet
Cylinder.
Cylinder-cocks.
Discharge-valve.
Dome.
Drivers.
Dry-pipe.
Eccentrics.
Eccentric-rods.
Eccentric-straps.
Equalizing-bar.
Feed-pipe.
Fire-bars.
Fire-box.
Fire-door.
Fire-grate.
Flag.
Flag-staff.
Flues.
Flue-plates.
Foot-board.
Frame.
Gage-cocks.
Galoot-spring.
Grate-bars.
Guides.
Hand-rail.
Hangers.
Head-light.
Head-plate
Injector.
Lamp.
Link-motion.
Low-water alarm
Main-rod.
Man-hole
Man-hole plate.
Oil-cups.
Parallel-rods.
Pet-cock.
Pilot.
Pipes
Piston.
Piston-rod.
Receiving-valve
Reflector.
Reverse-bar
Rocker-arm.
Running-board.
Safety-chain.
Safety-valve.
Sand-box.
Sand-pipe.
Slide-valve.
Smoke-box
Smoke-stack.
Spark-arrester
Springs.
Steam-dome.
Steam-gage.
Swing-bolster.
Tallow-cups.
Throttle-bar.
Throttle-lever.
Throttle-valve.
Truck.
Valve-gear.
Water-cocks
Water gage.
Wheels.
Whistle.
Whistle-cord.
Whistle-valve.
Wrist.

Lo′co-mo′tive-boil′er. (*Steam-engine.*) A boiler with numerous flues connecting the fire-box with the smoke-box beneath the chimney. See LOCOMOTIVE.

Lo′co-mo′tive-car. (*Railway.*) A locomotive and car combined in one vehicle.

Lo′co-mo′tive-chair. A wheeled chair for an invalid. That shown is propelled by turning the crank which is geared to the forward wheel. Levers actuate the rear wheels, whose axles are pivoted and form the means of guidance. The back and foot piece are connected, and are simultaneously moved to a sitting or reclining adjustment.

Fig. 2990.



Locomotive-Chair.

Lo′co-mo′tive-fur′nace. (*Steam-engine.*) The fire-box of a locomotive. See LOCOMOTIVE.

Lo′co-mo′tive Pile-en′gine. A pile-driver.

Lo′co-mo′tive-pump. (*Steam-engine.*) The feed-pump by which a locomotive-boiler is supplied with water. See INJECTOR.

Lo'co-mo'tive Smoke-pipe. The chimney-stack of a locomotive. See LOCOMOTIVE.

Lo'co-mo'tive Valve-gear. (*Steam-engine.*) The means by which the engineer governs the motions of the valves, opening, closing, or reversing. See LINK-MOTION.

Lode. 1. (*Mining.*) A regular vein affording metal.

When parallel to the axis of elevation of the district, it is termed *right running.*

When at right angles to the said axis, it is termed a *cross course.*

When at an angle of 45°, it is termed a *contra-lode* or *counter.*

A *rake-vein* is a perpendicular mineral lode.

A *live vein* or lode is one which contains metallic ores. It is said to be a *dead* lode when the ores give out.

The *back* is the upper part of a *lode.*

The *walls* or *cheeks* are the sides of the *lode;* as the vein inclines, the *walls* are known as the *upper* or *hanging* wall and the *under* wall.

The *hade* or *hading* is the slope or inclination.

The *bearing* is the course or direction.

The *country* is the rock traversed by the *lode* or *vein.*

Side-lodes, strings, feeders, and *branches* are minor ramifications of a vein or lode.

The *gangue* is the non-metalliferous portion of the vein. (German, *Gang,* vein.)

A *heave* or *fault* is a displacement or dislocation of a vein.

Gossans are surface indications of a vein.

Bunches, nests, concretions, nodules, are detached masses of different characters.

2. (*Hydraulic Engineering.*) A reach of water in a canal, or slack-water navigation.

Lodg'ing-knees. (*Shipbuilding.*) Compass-timbers lying horizontally and securing the junction of the deck-beams with the frames.

Lodg'ment. (*Fortification.*) An intrenchment hastily thrown up in a captured work to maintain the position against recapture.

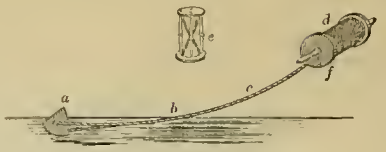
Loft. (*Architecture.*) *a.* An elevated gallery in a church, for an organ or choir.

b. An elevated story in a barn or stable, as a *hay-loft* above the floor on which the animals are stalled.

Log. 1. (*Nautical.*) A device for ascertaining the rate of a ship's motion. In its common form it consists of a triangular piece of wood, called the *log-chip,* curved at the bottom, which is loaded so that it may float upright in the water. It has a radius of about 6 inches, and a thickness of ¼ inch. To its corners is attached a cord, termed the *log-line,* which is wound around a reel, the axis of which projects, allowing it to turn freely when held in the hollow between the thumb and forefinger. The line is long enough to measure the distance sailed by the ship at her greatest speed during a given time, usually 30 seconds, and is divided into *knots,* corresponding to a proportionate part of the nautical mile, that is, 51 feet, though some navigators make it a trifle longer or shorter, as they conceive that the ship overruns or underruns her reckoning.

The string is knotted at such intervals that the spaces bear the same relation to a nautical mile that a half-minute does to an hour. That is, the knots must be the 120th of a nautical mile apart. The English geographical or nautical mile is $\frac{1}{60}$ of a degree of latitude, about 2,025 yards. Each *knot* is therefore $50\frac{75}{120}$ feet. For ordinary land measure, the English statute mile is used, = 5,280 feet. A knot would be 44 feet. See PEDOMETER.

Fig. 2991.



Log.

a, log-chip.
b, stray-line
c, forerunner or stray-mark.
d, log-line.
e. sand-glass
f, reel.

A certain length of line — not marked — intervenes between the chip and the first division on the line. This is termed the *stray-line,* and serves to allow the chip to drift beyond the dead-water in the wake of the ship.

Each knot is made sensible to the feeling as well as to the sight, and is subdivided into ten fathoms, so called. The time is measured by a small sand-glass. In heaving the log, the observer, usually an officer or petty officer, throws the chip over the taffrail, and as the first mark on the line passes over the reel, calls out "turn" to the assistant, who immediately inverts the glass. When the sand has all run out the latter calls out "out," when the observer checks the line, noting the knots and fathoms which have passed out. This operation, in well-regulated vessels, is performed every hour, and the result, as well as the course by compass which the vessel is steering at the time, is entered in the log-book, to serve as a basis for the *dead reckoning.* Sometimes, as in the British navy, a 28″ glass is employed, the length of the line being proportionately reduced.

Estimating a mile at 6,139.75 feet, and using a 30″ glass, —

1 knot = 51.1629 feet, or 51 feet 1.95 inches.
1 fathom = 5.11629 feet, or 5 feet 1.395 inches.

If a 28″ glass is used, and 8 divisions, then —

1 knot = 47 feet 9.024 inches.
1 fathom = 5 feet 11.627 inches.

The line should be about 150 fathoms long, having 10 fathoms between the chip and first knot for stray-line.

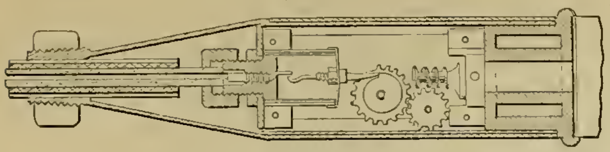
Bowditch gives 6,120 feet in a sea-mile, which, if taken as the length, with a 28″ glass, will make the divisions 47.6 feet and 5.95 feet.

Some logs, the earliest of which, perhaps, was Massey's, are actuated by wings on a rotating rod, which turns as the vessel passes through the water, operating, by means of an endless screw, a series of multiplying wheels, which register the total distance run between the time the log was thrown overboard and that at which it was taken from the water. These are only taken in when the ship's course is changed, or when the speed is below two or three knots per hour. They are somewhat liable to turn up missing, owing probably to their being bitten off by sharks.

Reid's log is of this class, but the spindle which carries the wings is combined with a mechanism for breaking galvanic circuit upon a certain number of rotations of the spindle. The armature operates a registering mechanism.

The "Berthon log" is an adaptation of Pitot's tube. In its elementary form it consists of a small tube passing through the ship's keel nearly amidships, and carried up to any convenient hight, when

Fig. 2992.



Reid's Log.

it is curved downward and united to the leg of an inverted siphon containing mercury. When the ship is making headway, the water which enters the tube through an aperture near its lower end rises, forcing up the mercury, which indicates the ship's speed on a suitable register. By turning the tube so that the aperture forms a certain angle with the keel, the ship's draft may be ascertained.

In reference to this subject Humboldt says, —

"It has frequently been asserted that the use of the log for measuring a ship's way dates back only to the end of the sixteenth or beginning of the seventeenth century, the year 1607 being usually assigned as the period when the first mention of it occurs. Navarrete says that it was used on board English ships in 1577, and that in Magellan's time the ship's speed was estimated by the eye. On the contrary, Pigafetta, a companion of Magellan, speaks of the log, *la catena a poppa*, as of a long-known means of measuring distances at sea.

"The Romans, in the time of the Republic, had in their ships an apparatus for measuring the distance passed over, consisting of wheels four feet high, provided with paddles placed outside the ship, after the manner of a modern steamboat, and according to the detailed description of Vitruvius, having a train of gearing consisting of three-toothed wheels, and registering the number of revolutions made by the exterior paddles, and also miles traversed by the ship, by the dropping of small round stones from an aperture in a wheel-case.

"This was constructed on the principle of the odometer (or *hodometer*), which was also employed by the Romans on land, mention being made of a traveling carriage belonging to the Emperor Commodus provided with such an apparatus. Hero of Alexandria, in his manuscript on the *dioptra*, describes an odometer of much more perfect construction, adapted for use both by land and water.

"The earlier nautical works of the Spaniards refer only to the method of arriving at the distance made by estimation; judging the velocity of the ship during the time occupied by the running out of each hour or half-hour glass. This would seem to have involved, on the part of the navigator, if even a rude approximation to accuracy were attained, not only a general knowledge of the usual rate of speed of vessels and an acquaintance with the effects produced by drift and set of the sea, but also with the sailing qualities of the particular vessel in which he happened to be. Medina lays down, as a general rule, that 'the most a ship advances in an hour is four miles, and with feebler breezes three, or even two.' Columbus, in his journal, frequently refers to his disputes with his lieutenant, Pinson, in respect to the distance made by the fleet since leaving Palos, and speaks of making 8 miles per hour, double the speed referred to by Medina. He makes no mention of the log. When it was proposed, in 1495, to determine the Papal line of demarcation between the discoveries of the Spaniards and Portuguese, the distance sailed over was to be determined by the judgment of 20 very experienced mariners, who were to prick off on the chart the distance made by the ship every six hours, according to their estimation. In Pigafetta's journal of Magellan's voyage, he speaks of a 'chain at the poop,' used throughout the entire voyage to measure the way. This would seem to have been an arrangement similar to the log-line, though no mention is made of the sand-glass, the log-chip, or of marks or divisions of the chain."

In connection with this subject, it may be mentioned that Professor Scoresby made careful observations during a passage across the Atlantic and during the prevalence of a protracted storm. He found: —

Extreme altitude of waves above the intervening depressions or hollows .	43 feet.
Mean distance between waves . .	559 "
Extreme distance from crest to crest .	600 "
Interval of time between waves .	16 seconds.
Velocity per hour	32½ miles.

Newton found that the velocity of the waves is as the square roots of their breadths; as taken between the tops of the ridges. Also, that they move through a space equal to their breadth in the same time in which a pendulum oscillates whose length is equal to the distance between the ridges. Waves whose breadth is 39⅙ inches will move that distance in a second of time. Their motion is progressive, but does not impart a like motion to a floating object, as the water does not move at the rate of the undulations.

2. (*Steam-engine.*) A tabulated summary of the performance of the engines and boilers, and of the consumption of coals, tallow, oil, and other engineers' stores on board a steam-vessel.

3. A stick of timber butted at the ends and ready for sawing.

Log-board. (*Nautical.*) The hinged pair of boards on which the memoranda of time, wind, course, rate, etc., are noted for transcription into the *log-book.*

Log-book. (*Nautical.*) The book which contains a journal of the vessel's progress from day to day, with any event occurring on board, of spoken vessels, etc. It is transcribed from the *log-board*, and forms the *rough-log* from which (in government vessels) the *smooth-log* is transcribed for the navy department.

Log-chip. (*Nautical.*) The triangular board on the end of the *log-line.* See Log.

Log'ger-head. (*Nautical.*) A runnel on the gunwale of a whaleboat, over which the line passes as it is drawn out by the fish.

Log'ging-axe. An axe used in cutting off logs. It is usually heavier than a *felling* or *lopping* axe. A substitute in the *cross-cut* saw, or the *drag* saw.

Log'ging-head. The working-beam of a steam-engine.

Log-glass. (*Nautical.*) The sand-glass used at heaving the log. Half-minute or quarter-minute glasses are used, according to the rate of sailing. See Log.

Log-line. (*Nautical.*) A line 150 fathoms in length. See Log.

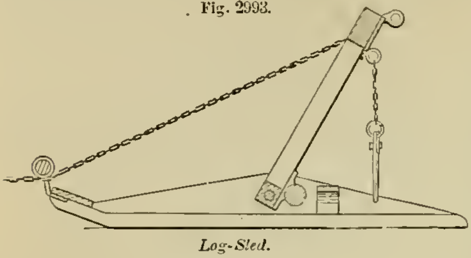
Log-meas'ur-er. A device for gaging logs, taking the round measure with the allowance for the squaring, and giving the results in board measure of the ascertained square in running feet of the log.

Log'o-type. A type having for its face a whole word or a combination of letters in common use; as, *con, com, tion, ing, the, and, in, on*, etc. These compounded types are not now used, but the practice still remains in combinations of letters, such as *ff*, *ffi*.

Log-reel. The reel of the log-line. See Log.

Log-sled. A short, strong, low-benched sled for hauling logs. In the example, the sled has an angular frame provided with trunnions at each end of its base or lower portion, with bearings in the sides of the sled, and is so connected with a chain and log-hooks that the draft force of the team will act to raise the log and draw it forward upon the sled.

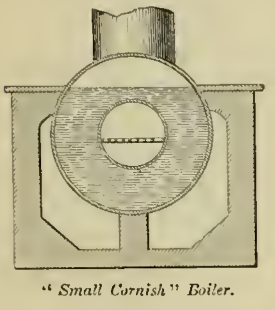
Fig. 2993.



Log-Sled.

Log'wood. A dyewood obtained from trees of the genus *Hæmatoxylon campeachianum.*

Fig. 2994.



"*Small Cornish*" *Boiler.*

Lon'don-boil'er. Also known as the "Small Cornish Boiler." It has a cylindrical fire-tube flue running through it, which contains the furnace and fire-bars. The fire-grate is so arranged with a removable brick bridge, that the whole or any less area of grate can be used that is found most economical.

The current of flame and hot air in this boiler first passes from the fire through the flue-tube to the back end of the boiler, whence it returns under one side of the shell to the front, where it crosses into the other side-flue, through which it proceeds to the chimney in a continuous or *wheel* draft.

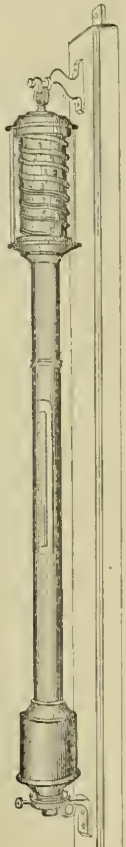
Long-boat. A large ship's boat, from 32 to 40 feet long, having a beam from .29 to .25 of its length. Has a heavy, flat floor, and is sharper in its floor than a *launch.* It is *carvel* built.

Long-bow. (*Weapon.*) A bow the hight of the archer, formerly used in England. See Bow.

Long-cloth. (*Fabric.*) A peculiar kind of fine cotton cloth, made milled or plain.

Long-flax. Flax to be spun its natural length without cutting.

Fig 2995.



Long-Range Barometer.

Long-plane. (*Joinery.*) A joiner's plane used when a piece of stuff is to be planed up very straight. It is 2 feet 3 inches long.

Long-poil. (*Fabric.*) A shaggy velvet.

Long Prim'er. (*Printing.*) A size of type between *Small Pica* and *Bourgeois.*

Small Pica, 83 ems to a foot.

Long Primer, 89 ems to a foot.

Bourgeois, 102 ems to a foot.

Long-range Ba-rom'e-ter. A barometer, the upper portion of whose tube is in spiral form, and of diminished diameter, the distance between the coils being usually 12 base to 1 perpendicular, so that each inch rise of mercury in the tube is indicated by an advance of 12 inches in the spiral coil, admitting of small variations being read without the aid of a vernier.

In another form, the diameter of the tube is diminished at its upper end, and this, with the upper part of the enlarged portion, is filled with a fluid proportionately lighter than mercury. The indications of the latter are thus multiplied in proportion to the difference between the sectional areas of the contracted and enlarged portions of the tube.

Long-ruff'er. A coarse heckle. See Heckle.

Long-saw. A pit-saw; used by a man standing above the log, and one below.

Long-slide. A slide-valve of such length as to govern the ports at both ends of the cylinder, and having a hollow back which forms an eduction passage. It was invented by Murdoch, of the firm of Boulton and Watt. See Cornish Engine.

Long-tack'le Block. (*Nautical.*) A block having two single sheaves, one above the other. The lower one is ⅔ the size of the upper. It is used in combination with a single block, to form long-tackle for loading or other purchase.

Long-tim'ber. (*Shipbuilding.*) A timber rising from the *cants* and continued in one piece to the top of the second futtock.

Long-tom. 1. A kind of gold-washing cradle.

2. (*Nautical.*) A pivot-gun amidship. See Pivot-gun.

Long-valve. A slide-valve found in some of the Watt engines, and which was long enough to cover the ports at both ends of the cylinder. A *long-slide.*

Long-wool. *Combing* wool; in distinction to the shorter, which is carded.

Loobs. (*Mining.*) The slimes of tin ore.

Loo'er. From *Lour* (Fr. *velour*, velvet), a hatter's brushing-pad. See Lure.

Loof. (*Shipbuilding.*) That part of the bow where the timbers begin to *cant* or curve in towards the *stem.*

Look'ing-glass. The old mirror of Narcissus is older than bronze or glass, and the handful of black liquid still holds its place as the mirror of incantations. (See Mirror.) "As in water face answereth to face" (Prov. xxvii. 19) was a comparison adapted to the comprehension of a people who had left Egypt and the arts behind them for a period of near 500 years.

Mirrors to show the full length of the person were known in Greece and Rome. (*Specula totis paria corporibus.* — Seneca.) Pliny refers to glass mirrors with a backing of leaf-metal, made at Sidon.

Looking-glasses were made in Venice, 1298, and in England at Lambeth, 1693.

"Bought a looking-glass by the Old Exchange, which costs me £5 5*s.*, — a very fair glass." — Pepys's *Diary*, 1664.

Looking-glasses are silvered, as it is called, by the following process: A sheet of tin-foil is placed very smoothly on a table or stone, and the foil is then flooded with mercury. The glass is laid upon it in such a way as to expel air-bubbles, and heavy weights are laid on the glass. The weights press out the superfluous mercury, and what remains forms an amalgam with the tin, which adheres to the back of the glass. See SILVERING.

Liebig recommended the following solution for silvering mirrors: —

One part nitrate of silver dissolved in 20 parts pure water. Form a solution of nitrate of ammonia, of a specific gravity of 1.115, and a lye of carbonate of soda, specific gravity 1.035, reduced one third by evaporation. The silvering liquid consists of the ammoniated solution, 100 parts; silver solution, 140 parts; lye, 750 parts. The application of a separate solution causes a deposition of silver on the glass. See also SILVERING-GLASS.

Siemens has modified the operation, as suggested by Liebig, and greatly simplified the reduction of the silver. Dry ammonia gas is passed through aldehyde to produce aldehyde ammonia; 2.5 grammes of aldehyde ammonia and 4 grammes nitrate of silver to 1 liter of water is the proper proportion to take. The nitrate of silver and aldehyde ammonia are separately dissolved in distilled water, mixed, and filtered.

The object to be silvered must be thoroughly cleansed to free it of grease, and if it be a globe or bottle, the liquid is poured in as high as it is desired to form the deposit. As soon as the heat, which must be applied, shows 50° Centigrade, the separation of the silver begins and soon spreads itself over the whole surface. At first, when the coating is very thin, it looks dark, but soon assumes a metallic luster; when it is a brilliant white, it is time to remove the fluid contents, as the mirror is apt to be injured by too long contact with the aldehyde.

Flat objects are laid upon the mixture in the usual manner.

In Germany, where aldehyde ammonia can be purchased at a reasonable cost, this process is highly prized. By making his own salt, in the manner described above, the chemist in this country can also avail himself of the method.

Drayton's method is to employ a silvering fluid made of nitrate of silver, ammonia, and an alcoholic solution of the oil of cassia. This is poured upon the glass, and a reducing fluid of alcohol and oil of cloves applied. This causes a separation of the silver, which deposits itself upon the glass.

Vohl's method of silvering the interior of globes is to cause a precipitation of nitrate of silver by the use of a solution of gun-cotton dissolved in hot caustic potash.

Steinheil uses nitrate of silver, caustic ammonia, caustic soda, milk, sugar, and water. The deposit is pure silver.

Thomson's method, used mostly for silvering the inside of globes and bottles, deposits from an oxide or salt of silver.

Martin's process is quite similar to the last mentioned.

Some looking-glasses have a dark varnish or coating at the back. These reflect only a small portion of the light.

M. Salvetat has announced to the Society of Encouragement, in Paris, a process of preparing looking-glasses, in which tin-foil is replaced by platinum applied in a metallic and brilliant powder. The glass, having been carefully cleaned and polished, is covered, by means of a brush, with a mixture of chloride of platinum, essence of lavender, and a composition of litharge and borate of lead. When dry, the glass is placed in muffles, when the essence, being volatilized, leaves a deposit of platinum dust firmly united to the glass. The new process requires but a few hours. See PLATINIZING.

Dode's plan is to dissolve platinum in nitro-muriatic acid, evaporate to dryness, mix with oil of lavender, take the resulting precipitate, mix with litharge or borate of lead, apply to the glass and bake in an oven.

Lool. (*Metallurgy.*) A vessel to receive the washing of metallic ores.

Loom. A machine in which yarn or thread is woven into fabric.

A woven fabric consists of yarns called the warp laid in one direction, and crossed by yarns laid transversely and known as the *woof*. The *warp* is also called the *chain*. The words *woof, weft, filling,* are synonyms.

The essential parts of a loom are, —

1. A frame in which the row of yarns forming the warp is held.
2. Leashes or harness which govern the decussation of the threads to form a shed for the *woof*.

Means for holding and actuating, when of the simplest description, may be said to be a *yarn-beam*, to pay off the yarn as the weaving proceeds; a means for operating the *leashes*, by which alternate threads all across the warp are raised and their intermediates lowered, so as to make a decussation (Lat., *decussis* = *decem asses* or X) or crossing known as the *shed*, in which the *woof* is deposited; a means for holding taut the web, so as to keep a proper strain on the warp. A *shuttle* or bobbin for the yarn is usual, but this is not absolute, as a ball of yarn or other filling can be, and is, rolled through the shed. In horsehair and slat looms, the stiff filling is drawn through by fingers, or thrust through, and in some narrow-ware and fringe looms the filling is put in by a rod which goes and returns.

Stripped of its familiarity, weaving is a very ingenious and remarkable process, and many must have been the essays before a serviceable fabric was produced. The preparation of the fiber, its spinning, winding, warping, and weaving, must have had a gradual growth, but with the commencement of historical notices of civilization we find nations in possession of the art.

Egypt excelled in fine linen for ages before Abraham; and the inhabitants of India doubtless spun and wove their cotton before Osymandyas, whose

> "Vast and trunkless legs of stone
> Stand in the desert."

It is natural to conclude that the plants which yielded fiber in bolls, such as the cotton and asclepias, were the first to be utilized, as the uses of flax, hemp, and silk require peculiar preparatory processes. Bark, although used extensively by the natives of some of the islands of Polynesia, has not come into general use for raiment elsewhere; but few trees yield a bark which will make clothing equal to the *tapa* cloth of the Fijis. This is made from the paper mulberry, which grows wild in Oceanica and Polynesia, as well as in parts of Asia. The Fiji group is near the equator, and was discovered in 1643 by Tasman, the Dutch navigator. There are 225 islands, 80 of which are inhabited by a population estimated at 250,000. Paper is also made of the same material (Broussonetia), and specimens are in the Patent Office and Agricultural Department Museum.

The *masi* cloth is made by the same islanders, of the bark of the *malo*-tree. The bark, as removed from the tree, is steeped in water, and beaten on a flat log with a grooved mallet. Two lengths of the wet stuff are beaten together at their edges, being united by their gluten. Separate pieces are united by the starch of the *taro* and then dyed. The mode of uniting is exactly the same as that practiced with the strips of papyrus, as described by Pliny. See Paper.

The Fijis are strangely cruel, ingenious, and versatile, being the manufacturers for the islanders of other groups, supplying them with canoes, spars, sails, pottery, mosquito curtains, cloth, *sinnet*, rope of *coir* or cocoa-nut husk.

In Captain Cook's time the inhabitants of the Pacific islands had no knowledge of *weaving*, though ingenious in *braiding*, *plaiting*, and *netting*.

Perhaps the earliest examples of weaving were baskets, hurdles, and mats, in which the intersections are exactly the same, though the mode of production is different.

The invention of the loom antedates all authentic history of the Chinese, Hindoos, and Egyptians, and chance references to woven goods are found at an early period of the Old Testament history, as in the case of the "vestures of fine linen" in which Joseph was arrayed by Pharaoh. (See Flax; Linen.) The references to woven goods in the Mosaic period are very numerous. The art of weaving was held to have been derived from the early sovereigns of the land; so great regard was felt for the inventor, that the work was generally thus associated.

Semiramis, the Assyrian queen, is credited with the invention of weaving. The Greeks represented Minerva with a distaff, as being the inventress of spinning. Homer refers to the products of the loom. The Egyptians credited it to Isis; the Mohammedans to a son of Japhet; the Chinese to the consort of the Emperor Yao (Noah); the Peruvians to Mamaoella, wife of Manco Capac, their first sovereign.

The modern Arabs and the Hindoos use a procumbent loom. The Bible notices of weaving refer to *loom-work*, *netting*, and *braiding*. 1. When Delilah wove into the web the seven locks of Samson's hair.

2. Where Isaiah pronounces a curse upon Egypt, which shall destroy all her vast works of irrigation and improvement, and "confound" those who live by weaving networks.

The Bible also refers to needlework and embroidery, in the mournful song of the mother of Sisera. See Damask.

The mode by which the weavers of India execute the *jamdance* has been explained by Mr. Taylor as follows: —

"The Hindoo weavers place the pattern, drawn upon paper, below the warp, and range along the track of the woof a number of cut threads equal to the flowers or parts of the design to be made; then, with two small, fine-pointed bamboo sticks, they draw each of these threads between as many threads of the warp as may be equal to the width of the figure which is to be formed. When all the threads have been brought between the warp, they are drawn close by a stroke of the lay or batten; the shuttle is then passed by one of the weavers through the shed, and the weft having been driven home, it is returned by the other weaver."

Pliny accorded the invention of the loom to the Egyptians. The Israelites carried with them the art of weaving when they left Egypt, and in Leviticus (chap. xiii.) the warp and the woof of linen and woolen fabrics are fairly distinguished.

The finest of the linen mummy-cloths of the ancient Egyptians — specimens of which may still be found — have about 140 threads to the inch in the weft and about 64 in the warp.

The looms of Egypt are shown abundantly in the tombs, and the web was either horizontal or perpendicular; the former are shown at Beni Hassan, the latter at Thebes. The woof was sometimes pushed upward, sometimes downward. The product was check or plain. The shuttle was not usual, but the filling was pushed through the shed by a stick or hooked rod. Wilkinson says that some of the colored patterns of the Egyptian cloths were worked by the loom; and others are the result of dyeing and printing processes.

"Colored dresses," says Pliny, "were known in the time of Homer, from whom the robes of triumph were borrowed; and from the Phrygians having been the first to devise the method of giving the same effect with the needle, they have been called 'Phrygiones.' But to weave cloth with gold thread was the invention of an Asiatic king, Attalus, from whom the name 'Attalic' was derived; and the Babylonians were most noted for their skill in weaving cloths of various colors."

It reminds one of the "prey of divers colors of needlework on both sides," in the famous Hebrew song more than thirteen centuries before Pliny, and of the "goodly Babylonish garment" secreted by Achan from the spoils of Ai, 1,500 years before the erudite Roman made his miscellaneous collection of curiosities.

A specimen of an ancient Egyptian rug in the possession of Mr. Hays is described by Wilkinson as made of woolen threads on linen strings, having a central figure in white on a green ground, a border of red and blue lines, and the remainder of it a ground of yellow with figures and ornaments in red, white, and blue. This is but 11 x 9 inches, and may be needlework on linen canvas, with one set of linen strings pulled out, and it cannot be relied upon as illustrative of *loom-work*, though interesting as *embroidery*.

Rugs and mats were the earliest form of carpets, and the early notices of them are frequent and interesting. (See Carpet.) Pliny says: —

"Thick flocky wool has been esteemed for the manufacture of carpets from the very earliest times. It is quite clear from what we read in Homer, that they were in use in his time. The Gauls embroidered them in a different manner from that which is practiced by the Parthians. Wool is compressed, also, for making a felt, which, if soaked in vinegar, is capable of resisting iron even; and, what is still more, after having gone through the last process, wool will even resist fire; the refuse, too, when taken out of the vat of the scourer, is used for making mattresses, an invention, I fancy, of the Gauls." "The *gausapa* [a thick cloth, shaggy on one side, and used for coverlets and cloaks] has been brought into use in my father's memory, and I myself recollect the *amphimalla* [napped on both sides] and the long shaggy apron [*ventrale*] being introduced; but at the present day, the *laticlare* [broad-striped] tunic is beginning to be manufactured into an imitation of the *gausapa*."

"Varro [50 B. C.] informs us that he himself was an eyewitness that, in the temple of Sancus, the wool was still preserved on the distaff and spindle of Tanaquil [wife of Tarquinius Priscus, 616 B. C., and a native of Etruria], who was also called Caia Cæcilia; and he says that the royal waved [watered] toga formerly worn by Servius Tullius [578 B. C.], and now in the temple of Fortuna, was made by her. Tanaquil was the first who wove the straight tunic [*tunica recta*, woven in a perpendicular loom]. Such as our young people wear with the white toga; newly married women, also. Waved [*undulata*, watered] garments were first the most esteemed of all, after which those formed of various colors came into vogue. Fenestella informs us that togas with a smooth surface, as well as the Phrygian togas, began to be used in the latter part of the reign of Augustus. The *pretexta* had its origin among the Etrurians."

"The method of weaving with more than one thread was invented at Alexandria. These cloths are called *polimita*; it was in Gaul that they were first divided into checkers."

Pliny gives the Gauls good credit, — checker-work weaving, the reaping-machine, beer of malt, bread raised by yeast, sieves of horsehair, embroidered rugs; but all *trans Padanus* (Po) seems to have been Gaul with Pliny.

The Greeks and Romans had looms in which the warp was horizontal, and others in which it was vertical, so that the weaver *sat* at work. The boxwood shuttle was of the modern shape, pointed at each end, and had a cavity in which the woof-thread was wound on a stationary pirn or quill, or on a bobbin which revolved as the yarn unwound, and passed through a hole in the side of the shuttle.

The threads of the warp were decussated by a stick (*arundo*), which divided the threads alternately, and the respective sets were passed through the loops of the leashes (*liciæ*) of the harness; the leashes of a given set being attached to a straight rod called a *liciatorium*. The simplest form had one set of leashes, which alternately raised and depressed its set of threads above and below the intervening threads. The number of sets of leashes was increased according to the complexity of the pattern. The woof-thread was beaten up to compact the fabric by a sword (*spatha*) or a comb (*pecten*), like the modern *reed*.

The term *polimita*, signifying "many leashes," and the reference to it by Pliny, indicate that the Greek and Roman looms had harness in which the leashes were arranged in sets to weave twills or patterns, which the Latin terms *bilex*, *trilex*, and the Greek *dimitos*, *trinitos*, *polimitos*, alluding to the degree of complexity of the system, fully confirm.

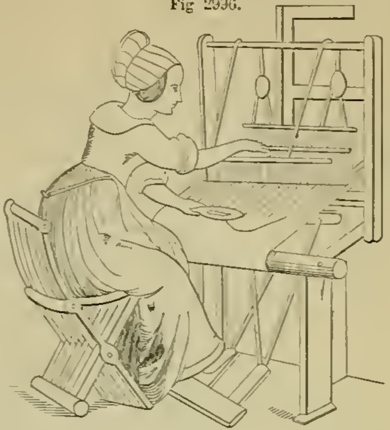
What the Gr. *ἑξάμιτον*, or *six-threaded*, may have been it is not easy to tell; but the word is used in connection with a sprig or ornament produced in the texture at regular intervals, and it is probable that it was a six-part harness, floating the woof to make a pattern. The name came down through the ages as *ξάμιτον*, Lat. *samitum*, O. Fr. *samet*, Ger. *sammet*, Sp. *xamete*, It. *sciamito*, and in our own archaic, —

> "So flashed and fell the brand Excalibur:
> But ere he dipt the surface, rose an arm
> Clothed in white *samite*, mystic, wonderful,
> And caught him by the hilt."

The arts of dressing flax and wool were known in Britain previous to the conquest by Cæsar, who states that the art of weaving was not known by the islanders. However this may be, an imperial manufactory of woolen and linen cloth for the use of the Roman army in Britain was established at Venta Bulgarum, since called Winchester. In Bishop Aldhelm's book, A. D. 680, in an essay on character, occurs a simile from the art of figure-weaving, in which he refers to a "web woven by shuttles, filled with threads of purple and many other colors, flying from side to side, and forming a variety of figures and images." A famous specimen of embroidery of this character is preserved in the Cathedral of Bayeaux. It is a piece of linen about 19 inches in width and 67 yards in length, containing the history of the conquest of England by William of Normandy. It is supposed to have been executed by Matilda, wife of William, and the ladies of her court. Its beauty is principally needlework.

The annexed cut is from Erasmus's book, the "Praise of Folly," and shows the lady of the house at her loom. The cloth-beam, shuttle, and harness are clearly shown.

Fig 2996.



A Ladye at her Loom.

> "What need we name the sev'ral kinds of looms?
> Those delicate, to whose fair-colour'd threads
> Hang figur'd weights, whose various numbers guide
> The artist's hand: he, unseen flow'rs, and trees,
> And vales, and azure hills, unerring works"
>
> DYER, *The Fleece*, 1757.

Toward the close of the eleventh century, the weavers in the large towns of England were formed into guilds or societies.

In the reign of Richard I. (1197) a law was passed for regulating the fabrication and sale of cloth.

Edward III. encouraged the immigration of weavers and cloth-makers, but the art does not seem to have flourished in England as it did on the Continent, as wool continued to be a staple article of export.

During the persecutions of the Duke of Alva in Flanders, in the sixteenth century, many Flemish weavers settled in England, and introduced or promoted the manufacture of baizes, serges, crapes, and other descriptions of stuffs. The revocation of the Edict of Nantes in 1685 (granted to the French Protestants by Henry IV. in 1598, confirmed by Louis XIII. in 1610, and by Louis XIV. in 1652), by Louis XIV. drove from France many ingenious artisans, who carried with them to England and other countries the arts of silk working, making crystal glass, jewelry, etc.

In weaving plain cloth the threads which run lengthwise of the fabric constitute the *warp*. Those in the direction of the width are called the *weft*, *woof*, *shoot*, or *tram*.

The warp is divided into two parts, each containing an alternate thread, which are alternately raised and lowered, allowing the weft-thread to pass between them through a space termed the *shed*.

The principal working parts of the hand and power loom are the same, comprising a frame, at one end of which is the *beam* or *yarn roll*, on which the warp-threads are wound, and at the other the *cloth-beam* on which the finished cloth is wound. The means for paying off the yarn from one beam and winding the cloth on to the other are known as the *let-off* and *take-up* respectively.

Each half of the warp is alternately raised and lowered by means of the *healds* or *heddles*, threads having loops at their lower ends and attached above to two horizontal rods connected by a pulley, the whole collectively constituting the *harness*, so that when one heald rises the other falls. Each warp-thread passes through one of these loops. The warp-threads also pass through the *dents* or teeth of a *reed* at the lower part of a movable swing-frame called the *lathe*, *lay*, or *batten*, which beats home and compacts the warp-threads as the work progresses.

The bottom of this frame has a projecting ledge, forming a path for the *shuttle* which contains a *cop*, on which the weft-yarn is wound.

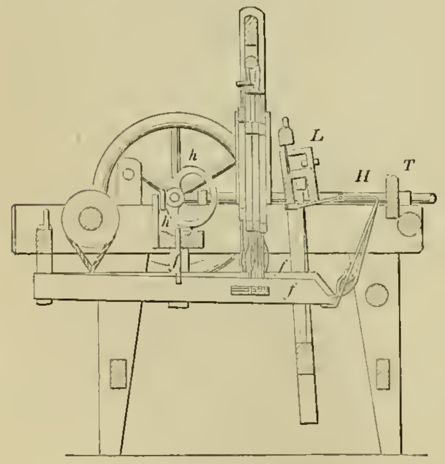
The shuttle in hand-looms is thrown across the race by hand or by means of the *fly*. When the latter is used the two ends of the shuttle-race are closed, so as to form a trough in which two pieces of wood, called *pickers* or *peckers*, are caused to move along wires. A string from each picker is attached to a handle which the weaver holds in his right hand, and by means of a smart jerk he propels the shuttle back and forth along the race. The weaver is seated at the end of the loom next the cloth-beam, and by pressing with his foot on one of two treadles he raises one of the *healds*, and with it one set of warp-threads. The shuttle is then thrown, passing through the shed between the two sets, and the weft-thread is driven home by the batten, which the weaver guides with his left hand. The other treadle is now depressed, raising the other set of warp-threads, the shuttle thrown back to its first position and the weft-thread beaten home as before. In this manner the weft-thread is caused to pass alternately above and below the threads of each of the two sets composing the warp until the work is completed. When a few inches of cloth are woven it is wound upon the cloth-beam.

In order to prevent the cloth from contracting in breadth before being wound on the cloth-beam, two pieces of wood with sharp-pointed ends, which are inserted in the selvage of the cloth, are employed. This stretcher is called a *temple*.

Previous to being wound on the yarn-beam, the warp-yarns require to be laid side by side in one plane. This is effected by a device called the Warping-mill (which see).

In Fig. 2997 is shown an improved hand-loom, operated by a crank on the shaft H. The warp-roller is at the left and the cloth-roller at the right of the machine. The harness-frame carries four heddles, which are actuated by the revolution of the cams h h, acting on levers f f connected to the heddles. L is the shuttle-box on the lay, and T the breast-beam. A fly-wheel on the same shaft with the cams equalizes the motion. The cams are so arranged on the shaft as to act in the required consecution to produce the twill or pattern required, and by increasing the number of cams and heddles a variegated recurrent pattern of considerable complexity may be produced. The revolution of the crank gives all the motions of the machine, — heddles, shuttle, and batten. (See Hand-loom.) In other forms of hand-looms the motions are derived from the vibration of the batten.

Fig. 2997.



Hand-Loom.

A positive motion has been given to the shuttle in place of the fly motion, on several occasions. Once in Greenough's circular loom, and again in Lyall's reciprocating loom. In the latter case, the shuttle is conveyed through the shed by a carriage which is impelled by cords, which are wound upon a reciprocating drum beneath the frame. The carriage and the shuttle have rollers which move in contact with the yarn, so as to have a rolling but no rubbing action. The rotary motion of the rollers in the carriage is transmitted through the warp to the lower rollers of the shuttle, as the threads of the warp pass between the two.

The earliest power-loom on record was contrived by a French naval officer, M. de Gennes, and is described in the "Journal des Sçavans," 1678. The inventor claimed that a single mill could give motion to 10 or 12 looms, and that cloth could be made by their means much wider than by the ordinary loom then in use. It does not appear to have been a practical working apparatus, and never came into use.

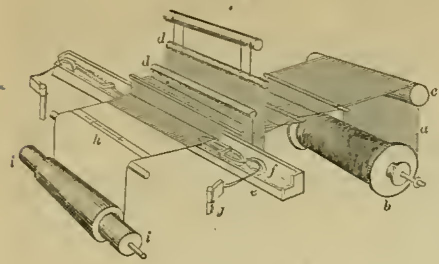
We are indebted to Dr. Edmund Cartwright for the first practical power-loom. He was a minister of the gospel, and unacquainted with mechanics; but had his attention turned to the subject by a remark, that when Arkwright's patents expired so many persons would go into the spinning business that no hands would be found to weave the cotton. He declares that his first attempt was a most rude piece of machinery. "The warp was placed perpendicularly, the reed fell with the weight of at least half a hundred weight, and the springs which threw the shuttle were strong enough to have thrown a Congreve rocket." It required the power of two men to work it. He secured his patent April 4, 1785. He then went for the first time to see how other people wove, and was astonished at the comparative clumsiness of his own contrivance. He went on improving, and took out his last patent 1787. He met with the trouble incident to great inventors, — an ignorant populace and rich pirates. He spent £30,000 in his endeavors to perfect his loom, and in 1808 received a Parliamentary grant of £10,000 for his great national services. On this sum he retired to a farm in Kent, and spent his declining years in comfort, occaionally trotting out his hobbies. He died in 1823, aged 80.

Steam was applied to his looms in 1807.

Fig. 2998 shows the working parts of a power-loom, the framing being omitted.

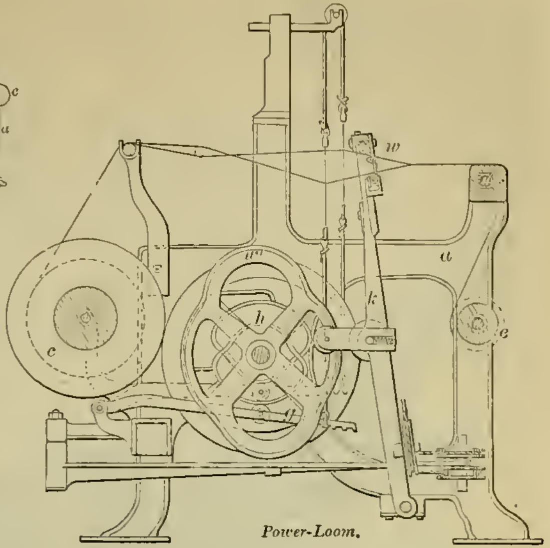
The warp a is wound upon the warp-beam b, and, passing over the roller c, is carried through the two healds d d, which alternately raise and lower the two sets of warp-threads, forming the shed for the passage of the shuttle. The shuttle is driven along the shuttle-race e by a kind of hammer f, worked by a lever g moving through a small arc of a circle. The finished cloth is kept tight by the temples h, a portion being wound on the cloth-beam i i.

Fig. 2998.



Working Parts of a Power-Loom.

Fig 2999.



Power-Loom.

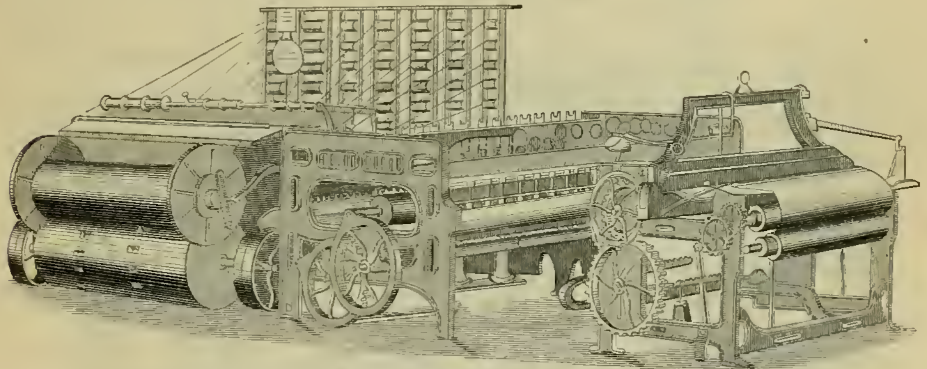
In the power-loom, five distinct actions are performed by steam-power.

1. Raising and lowering alternately the two sets of warp-threads.
2. Throwing the shuttle.
3. Driving up each weft-thread after the shuttle is thrown.
4. Unwinding the warp from the beam.
5. Winding the cloth on the cloth-roller.

An arrangement is also introduced for stopping the loom when a thread breaks, when the shuttle sticks in its passage, or when the yarn on the cop contained in the shuttle has run out. This may be effected in various ways, depending on the nature of the loom.

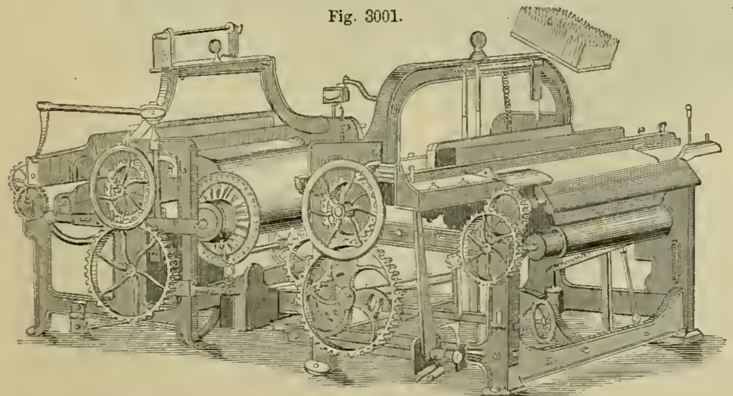
Fig. 2999 represents an improved power-loom. *a* is the frame, *c* is the warp-beam, and *e* the cloth-beam; *k w*, the lay. The heddles are actuated by cams *h* acting on the levers *g*, to which they are connected. On the same shaft is the scroll-cam *w'*, in which traverses a roller imparting a vibratory motion to the lay, in which is a raceway for the shuttle.

Fig 3000.



Warping-Mill, Winding-Machine, and Power-Loom.

Fig. 3001.



Looms for "Domestic" Cottons and for Linens

Fig. 3000 is a perspective view of a *warping-machine*, *winding-machine*, and a *loom* for light and medium cotton goods.

Fig. 3001 is a perspective view of two looms, one for "domestics" and heavy cotton goods, the other, on the right of the picture, for linens.

With the modern power-loom, the cost at Manchester of weaving a piece of cotton cloth 25 inches wide, 29 yards long, and 11 picks per ¼ inch, is estimated at 10¼ cents. One person can attend to two or three looms, and each loom produces 26 pieces of such cloth per day.

On the old hand-loom of 1800, one man would attend to one loom, and would produce 4 pieces at an expense of 66 cents each.

In plain cloths the warp and weft threads are of about equal fineness. Yarns of two different sizes introduced into the web produce a sort of striping. When the warp and weft threads are of different colors a shot pattern is produced.

Striped patterns are formed by introducing at regular intervals the different colored threads required; checks, by inserting different colored threads at proper distances in the warp and crossing them in the weft by threads of the desired color in sufficient number to give the desired width.

In twills, each weft-thread does not cross alternate warp-threads, but only the recurrent third, fourth, fifth, or sixth, the required number being inserted through each heald. See Twill.

Piled work, as velvet, velveteen, fustian, or piled carpet, is formed by introducing a third thread, previously looped by weaving it over wires the breadth of the fabric. In some kinds these are cut out with a knife, in others they are simply withdrawn from the loops.

Fig. 3002.

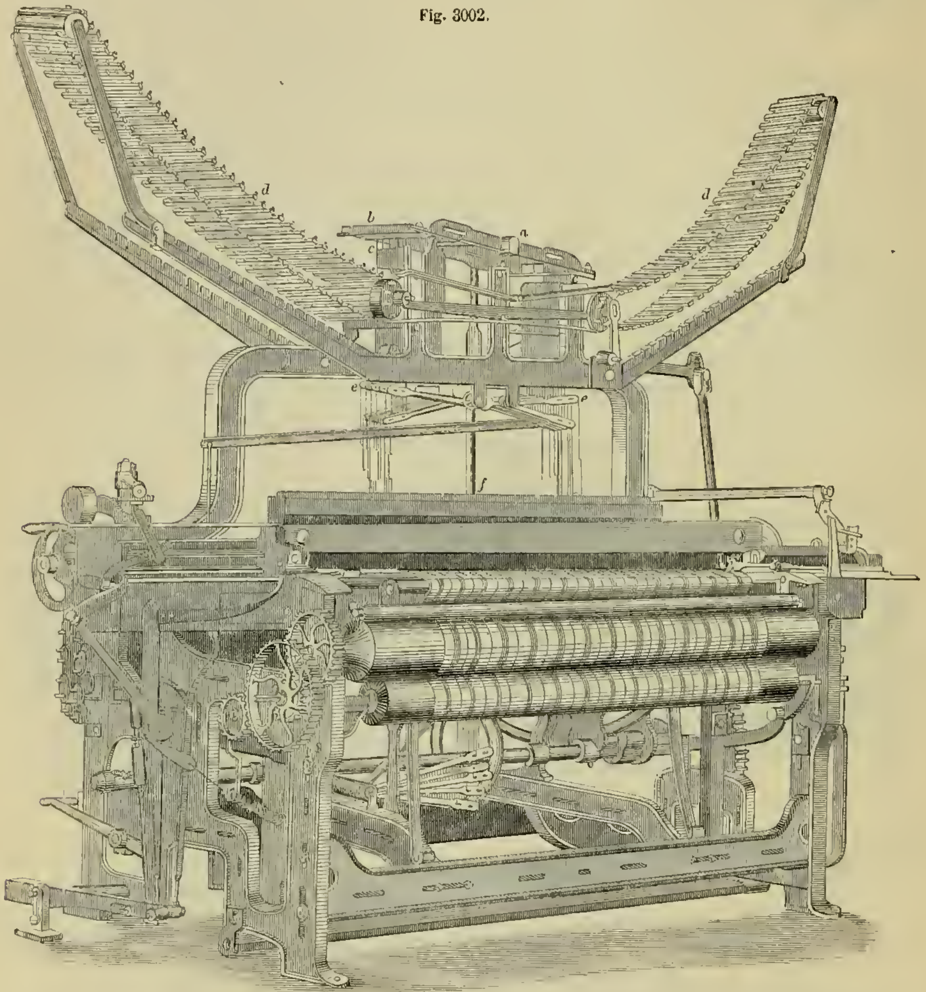


Figure-Loom.

One mode of making goods in patterns of colored figures is by means of a variety of shuttles, each carrying its own colored thread. These shuttles are arranged in a box which may be raised or lowered, so as to bring the required shuttle opposite to the picker which drives through the shed. This motion of the shuttle-box is obtained by means of a Pattern-wheel or Pattern-chain (which see).

Figures, previous to the invention of Jacquard, were formed in the *draw-loom.*

In this, the warp-threads were arranged in separate groups so disposed as, in conjunction with the weft-threads, to form the figures. The proper succession of the weft-threads as to color, etc., was arranged by the weaver, several shuttles being employed, if necessary. For this purpose, a pattern-card was provided, to which the workman could constantly refer. Each set of warp-threads was attached to a handle by which they were drawn up at the proper time by an attendant called a *draw-*

boy. This involved liability to mistakes, deranging the pattern, and to obviate this a mechanical draw-boy was invented.

Jacquard's ingenious invention superseded this, producing an entire revolution in the art of figure-weaving.

Joseph Maria Jacquard was born at Lyons, 1752; invented his loom for weaving figured fabrics in 1801; and died at Orleans in 1834.

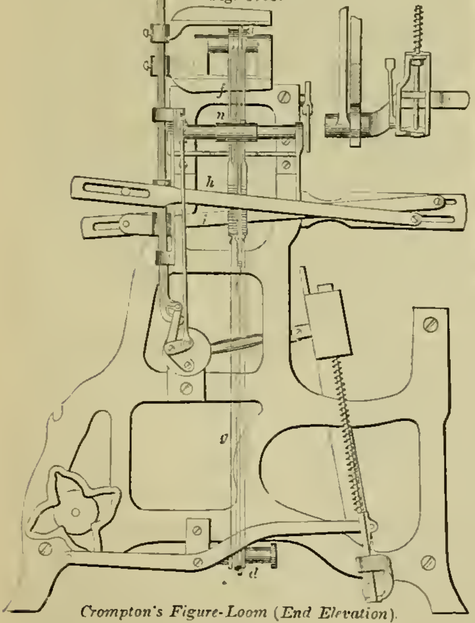
The action of the Jacquard in producing patterns upon fabric may be briefly described as follows: —

To the ordinary looms perforated cards are added, through which certain needles pass, causing the threads to rise and fall, according to the holes in the cards, thus reproducing upon the tissue in the loom the pattern which is perforated in the card. See Jacquard Loom.

Fig. 3002 is a view of an English power-loom for fancy weaving, having what is called a *dobby*, with the harness controlling mechanism.

The pattern-chains *d* are mounted in a frame at the top of the loom, and in their movement their pins act on vertical hooked wires or jacks *c*, connected with a series of coupled levers *e*, connected in turn with the harness-frames *f*. A rocking frame *a* at the top of the loom, provided at its opposite ends with cross or griff knives or bars *b*, engages the hooked wires selected by the pins of the pattern-chains, and raises the harness-frames necessary to produce the pattern. Plain and fancy twills, spots, satin checks, etc., may be produced. The loom also shows changeable shuttle-boxes.

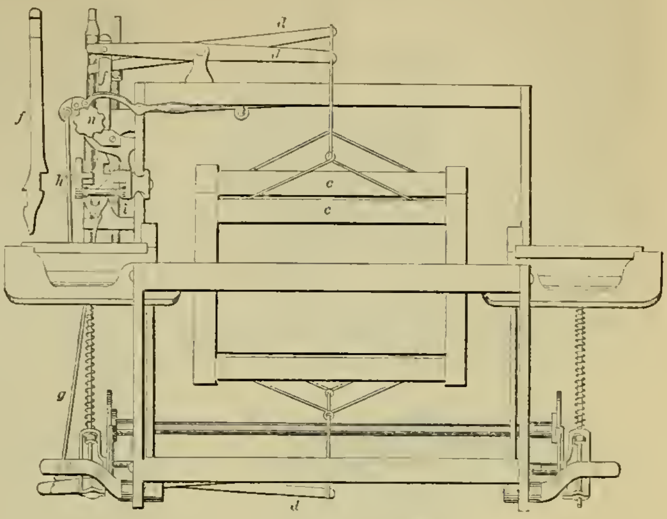
Fig. 3003.



Crompton's Figure-Loom (End Elevation).

One example of Crompton's looms is given in Figs. 3003 and 3004, the former being an end elevation and the latter a front elevation.

Fig. 3004.



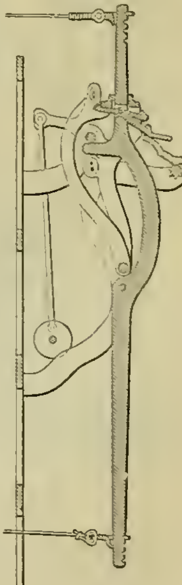
Crompton's Loom (Front View).

The harness-frames *c* are attached by cords or wires to horizontal top and bottom levers *d*, whose opposite ends are connected by means of notched jacks *f* and wires *g*. The notched jacks are moved by pins on a pattern-cylinder *n*, so that their notches are engaged by either the lifter or depresser *h i*, to raise or lower the harness-frames. This loom has also shifting shuttle-boxes, and the box-lever is moved by a star cam.

On the left of Fig. 3004, one of the jacks *f* is shown on an enlarged scale to exhibit the notches more clearly.

In another variety of Crompton's loom (Fig. 3005), vertical levers pivoted at the side are connected at bottom and top to the heddle or harness-frames by cords, and notched jacks pivoted to such vertical levers and controlled by a pattern-cylinder are engaged by bars which move the levers and open the shed, these bars acting as lifters, depressers, and eveners. The figure shows the motion work merely.

Fig. 3005.



Crompton's Loom (Shedding Motion).

In Short's loom for weaving fabrics of any width, the shuttles are carried through the shed by a belt having a continuous motion. This is supported on a carriage with small anti-friction rollers traversing the raceway when it is swung as a batten. A shuttle is engaged by a lug on the belt, and, after crossing the shed, deposited in a chaunel in the frame, when the belt engages another shuttle and carries it across in the opposite direction.

The number of patented inventions relating to looms and their appliances, both in this country and England, many of them of slight importance, is too great to give even a brief idea of here. Some of the more important will be found under their specific heads. See Weaving.

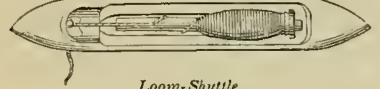
2. (*Nautical.*) The part of the length of an oar inside the gunwale in rowing. In contradistinction to the *blade.*

Loom-card. (*Weaving.*) A pierced pattern-card for Jacquard weaving.

Loom-har'ness. (*Weaving.*) That portion of the loom by which the warp-threads are moved to make the decussation, forming the shed in which the shuttle travels and leaves the weft-thread. The harness has heddles with loops for the warps, and a part are raised above the others, either in regular alternation for plain weaving, or in other order, according to the pattern. See Loom; Twill.

Loom-shut'tle. One for carrying the *weft*-thread through the *shed* formed by the decussation of the warp. An orifice is made through the shuttle in line with the yarn-eye, and another through the bottom at the same distance from the end. There are many varieties.

Fig. 3006.



Loom-Shuttle.

Loon'ghie. (*Fabric.*) A silk and cotton cloth of rich color, made in Sinde, in pieces about 4 yards long and 2 feet wide.

Loop. 1. (*Machinery.*) A slotted bar which forms a guide and limit to the motion of an object.

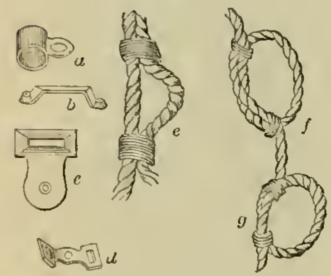
2. A sleeve or collar *a*, as that upon the middle of a neck-yoke.

3. (*Nautical.*) *e*, a bastard loop; a rope stopped with yarns.

f is a loop for slipping other lines, acting as a fair-leader.

g, a bend stopped with seizings.

Fig. 3007.



Loops and Loop-Holders.

4. A hinge of a door or gate.

5. A panel of bars joined together like a gate, to be removed in and out at pleasure.

6. (*Telegraphy.*) A wire going out and returning to the same point, as to a branch office, and forming a part of a main circuit.

7. (*Metallurgy.*) A mass of iron gathered into a ball on the floor of a reverberatory furnace, and in a pasty condition ready for the tilt-hammer or rolls.

It is conveyed by dragging on the iron plates which form a track on the floor, or in a little truck called a *ball-trolly.* A *loup.*

Loop'er. A perforated blade or bodkin for inserting the end of a carpet-rag through the end of another piece, looping them together to avoid the trouble of sewing.

Loop-hold'er. A carriage-iron (*b c d*, Fig. 3007) by which the *loop* of a strap is attached to running-gear or the bed.

Loop-hole. (*Fortification.*) An aperture or slit in a stockade or other defense, from whence musketry may be fired at assailants. Machiolation, embattlement, embrasure, crenelle.

Loop-line. 1. (*Railway Engineering.*) A connecting line of railway; one running into the trunk.

2. (*Telegraphy.*) A wire going out and returning to the main circuit. A *loop.*

Loos'en-ing-bar. (*Founding.*) A stiff bar with a point or screw which stands in a hole in the pattern, and extends upward through the top box. After ramming up, and before lifting the top part, this bar is struck alternately from opposite sides with a short, heavy piece of iron, so as to loosen the pattern slightly in the sand, after which it is removed. This operation facilitates the separation of the sand from the pattern, and lessens the amount of mending required. See Molding.

Loose-pul'ley. (*Machinery.*) A pulley running loosely on the shaft, and receiving the belt from the *fast-pulley* when the shaft is to be disconnected from the motor.

Lo'per. (*Rope-making.*) The swivel at the end of a ropewalk remote from the *whirl*, and to which the ends of the yarns are attached when laying up several yarns into a rope. As the twisting proceeds, beginning at the remote end, the *top* which holds the strands apart is gradually advanced towards the *whirl.*

Lop'ping-axe. A light axe used for trimming trees. The term may be considered as in contradistinction to *felling-axe* or *logging-axe.*

Lop'ping-shears. A pair of heavy shears for trimming bushes, hedges, etc.

Lor'cha. (*Nautical.*) A light Chinese coaster having a hull of European model and Chinese masting and rigging.

Lor-gnette'. An opera or spy glass.

Lor'ry. A handcart used on tramways, in mines, or at railway stations.

Losh-hide. An oiled, undressed hide.

Lost-mo'tion. The difference in the motion of a driver and a driven part, owing to looseness of fit of boxes, the connecting portion, or slip of belt.

Lounge. A sofa with a back and one end.

Lou'vre. (*Architecture.*) *a.* A turret on a roof for the escape of smoke or steam. A *lantern.*

b. Sloping boards overlapping each other, with a space between for ventilation. Also called *luffer-boarding; louvre* or *luffer* window or work.

Low-bell. 1. A bell used to slightly alarm birds and cause them to lie quiet, until they are flushed by a sudden noise.

2. A *sheep-bell.*

Low-blast Fur'nace. A metallurgic furnace in which the air of the blast is delivered at moderate pressure.

Low'er An'chor. (*Nautical.*) One down stream for anchoring boats.

Low'er Case. (*Printing.*) *a.* The case standing below the upper case which contains the capitals, etc. The lower case has the small letters, the points, and some other sorts.

b. The letters belonging to said case.

Low'er Deck. See Deck.

Low'er-ing. (*Printing.*) A depression of the face of a type or woodcut to cause it to print lighter. The removal of the thickness of the tympan in the appropriate spots assists in producing the required effect.

Low-press'ure En'gine. (*Steam-engine.*) In

England, one in which *a condenser is used*, and whose safety-valve is loaded at from *four to six* pounds to the square inch. — LARDNER.

The terms *high* and *low pressure* steam were formerly held to mean saturated steam at a pressure above or below that which will sustain a column of thirty inches of mercury; the boiling heat of water, 212° of Fahrenheit.

The term *low pressure* signifies in this country a pressure of not over fifty pounds to the square inch.

Low-re-lief′. The slight prominence of a sculptured object from the plane surface to which it is attached. Also known as *basso-rilievo.*

Low′ry. (*Railway Engineering.*) An open box-car.

Low-wa′ter A-larm′. The devices for this purpose may be classed under four heads.

1. Those in which a float in the boiler subsides with the water, and is the means of opening a feed-valve, turning a steam-cock to the whistle, and indicating on a dial the condition of the boiler.

2. Those in which the subsidence of the water uncovers the end of a pipe, and admits steam to a rod or tube whose increment of heat and consequent expansion operate mechanically upon a valve, and allow steam to pass to a whistle.

3. Those in which steam admitted to a pipe, as just stated, melts a fusible plug, and so allows steam to pass to a whistle.

4. Those in which the subsidence of the water uncovers the end of a pipe and allows water to flow from a reservoir on the end of a lever, the steam from the boiler occupying the place thus vacated. The change of weight incident to the substitution causes the motion of a lever, which is made to open a valve or turn a stop-cock and emit steam to the alarm-whistle.

1. The *float movement.*

A. The float is attached to an arm, and is immersed in water in the chamber which communicates by pipes with the boiler. Should the end of the lower pipe be uncovered by the subsidence of the water to that level, the water leaves the chamber and the float falls, depressing the valve and admitting steam to the whistle. When the water rises again, the upper valve is moved to allow steam to depart, and the normal condition is re-established.

B. The hollow steam-tight case has a central hub and a sector space, occupied by the arm of a float, which rises and falls with the changes of level of the water in the boiler. An indicator on the same axis moves with the float.

C. A float is placed on the crank-arm of the valve-stem, and rises and falls with the changes of the water-level, bringing a stud on the stem against an inclined socket, and raising the valve from its seat. This allows steam to pass to the whistle.

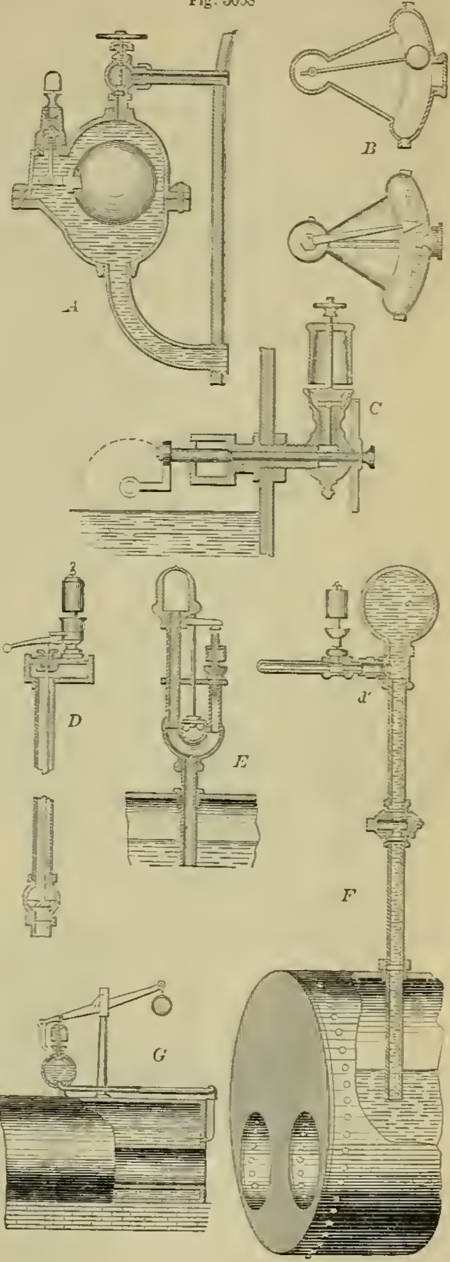
2. The *thermostat movement.*

D. When the water subsides below the end of the vertical pipe, which extends downward into the boiler, the water contained therein is discharged and steam substituted. The increased heat, due to the presence of steam, elongates the thermostatic rod in the tube and acts upon the lever to lift the valve from its seat; the steam rushes out and sounds the whistle.

E. This acts similarly to the foregoing, except that the effect is due to the expansion of the steam-pipes when the water is emptied and steam admitted. The lever has its fulcrum on a post between the pipes; the expansion of one of the latter depresses the valve-stem and withdraws the valve from its seat; the expansion of the other pipe withdraws the seat from the valve. The action of the two is cumulative. The passage of steam sounds the whistle, as in other devices for the same purpose.

3. The *fusible-plug action.*

Fig. 3008



Low-Water Alarms.

F. After the boiler has been filled to the water-line and put in operation, the pressure of the steam forces the water into the pipe and air-chamber *c*. As there can be no circulation of water in the pipe as long as the lower end of it is under the water-line, the *disk d* will continue solid; but when the water in the boiler evaporates below the end of the pipe to the alarm water-line, then the water in it falls of its own weight into the boiler, and steam at once takes its place, melts the plug, and notice of low water is given by the sounding of the whistle.

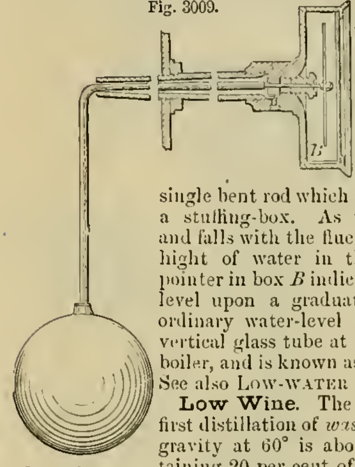
There are many variations of the fusible-plug device, some depending upon the direct heat of the steam, and others, as above, upon the admission of steam to a pipe which is normally charged with water.

4. The *gravity movement*.

G. A vertical pipe passes into the boiler, and its open end is at the level at which it is desired notice shall be given. This pipe forms a communication between the boiler and a reservoir on the end of a hollow arm and axis. In the normal condition this reservoir is filled with water; but when the end of the pipe is uncovered by the subsidence of the water-level in the boiler, the water runs out of the reservoir and steam takes its place. The change of weight in the reservoir, due to the substitution of steam for water, causes the arm to be lifted by the weighted lever and raise the valve which admits steam to the whistle.

Low-wa'ter In'di-ca-tor. An attachment to a boiler to show the depth of water in the boiler. It may, as in the example, be an arrangement of float and needle mounted upon opposite ends of a single bent rod which passes through a stuffing-box. As the float rises and falls with the fluctuations of the hight of water in the boiler, the pointer in box *B* indicates the water-level upon a graduated arc. The ordinary water-level indicator is a vertical glass tube at the end of the boiler, and is known as a *water-gage*. See also LOW-WATER ALARM.

Fig. 3009.



Low-Water Indicator.

Low Wine. The product of the first distillation of *wash*. Its specific gravity at 60° is about 0.978, containing 20 per cent of alcohol.

Loz'enge. 1. An oblique-angled parallelogram. A *rhomb*. A *diamond*.

2. A confection.

Loz'enge-grav'er. (*Engraving*.) A graving-tool whose cross-section is of a rhomb or diamond shape. The two faces which meet to form the belly of the graver have an angle less than 90°.

Loz'enge-ma-chine'. A machine for rolling out and cutting lozenges, crackers, etc.

In the machine shown in Fig. 3010, *dough* is rolled out to the required thickness by passing between rollers *B*, follows the endless band *C*², and passes over the perforated cutters *E*². Here the feed is stopped, and the platen *H* falls on the dough, forcing the lozenges down upon an endless belt *I*³. When the platen rises, the unused *dough* is carried to the end of the machine by the forward motion of the cutters, and returned to the rolling-cylinders by an attendant.

Loz'enge-mold'ing. (*Architecture*.) An ornament inclosing diamond-shaped panels.

Lub'ber's-hole. (*Nautical*.) An opening in the floor of the *top* for those to crawl through who are afraid to climb up by the *futtock-shrouds*.

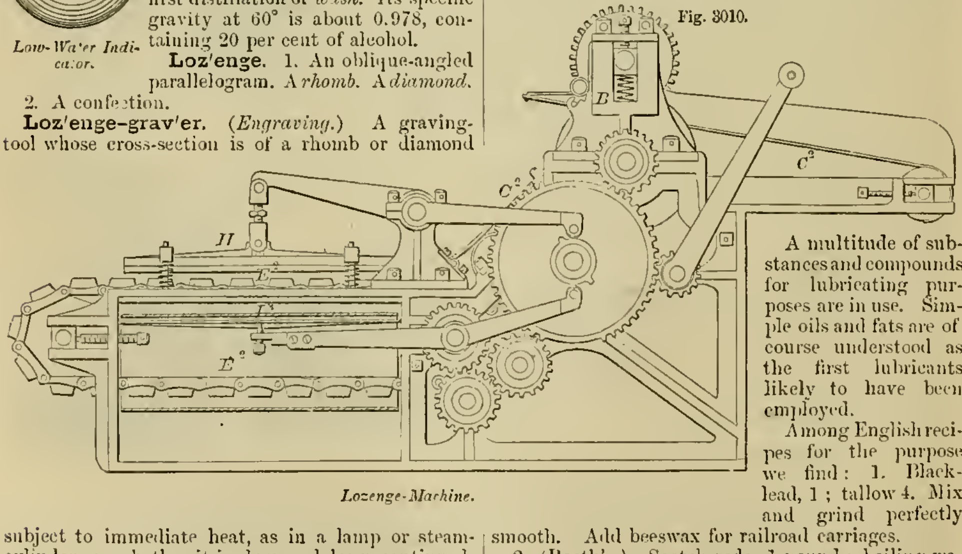
Lu'bri-cant. A substance used to diminish friction of the working parts of machinery.

According to M. Morin, the friction of a cast-iron shaft upon a dry bell-metal bearing amounts to nearly one fifth of the power transmitted, while with a wrought-iron shaft friction absorbs more than one fourth. When well lubricated, the loss is reduced to .065 and .09 respectively.

The requisites of a good lubricant are that it must endure the heat even of melted lead, without change, in order to stand friction and lubricate the cylinders of steam-engines. (The heat under a pressure of 150 pounds of steam is enough to decompose or distill and dry up most of the natural oils in market.) They must be fixed and not volatile oils, as produced by destructive distillation, otherwise they are decomposed by friction, and burnt or dried up. They must not show or possess any acid reaction, either naturally or artificially, otherwise the bolts are cut in the steam-chest, and the iron, particularly wrought-iron, is made porous. They must possess a sufficient power of tenacity without oxidation, otherwise they will gum.

The same laws are applicable to signal and burning oil, for it makes no difference whether the oil is subject to immediate heat, as in a lamp or steam-cylinder, or whether it is slow and long continued, as in slides and other bearings, the effect and result are the same in the end upon the oil.

Fig. 3010.



Lozenge-Machine.

A multitude of substances and compounds for lubricating purposes are in use. Simple oils and fats are of course understood as the first lubricants likely to have been employed.

Among English recipes for the purpose we find: 1. Black-lead, 1; tallow 4. Mix and grind perfectly smooth. Add beeswax for railroad carriages.

2. (Booth's.) Scotch soda, 1 pound; boiling water, 2 gallons; palm-oil or tallow, 10 pounds. Agitate till the mixture is cooled to 65° Fah.

3. (Mankettrick's.) Caoutchouc dissolved in oil of turpentine, 4 pounds; Scotch soda, 10 pounds; glue, 1 pound; dissolve in water, 10 gallons; oil, 10 gallons. Stir, adding caoutchouc last.

4. Rape-oil, 1 gallon; caoutchouc (cut small), 3 ounces. Dissolve with heat.

The following compounds have been used in America: —

Resin, flowers of sulphur, antimony, oil rosemary, lampblack, water, carbonate of iron, sheep's tallow.

Animal oil, palm-oil, paraffine.

Asbestus, graphite.

Palm-oil, tallow, borax, salt, water.

Soapstone, petroleum, sulphur, antimony, oil.

Lampblack, petroleum.

Coal-oil, isinglass, Irish moss, glue.

Caustic soda, tallow, petroleum, animal hair.

Paraffine, resin, cotton waste.

Tallow, sulphur, soapstone.

Petroleum, plumbago, beeswax, mutton-tallow, soda.

Lime, chalk, carbonate of potash.

Leather boiled in carbonate of soda, oil, sulphuric acid.

Water, salts of niter, sulphur, soft soap, salt pork.

Borax and oil.

Petroleum residuum, alkali, ammonia, saltpeter.

Graphite, oil, caoutchouc.

Asbestus and grease.

Lignum-vitæ, spermaceti.

Ivory dust, spermaceti.

Tin and petroleum.

Zinc and caoutchouc.

Plastic bronze and caoutchouc.

Boiling water, tallow, palm-oil, salts of tartar.

Oil, lime, graphite, castor-oil.

Shorts, soapstone, graphite.

Coal-oil residuum, chloride of sodium, hydrated potassa, muriate of ammonia, spirits turpentine, linseed-oil, flowers of sulphur.

Petroleum residuum and flour.

Petroleum residuum, soapstone, sulphur, and lard.

Mixed heavy and light petroleum.

Oil, wax, resin, india-rubber, potash.

Petroleum residuum, sal-soda, brimstone, kerosene.

Glycerine, graphite, asbestus, kaolin, manganese, steatite, sulphide of lead, carbonate of lead, cork.

Saponified resin, wheat flour, middlings, petroleum, animal fat, soda.

Type-metal and caoutchouc.

Anthracite coal and tallow.

Oxide tin, beeswax.

Soapstone, magnesia, lime, oil.

Sulphur, petroleum.

Vulcanized rubber, petroleum, tallow.

Paraffine, oil, milk of lime.

Asbestus, tallow.

Spermaceti, india-rubber.

Tallow, petroleum, soda, hair.

Mercury, bismuth, tin, antimony.

Crude petroleum, sal-soda, lime, tallow, lard, salt, pine-tar, spirits turpentine, camphor, alcohol.

Sulphur, plumbago, mica, tallow, oil.

Palm-oil, paraffine, tallow, alkali, asbestus.

Tallow, oil, paraffine, lime-water.

Flaxseed-oil, cotton-seed oil, lime-water, tallow.

Petroleum, tallow, beeswax, soda, glauber's salts.

Animal-oil, croton-oil, spermaceti, tallow, soda, potash, glycerine, ammonia.

Mica.

Sheets of paper or of fabric, impregnated with graphite, steatite, paraffine, tallow, size, or soluble gums, are used for lubricating.

The best lubricant for bullets was found by the Springfield Board to consist of eight parts bayberry-wax and one part graphite. Japan wax is often used with graphite, but with inferior results.

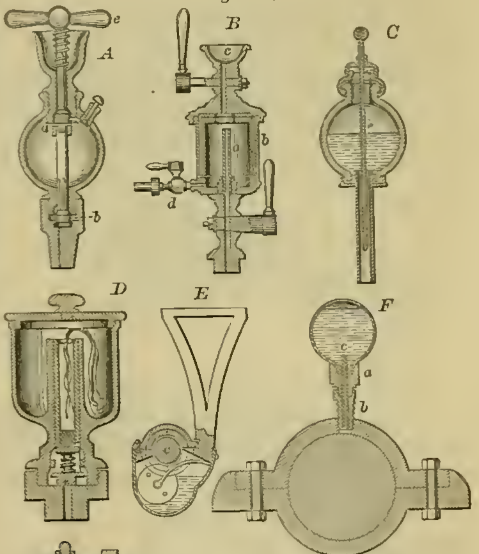
Graphite cannot be made fine enough for lubricating purposes if separated by bolting, but must be separated by floating either in water or air. The simplest method is the water separation, and during the process it should be treated to a bath of dilute sulphuric acid, which will take up the particles of spar and iron, leaving the sulphates of lime, magnesia, and iron easily washed out. The mode of floating and settling to obtain the powder of ultimate fineness is described under PENCIL. For the finest pencils, for lubricating and for electrotyping, the mineral should be in impalpable condition.

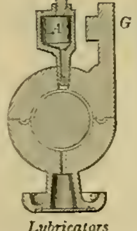
Lu′bri-ca-tor. 1. (*Steam-engine.*) An oil-cup or other contrivance for supplying oil or grease to rubbing surfaces, in order to diminish friction. The number of patented devices of this kind is large. A few are shown in Fig. 3011.

In *A* the two valves *a b* are connected by a rod. By turning the handle *e* in one direction the valve *a* is depressed by means of a pin working on an inclined plane, and admits oil to the reservoir. A reverse motion opens the valve *b*, furnished with a similar contrivance, permitting the oil to flow from the reservoir. The valve *a* is kept to its seat by a spiral spring on the rod.

B. Steam is admitted through the pipe *a* to the oil-chamber *b*, forcing out the lubricating material through an opening to the desired point. The supply of oil from the cup *c* is regulated by a cock, and a cock *d* at the side of the oil-chamber permits accumulating water of condensation to be drawn off. The oil-chamber is of glass, protected by a metallic casing.

Fig. 3011.





Lubricators for Machinery.

C. The central tube *c* is open, and when the oil sinks below its lower end air is admitted through it and the annular passage to the reservoir above, and allows an equivalent amount of oil to descend. The vertical adjustment of the tube regulates the flow by determining the hight of the column of oil resting upon the journal.

D. The oil is conducted from the annular reservoir by a wick of fibrous material into the tubular valve-stem. This stem has radial holes at its lower end for the discharge of oil, and wire-gauze to arrest impurities. Between the upper and lower valves is a spiral spring. When the engine is running, the valves are closed by steam and spring pressure; when stopped, the upper valve is closed by the spring, and when running without steam both valves are sucked open and the oil flows.

E. 2. (*Shafting.*) A pivoted disk in a cup below the lower journal-box is revolved by contact with the under side of the shaft *c*, and carries up oil to lubricate the latter. See also SHAFTING; JOURNAL-BEARING.

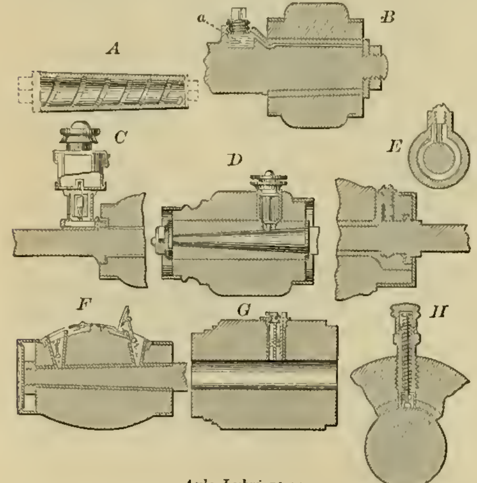
F has a transparent reservoir with metallic socket *a* screwing into the seat *b*, fitted to the cap of the journal-box. Between this and the journal is a slight vacuity, from which air is admitted through the tube *c*, allowing a greater or less quantity of oil to flow in proportion as the journal turns more or less rapidly. When at rest the flow ceases.

G. The flow of oil from the cup *A* is regulated by an adjustable screw-plug. The bearing has ducts for conveying surplus oil from the upper part of the shaft toward the center, and at its lower part is a closed chamber forming a drip-cup.

3. (*Vehicle.*) The ordinary mode of lubricating carriage or wagon axles is by placing grease on the spindle and then putting on the wheel, giving it a few revolutions before lowering it again to the ground. The grooves in the box of the hub form pockets in which the grease collects, and from which it passes to the spindle as it gradually wastes away. Many patents have been granted for devices in the boxes for retaining the lubricant, and are cited under AXLE-BOX.

In Diller's (*A*, Fig. 3012), a spiral groove is formed around the inner surface of the box, and leads the grease to all parts of the spindle, while the integrity of the bearing-surface of the box is not materially interfered with.

Fig. 3012.



Axle-Lubricators.

The lubricating devices are attached to the spindle or axle, or to the hub of the wheel. Of the former, two will be cited as representatives of their section of this class. Those attached to the hub are the more numerous.

B. The reservoir *a* is closed by a screw-plug, which is turned to force the oil through a duct leading to a groove in the upper part of the spindle. The groove tapers toward the outer end, so as to distribute the oil equally.

C. A *lantern* is attached to the axle of the carriage just inside of the butting-ring. The oil-reservoir, besides furnishing supply to the wick of the lantern, also supplies oil through a duct to the bearing surfaces.

D. A tube passes radially through the hub, its lower end opening into the interior space of the box. The oil-reservoir is covered by a screw-cap. The inner end of the tube is closed by a valve whose stem is attached to the cap. By turning the screw-cap the valve is opened or closed, and the oil allowed to flow, or is cut off.

E. An oil-chamber is made in the box and communicates with the bearing surfaces. The reservoir is closed by a screw-plug, and the oil passes gradually to the spindle without special attention.

F. One or more conical openings in the hub, each closed by a spring-lid to which a rod and sponge are attached, extend to the axle. The sponge is charged with oil on opening the lid. This is kept shut by the spring when the wheel is in motion.

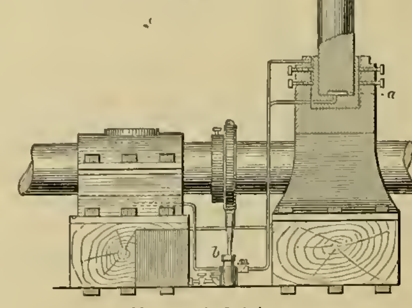
G. An oil-cylinder, having a piston on a screw-rod which works through the cylinder-cap, is inserted in the hub. Turning the head of the rod pushes the piston down, forcing the lubricant upon the axle-spindle. The piston is kept from rotating with the screw-cap by a groove in its edge, into which a feather on the inside of the chamber fits.

H. The depression of the spring-valve allows oil to flow from the chamber to the spindle of the axle.

The patents on lubricators are very numerous. Those referring to *railroad-axles* and *journal-bearings of machinery* are treated separately. Oil cups and cans, which are portable lubricators, are treated of under their proper title, OIL CUPS AND CANS.

The *hydrostatic lubricator* for heavy bearings consists of a chamber *a*, into which oil is forced by a hydrostatic pump *b*. By this means, at every revolution, the shaft is raised from its seat by the pressure of the oil. On the return stroke of the pump, the shaft seats itself on the oil that has been forced under it; the oil returns back to the pump as it flows through the bearing. Unlike other systems of hydrostatic lubrication, this does not seek to keep the shaft in equilibrium; but, on the contrary, it keeps it in constant motion up and down, by the injection of the oil, aiming thus to secure a more perfect lubrication.

Fig. 3013.



Hydrostatic Lubricator.

It is stated that a step in Starr's Flour-Mill, at Vallejo, California, supporting a four-ton shaft making ninety-three revolutions per minute, has been run constantly, day and night, for seven months, with this lubricator, without changing the oil; and the oil, when taken from the reservoir at the end of that time, had not become thickened or discolored in any appreciable degree. See PALIER GLISSANT.

4. (*Ordnance.*) An arrangement for lubricating and cleaning the grooves of rifled guns.

In the English service it consists of a copper wad containing equal parts of tallow and oil, then a felt wad, and then a disk of millboard, all joined together. The copper is placed against the projectile, and when the charge is exploded the oil is ejected and lubricates the bore, while the felt wipes out the piece.

Lu-cer'nal Mi'cro-scope. A microscope in which the object to be examined is illuminated by the light of a lamp.

The object is placed in a sliding tube between the lens and the lamp, which is contained in a box. The image is received on a screen or plate of ground glass.

Lu'ci-fer. Originally, a match tipped with a mixture of chlorate of potash and sulphuret of antimony, which were inflamed by friction upon a piece of emery-paper.

These were superseded by mixtures containing phosphorus. See LIGHTING-DEVICES.

Lu-cim'e-ter. An instrument for measuring the intensity of light. A photometer.

Various photometers have been invented by Huyghens, Rumford, Celsius, Bouguer, Priestley, Ritchie, Arago, and others, which are described under that head. See PHOTOMETER.

Celsius called his device a *lucimeter*, and the name has since been adopted by Deslaurier in his modification of Bouguer's apparatus.

Deslaurier's apparatus is designed for measuring the quality of burning oils by their illuminating power. It consists of two constant-pressure lamps, and its shape is triangular; sheet-iron screen, painted black, and divided into two equal compartments. The latter are turned toward the lamps, while the observer stands on the opposite side, which presents nothing but a flat vertical surface, pierced with a hole bisected by the partition. Each of the two lamps is so placed as to transmit its light to only one compartment, and exactly to the part where the hole is. The hole is covered with a piece of transparent paper, on which the light from the two lamps is contiguously depicted. If their intensity is the same, the observer will perceive no difference. If not the same, one lamp must be moved back until its light is equal to the other in intensity, and the difference in the distance of the two lamps will make the relative quality of the two oils, which, combined with the quantity consumed in a given time, will determine their marketable value. The ratio of value is directly as the squares of the distances.

Luff. (*Nautical.*) The foremost or weather edge or leech of a sail.

To *luff* is to bring the ship's head nearer to the wind.

A *luff-tackle* has a *double* and *single block* and a *fall*, and is used for many purposes.

Luf'fer-board'ing. Slanting slats placed one above another, with intervals, so as to shed the rain, but permit ventilation; or the exit of sound from a belfry, or smoke and steam from a boiling-house.

Luff-tack'le. (*Nautical.*) A purchase composed of a double and a single block. The standing end of the rope is fast to the single block and the *fall* comes from the double.

Luff upon Luff. (*Nautical.*) One luff-tackle applied to the *fall* of another.

Lug. A projecting stud or ear by which an object is grasped or supported, or which affords a bearing or point of attachment; as, —

The lugs on the *parts* of a flask by which they are united. The lugs by which a kettle is supported in a furnace, etc.

Lug'gage-sad'dle. (*Menage.*) A pad on a led horse for carrying baggage.

Lug'gage-van. 1. (*Railway.*) The English term for a baggage-car.

2. (*Vehicle.*) A *fourgon*, or van containing personal baggage, attending on a traveling-carriage.

Lug'ger. (*Vessel.*) A small vessel carrying two or three masts and a lug-sail on each.

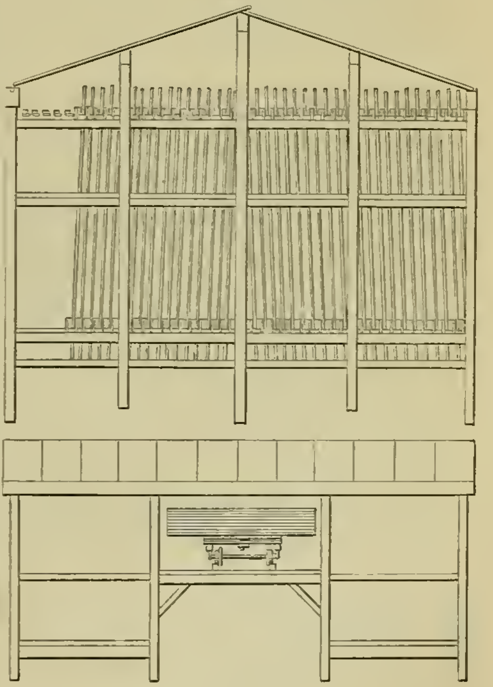
Lug-sail. (*Nautical.*) A four-cornered sail bent to a yard, which is slung at a point $\frac{2}{3}$ of its length from the peak.

A vessel thus rigged is a *lugger.*

Lum'ber. Timber sawed into merchantable forms.

Lum'ber-dry'er. A shed or closed chamber in which sawed lumber is subjected to an artificially heated and dried atmosphere. In the example, a series of girts having a ribbed edge on the inside, for the purpose of supporting strips, are arranged within a suitable building, the strips serving to hold boards or lumber on end. The drying-sheds have grated or open floors for sticking lumber standing on end, and are built double with a space between for an elevated railway track and car, the latter having a swivel platform.

Fig 3014.

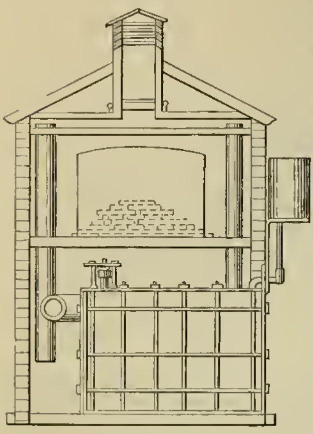


Lumber-Dryer.

In Fig. 3015, a continuous supply of water is introduced by gravity into the generator. The dry steam is introduced within the kiln, and, after absorbing the moisture of the lumber, is conducted to the escape.

In another apparatus for this purpose, the process consists in subjecting the lumber to the action of a gradually increasing temperature, in an air-tight chamber, until all or nearly all the moisture has been extracted from it ; in retaining all the heat and watery vapor about the lumber until a temperature of about 170° Fah. has been attained in said air-tight chamber ; and, finally, in compelling the heated moistened air to escape slowly from said chamber while the temperature is reduced therein.

Fig. 3015.



Lumber-Dryer.

Davis and Symington's lumber-dryer, English patent, 1843, acts by means of a heated blast upon lumber or wooden articles placed in a chamber through which the blast is driven. By their process, —

Mahogany is reduced in weight	24.4 per cent.
Pine is reduced in weight .	34.5 per cent.
Fir is reduced in weight . .	12.5 per cent.

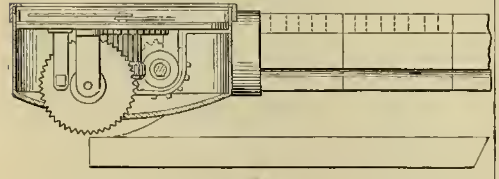
Lum'ber-kiln. A heated chamber for artificially drying lumber. See LUMBER-DRYER.

Plank should never be allowed to remain undisturbed until it seasons ; but should all be handled over and repiled from time to time, removing the sticks from their former positions. The planks should be turned over, especially if they have become bilged.

Two to six years are required to season timber, according to its size. It can be seasoned more quickly if it be steamed, but excess in steaming kills the elasticity of the timber. Too rapid kiln-drying evaporates the surface moisture too rapidly, and causes the timber to check.

Lum'ber-meas'ure. One by which the number of superficial feet contained in boards of different lengths can be estimated. Within the case is a disk in a vertical position, which, by being made to pass over the surface of the boards, indicates on a dial their superficial contents. Connected to the shaft of the disk is a sliding shaft, carrying on its end an endless screw, through which the motion of the shaft of the measuring-disk is transmitted to the arbor, carrying the index-heads in such a manner that by simply adjusting the sliding shaft the instrument can be set for boards of different lengths. A sleeve projecting from the bottom of this case and terminating under the center of the disk enables the operator to commence measuring with the edge of the board directly under the center of the disk.

Fig. 3016.



Lumber-Measurer.

Lum'ber-wag'on. A heavy wagon, long coupled, and having standards to the bolsters, for hauling sawed timber.

Lump. 1. A bloom or loop of malleable iron.

2. The nipple-seat on a gun-barrel.

Lu-nette'. A term applied to objects of a half-moon shape.

1. (*Fortification.*) A detached work presenting a salient angle towards the enemy, and having flanks open at the *gorge*.

With the flanks it has the character of a *detached bastion ;* without the *flanks*, it would be a *redan ;* with the *gorge* closed, it would become a *redoubt*.

2. (*Ordnance.*) A forked iron plate into which the stock of a field-gun carriage is inserted.

3. (*Architecture.*) *a.* An arched aperture in the side of a long vault, and having a less hight than the pitch.

b. A semicircular aperture in a concave ceiling.

c. An opening in the roof of a house.

4. (*Farriery.*) A horseshoe having only the front, curved portion ; lacking the branches.

5. The flue connecting the fire-chamber with the pot-chamber of a glass-furnace.

6. (*Harness.*) A blinder for the eyes of an intractable horse.

7. (*Optics.*) *a.* A perifocal spectacle-glass ; concavo-convex, its curve approximating the shape of the eye and affording more distinct oblique vision.

b. A flattened watch-crystal or glass, to avoid adding to the thickness of the watch.

The edge of the watch-glass fits within the bezel.

Lurch-line. The line which draws the bird-net over the prey.

Lure. A velvet brush or smoothing-pad used by hat-makers. From *Velure* (Shaks.), velvet. Fr. *Velours ;* Old Fr. *Villuse ;* from Lat. *Villosus*, hairy. Also called *velour ; lewer*.

Lus'ter. 1. (*Fabric.*) A lady's dress-goods with a cotton chain, woolen filling, plain or *self* color, and highly finished surface.

2. A sconce or chandelier.

Lus'ter-ing. 1. A polish ; as black-luster for stoves, etc.

2. (*Metallurgy.*) The brightening of metal in the crucible at the moment of reaching its point of purity. As in the cupellation of silver, when the last traces of lead pass off. *Brightening ; lightening.*

Lus'ter-ware. A stone-ware on whose surface are burnt metallic oxides of brilliant colors. It is made of a mixture of clay, flint, China-stone, and felspar, coated with a peculiar glaze on which is applied, by means of camel-hair brushes, a pigment prepared from metallic oxides, simulating the luster of various metals, etc. Platinum produces a luster like that of polished steel ; gold and silver, those of the precious metals. Iron and copper lusters may also be produced. A beautifully iridescent appearance is derived from chloride of silver in combination with other substances.

The luster is brought out by the heat of the oven in the process of baking.

Lus'tring. (*Fabric.*) A shining silk ; *lute-string* is a corruption.

Lute. 1. To stop with clay ; as the cover of a furnace, or a muffle to resist the passage of fumes, or of a charged retort to prevent the escape of gas around the cover.

2. A composition to secure the joints of chemical vessels and tubes, or as a covering to protect them from the fire.

Their compositions are various; e. g. —

1. Linseed-meal and whiting.
2. Lime and bullock's blood.
3. Plaster of paris.
4. Powdered clay and boiled oil.
5. Powdered clay, ground brick, and borax water.
6. Pipe-clay and horse-dung.
7. Vulcanized rubber thimbles.

A lute for the bungs of powder-cases is formed of tallow, 14; beeswax, 6. Melted together and softened by beating before using.

Lutes not exposed to high temperature may be made of *moistened bladder, linseed-meal*, and *gum-water, white of egg* and *quicklime, glazier's putty* (chalk and linseed-oil), *pipe-clay* and *drying-oil.*

Lutes for high temperatures are made of clay and sand, beaten into a paste and thinned with water. If intended to vitrify, borax or red-lead may be added.

Fat lute is made of finely pulverized pipe-clay and drying linseed-oil. It is used to join parts of apparatus exposed to considerable temperature, and intended to contain corrosive vapors. It is tied on by strips of bladder.

Iron cement is formed of sulphur, 1 : sal-ammonia, 2; iron turnings, 80. Calked into the joints.

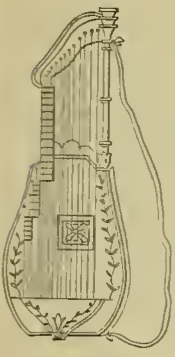
3. A packing-ring of india-rubber placed between the lid and the lip of a jar, to prevent the access of air to the contents. See Fruit-jar.

4. (*Music.*) A musical stringed instrument, played like a guitar, but having a pear-shaped form and a ribbed back. It is derived from the lyre.

The old Egyptian lute is represented in many places in Egypt; one at Thebes has a long neck without frets, three strings, and a fiddle-shaped body.

A lute shown on the signet-ring of Shoofoo, the Suphis of the Greeks (2325 B. C.), has a fretted neck. See the late Dr. Abbott's collection, New York. In Egypt we find the originals of most of the types of musical instruments. See Harp; Castanet; Drum, etc.

Fig. 3017.



Ventura's Lute.

The lute consists of four parts: the *table;* the *body*, which has nine or ten sides; the neck, which has as many stops or divisions; and the head or cross, in which the screws for tuning it are inserted. The performer strikes the string with the fingers of the right hand, and regulates the sounds with those of the left.

Simply constructed, it is called the *French* lute.

With two necks, — one for the base notes, — it is called a *theorbo.* If the strings of the *theorbo* are doubled, it is called an *arch-lute.*

Ventura's lute is intended to combine the principles of the *harp, lute,* and *guitar.* The performer is enabled to stop the treble strings on a finger-board, which materially increases its compass, and yet retains the fullness of tone of the other strings.

5. A straight-edge employed to strike off the surplus clay from a brick-mold.

Lute'string. (*Fabric.*) A plain, stout silk or silk ribbon: from *lustring.*

Lu'thern. An upright window in the roof. A *dormer*-window.

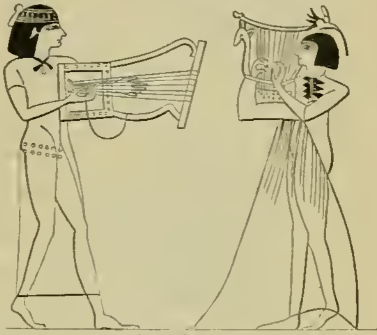
Lych'no-scope. (*Masonry.*) A narrow window near the ground.

Lye. A solution of an alkali. Used in soap-making; in neutralizing an acid; in cleansing grease from objects, such as thin iron plates in the operation of tinning, etc.

Lyre. A stringed instrument of the harp kind. Its origin is lost in antiquity. It is claimed of course by the Hellenic Greeks, who learned so much from the nations of Egypt, Phœnicia, and Asia Minor, and then slurred the debt in a muddle of mythology. This latter indeed was similarly derived and fearfully garbled. It cannot even be admitted that the Egyptian lyre was but of 3 strings, the other 4 being added by the Greeks to form the *heptachord.* The origin of the lyre is attributed by the Greeks to Hermes. (See Harp.) It was specially the musical instrument of Apollo.

The ancient Egyptian lyre was made in various forms, some of them very ornate. It was sometimes struck with the *plectrum*, and sometimes the strings were played by hand. The strings were of catgut, and numbered from four to eleven in the different figures.

Fig. 3018.



Egyptian Lyres.

The lyre is represented in the sculptures of Nimroud.

Some of the early Grecian lyres had an arrangement for changing the length of the string. This was done by a sliding bar, which might be moved by the musician during his performance.

The same idea has been introduced in modern lyres or harp-lutes, in which eight strings have, by this means, been made to yield twenty-four distinct tones.

The lyre was, in fact, a small harp, and the hollow resonant portion became, in time, expanded into a chamber over which the strings were stretched in parallelism, forming a *dulcimer*, the immediate parent of the *hammer* group, — *citole, clarichord, clavicytherium, virginal, spinet, harpsichord, piano* (see Piano). Another, and perhaps earlier, divergence of the instrument with strings in parallelism above a sounding-board is found in a portallo class, — the *monochord, cithara, guitar*, and a host of other instruments with names less widely known, such as *theorbo, pandore, mandolin*, etc. These instruments were played by the *fingers* or by a *plectrum*, and from them came out the class of instruments played by the *bow*, of which the *viol* is the head, and the others take their names as relatives, — *violin, viola d'amour, violoncello, bass-viol.* See "Description des Instrumens Harmoniques," by Father Bonanni, Rome, 1776.

M.

Mac-ad′am-iz-ing. A mode of paving roads, introduced by Macadam, the *metal* or surface stone consisting of pieces of granite, whinstone, limestone, or hard freestone, according to the kind of rock which is accessible.

Telford's rule, when two courses were used, was to make the lower one of blocks 7 inches in depth, laid by hand, broad end downward, and chinked with smaller stone.

Over this, 7 inches of smaller stones were laid, no stone to weigh over 6 ounces, and all to pass through a metallic ring 2½ inches in diameter. The stone is broken to uniform sizes, and several machines have been devised for this purpose. See Stone-crusher.

Ellis and Everard's stone-crushing mill has a strong feed-apron, composed of iron links and bars, which, passing around two wheels, delivers fragments of granite to a hopper which feeds them between two chilled-iron crushing-rollers; they then pass between a second pair of rollers which still farther reduce them in size. The rollers are fluted, and may be adjusted to break the stone to any required size. From the rollers they pass to a revolving griddle, which separates those of the proper size. Those which are too large are raised by an elevator to be again passed through the machine. Rolls weighing 10 cwt. each will, it is said, crush 1,800 tons of granite before being worn out; and it is claimed that the work is performed in England at one fifth the cost of doing the same by hand.

The stone-grinding mill of Neal is designed for *pulverizing* stone. See also Ore-mill.

Mace. 1. (*Weapon.*) A mallet, hammer, or slung-shot used in the Middle Ages to oppose warriors in armor. It had many forms: a simple iron club; a spiked club; a pointed hammer; an iron-spiked ball chained to a handle about 2 feet long. The latter were called *morning stars* by the train-bands of London; a grim pleasantry.

The Assyrian soldiers used "wooden clubs knotted with iron." — Herodotus, VII. 63.

The bent maces (*lissan*) are found in the old Egyptian pictures, and are yet common in Africa and elsewhere.

In the times of the Plantagenets the mace was used in battles and tournaments, and was superseded by the pistol in the time of Elizabeth. The mace is still retained among the Turkish cavalry.

2. (*Leather.*) A currier's mallet with a knobbed face, made by the insertion of pins with egg-shaped heads. It is used in leather-dressing to soften and supple the tanned hides, and enable them to absorb the oil, etc. It is analogous to the fulling-hammer.

Mac′er-ate. To wear away by steeping.

To saturate a substance, — fiber for paper, for instance, — so as to distend the fibers.

Mac′er-a′tion. The process of softening and separating the parts by steeping.

A *solution* is the diffusion of the particles of a solid in a liquid without change of its nature.

An *infusion* is a solution obtained by steeping at a moderate temperature.

A *decoction* is a solution obtained by boiling.

A *steep* is a solution obtained by maceration or soaking, as the ooze of bark; or by simply dissolving, as a mineral salt forming a mordant or a fertilizing liquid.

Ma-che′te. The Spanish implement for cutting cane, corn, vines, etc. It is now made in large quantities for the Southern market, and many of the implements are diverted to home use, as corn and cane knives. See Corn-knife.

Mach′i-co-la′tion. (*Architecture and Engineering.*) Apertures between the corbels supporting a projecting parapet. They were much employed in castellated architecture, and were intended for the purpose of allowing missiles to be hurled down on assailants approaching near the walls.

Ma′chi-cou-lis′-gal′ler-y. (*Fortification.*) A projecting gallery with loopholes arranged to obtain a downward fire on an enemy.

Ma-chine′. An instrument of a lower grade than an *engine*, its motor being distinct from the operating part, whereas the *engine* is automatic as to both.

It is also distinct from a *tool*, as it contains within itself its own guide for operation.

Ma-chine′-tool. A machine in which the tool is directed by guides and automatic appliances. Aptly called by Dr. Barnard "a mechanical artisan" with "iron arms." It is a workshop appliance for operating upon materials in the way of shaping and dressing, having devices for dogging the stuff and feeding the tool.

Among tools of this class for working in metal may be enumerated the lathe and machines for planing, slotting, shaping, drilling, punching, and shearing. See Metal-working Tools and Machines.

Machine-tools for wood are lathes, saws of various kinds, machines for planing, molding, boring, mortising, dovetailing, rabbeting, tenoning, shaping, etc. For these we are originally indebted to Sir Samuel Bentham and Brunel. See Wood-working Tools.

Ma-chin′ist's Ham′mer. A hammer which has a flat, round face and an edge-peen transversely of the helve. In some branches of the business it has two faces; in others, again, it has one face and a pointed peen for riveting.

Mack′le. (*Printing.*) A blurred impression, causing part of a page to appear double.

Ma-crom′e-ter. An instrument for measuring inaccessible objects by means of two reflectors on a common sextant. — Webster.

Ma′cron. An accent (¯) placed over vowels to give the long sound.

Mad-a-pol′lam. (*Fabric.*) A kind of fine, long cloth (cotton) shipped to the East India market.

Mad′der-style. (*Calico-printing.*) A method of calico-printing in which the mordants are applied to the white cloth, and the colors are brought up in the dye-bath. See Calico-printing.

Made-mast. (*Nautical.*) One composed of several pieces. A *built*-mast.

Mad-is-te′ri-um. (*Surgical.*) A tweezers. An instrument for extracting hairs.

Ma-drier′. *a.* A thick, iron-plated plank, having a cavity to receive the mouth of a *petard*, which is applied to a gate or other obstacle to be blown down.

b. A beam laid in a ditch to support a wall; or in a mine or bomb-proof to support a side or roof.

Mag′a-zine′. 1. (*Fortification.*) A building, vault, or apartment designed for the storage of ammunition, gunpowder, and other explosive substances.

Magazines in field fortifications are constructed in the most sheltered parts of the work, partly underground where practicable, and are lined with timber or with gabions, the ceiling being of timber. The whole is covered with a sufficient thickness of earth to render the structure bomb-proof.

Permanent magazines are usually constructed of brick, and should be surrounded by an earthen mound, so that in case of explosion the tendency of the explosive force may be upward.

As little iron as possible should be employed in the construction, and all iron nails, etc. should be sunk below the surface of the wood and their heads puttied over. The windows have exterior metallic shutters and interior shutters of wire-gauze; ventilators, closed by sliding metallic shutters, are also generally arranged around the lower part of the sides of the building. Powder is stored in barrels, three or four tiers high, with skids between each tier, or sometimes racks are arranged to receive the barrels. Alleys of sufficient width are left between the several piles to obtain ready access to each barrel. Fixed ammunition and small-arm cartridges are piled in a similar way, but these, when practicable, should not be placed in the same magazine with gunpowder.

2. (*Nautical.*) On shipboard the magazine is an apartment placed sufficiently below the water-line to be safe, under ordinary contingencies, from the enemy's shot. It is lined with sheet-copper, and has tiers of shelves on three sides and in the middle for the reception of the copper canisters, in which the cartridges for the heavy guns are contained. It is illuminated by a peculiarly constructed lamp and reflector placed at one end of and just outside the magazine, and carefully isolated therefrom. In action, the cartridges, when taken from the ammunition-boxes, are passed through a scuttle by a man in the magazine to another on the deck above, who in turn delivers them through a canvas screen having an opening covered by a flap, to another on the other side, who hands them to the runner-boys, who pass them through scuttles to others on the deck or decks above, until they reach the powder-boys, who deliver them to the loaders stationed at the guns.

Large vessels have two magazines, one forward and the other aft.

3. (*Stove.*) A chamber in a stove or furnace containing a supply of fuel which falls or is fed into the combustion-chamber as the fire burns away that previously introduced.

The first magazine-chamber for fuel known to the writer is the Athanor of the alchemists of the Middle Ages. This was the original *base-burning* furnace, and was adopted to keep up a continuous supply to the fire, which it was hoped would eventually transmute the baser metals into gold. See ATHANOR.

Delasme's furnace, 1685, is not exactly a magazine, but is a downward-draft furnace. See SMOKE-CONSUMING FURNACE.

Watt's base-burner furnace had a magazine (English patent of 1785). The fire is fed from a reservoir above, and the resulting volatile products pass through the fire to the chimney.

Cutler's magazine-grate was patented in England in 1815. The bottom plate of the chamber was movable, and by means of a wheel and axle the fuel contained in the chamber was raised so as to bring a new portion of fuel into the fire. The object is a full supply for a day, and a means of introducing below so as to burn the smoke.

Arnott's improvement, which he termed a smokeless fireplace, is somewhat similar.

Deakin's patent, 1816, had the magazine at the back of the fire, and the fuel was drawn forward horizontally by means of a screw.

Alkin's English patent, 1825, resembled Deakin's.

Rawe's magazine, 1854, is a fuel-pipe connecting the bottom of the grate with a side reservoir of fuel. The poker is the lever for introducing a fresh supply.

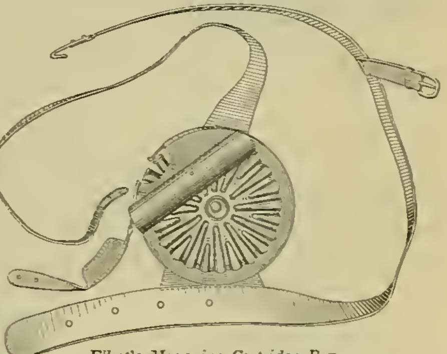
Leighton, in 1856, surrounded the sides and back of the chamber with a fuel-reservoir, from which the fuel was withdrawn by the poker. See MAGAZINE-STOVE.

4. (*Fire-arm.*) A chamber in a gun containing a succession of cartridges, which are fed one by one automatically, and loaded at the breech of the gun. See MAGAZINE FIRE-ARM.

Mag'a-zine' Car'tridge-box. A cartridge receiver attached to a gun, or to the person near the gun, to facilitate loading.

"Elliot's cartridge-box consists of two metallic plates mounted side by side on a common pivot, by which they are secured to a skeleton metallic frame covered with leather. They are fluted radially for the reception of 24 cartridges. These flutings are so arranged that the heads of the cartridges may lie in an almost continuous row, while the points overlap each other in such a manner that the cartridges are mutually supported by the ends of their cases, the weight being thus taken off the point of the ball, and removing its liability to be driven into the cartridge by the shaking of transportation.

Fig. 3019



Elliot's Magazine Cartridge-Box.

"The box when used is to be worn on the left breast. When charged it is rotated for firing by bringing each cartridge in succession to an open notch in the periphery of the frame." — *U. S. Ordnance Memoranda*, No. 15, p. 339.

Merrill's box is a slot in the top, back of the *small* of the stock, from which the cartridges are taken by hand and fed to the chamber.

Hagner's magazine is a box large enough for three cartridges, open at one end, and situated under the barrel, forward of the trigger-guard.

Benton's, Hare's, and Metcalfe's magazine-boxes are detachable blocks containing each a number of cartridges. The blocks fit in the cartridge-box, and when in use are attached to the side of a rifle, near the breech-block, by dovetail or pin fastening.

Mag'a-zine' Fire-arm. One containing a supply of cartridges, which are automatically fed to the chamber at the rear end of the barrel. There are several types.

1. Those in which the magazine is a tube below the barrel, as in the Winchester, the Ward-Burton, etc.

2. Those in which the magazine is in the stock, as in the Spencer, Meigs, and others.

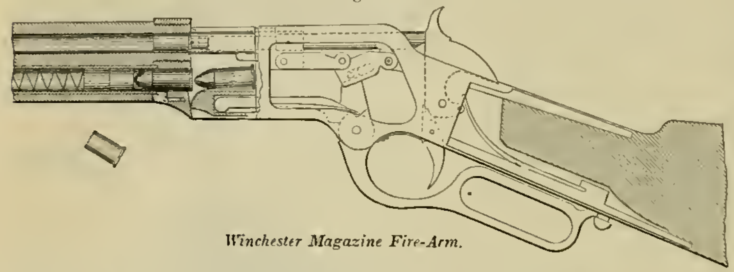
3. Those in which the magazine is a separate piece attachable to the gun when required, as in the Elliot carbine, the Gatling battery-gun, etc. See BATTERY-GUN.

The Marquis of Worcester (d. 1667), in his "Century of Inventions," refers to an "often-discharging pistol," but does not describe it. In 1575, several of such arms were stored in the Tower of London. Porta, in his "Natural Magick," 1658, speaks of a great brass gun, or hand-gun, which may discharge ten or more bullets without intermission. The idea is to load with powder and shot alternately, until the barrel is full; an intervening "dark powder" gives an interval between the firing of the separate charges, so as to avoid the simultaneous explosion and the results which would very certainly follow.

Most of the ancient repeating-guns were many-chambered revolvers, and not what we term magazine-guns. See Revolver.

The Henry or "Winchester" rifle will fire sixteen shots without reloading, and the gun is cocked by the same movement of the guard that opens and closes the breech; the exploded cartridge being withdrawn and a fresh one supplied at the same time and by the same movements. The copper cartridges, fifteen in number, are placed in a tube extending the entire length of the barrel on its under side, from which they are fed into the gun by the operation of the lever-guard, a spiral spring forcing back the cartridges as fast as they are used up. The piece has been fired fifteen times in less than ten seconds. 187 shots were fired in 3 minutes and 36 seconds, not including the time required to replenish the magazine; and, including the time thus employed, 120 loads were loaded and fired in 5¾ minutes, — 1,040 shots being fired without cleaning or repairing the gun. See *Y Y′*, Plate XVIII., Fire-arm.

Fig. 3020.

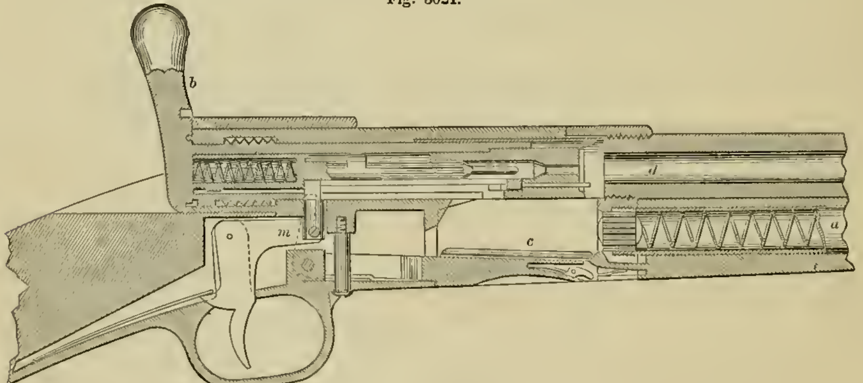


Winchester Magazine Fire-Arm.

Fig. 3020 shows a longitudinal section of the breech and working parts of the magazine, with a cartridge on the carrier ready to be fed to the firing-chamber.

The Ward-Burton arm is on the bolt system. A supply of cartridges is carried in a tube *a* beneath the barrel. These are fed backward by a spiral spring. The gun is opened by raising the handle *b* of the bolt and withdrawing it. As the bolt is fully drawn back, it strikes the upright arm of the carrier, shown by dotted lines (at *m*), on the tray *c* formed by the lower arm of which a cartridge has been fed by the action of the spiral spring in the magazine-tube. The motion of the bolt brings up this tray, so that, when pushing forward the bolt again to close the piece, the cartridge may be driven into the chamber *d*, where it is fired by the action on a heavy needle or pin of a spiral spring contained in the bolt and compressed in the act of closing, during which, also, the carrier is forced down to receive a fresh cartridge from the magazine.

Fig. 3021.



Ward-Burton Magazine-Arm.

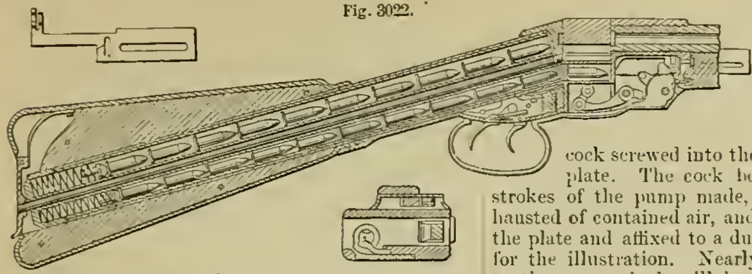
Projecting from the face of the bolt is seen the point of a spring hook, serving to withdraw the empty shells from the chamber, and also the end of the ejector-pin, which strikes them from below when withdrawn, and throws them clear of the gun. Near the head of the bolt is seen part of the sectional screw, which engages with a corresponding section within the gun when the piece is closed, and the handle turned down into place, and so supports the bolt against the force of the discharge. The magazine holds eight shots, which may be fired in about nine seconds; their issue may be cut off by a sliding piece; the arm may then be used as a single loader, (as shown in Plate XVII., opposite page 852), holding the magazine in reserve.

The Swiss magazine-rifle (shown on Plate XVIII., opposite page 853) has the bolt feature of the Ward-Burton, and the cartridge-loader of the Henry, so well known as the "Winchester."

The Spencer has a tube containing seven copper cartridges placed lengthwise in the stock, from whence they are forced, one at a time, into the barrel, by merely moving the lever-guard forward and back, — the shell of the exploded cartridge being removed by the same operation. The gun is then cocked and fired in the usual manner. This gun was more extensively introduced into the army, during the late civil war, than any other of its class, and is, therefore, very generally known. It is shown at *F*, Plate XVI.

The Cullen magazine-gun (Fig. 3022) has a revolving cartridge-carrier in the stock, which contains four sets of cartridges, ten in each set or column. As one column is exhausted another comes in place, so that forty shots may be fired without reloading.

Fig. 3022.



Magazine-Rifle.

The operating mechanism is connected to the trigger-guard, which works as in the Spencer.

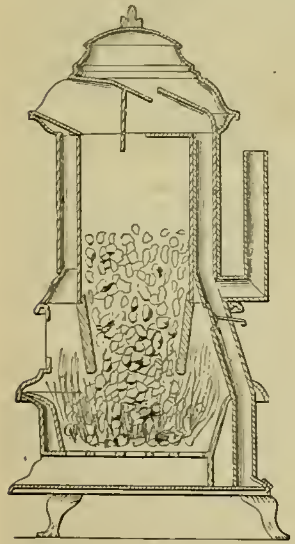
The Meigs magazine-gun, made at Lowell, Mass., contains five columns of ten each, or fifty cartridges, which were fired before the Austrian Military Committee in 16 seconds, and replaced by another magazine in a few seconds. The breech-block rises and falls by a backward and forward sliding reciprocation of the trigger-guard. When one line of cartridges is expended, the magazine is rotated on its axis by a spring bringing another line of cartridges in line with the feeding arrangement.

A number of magazine-guns carry cartridges in the stock, linked together like sausages, which are cut apart as they are used. See classification list under Fire-arm, pp. 854–862.

Mag'a-zine'-stove. One in which is a fuel-chamber which supplies coal to the fire as that in the grate burns away.

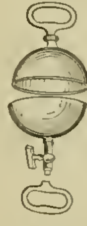
The example is a base-burning stove, having a fuel-magazine suspended free from the grate, and having an unobstructed free space around and below it, an illuminated casing surrounding it. See Base-burning Stove.

Fig. 3023.



Base-Burning Magazine-Stove.

Fig 3024.



Magdeburg Hemispheres.

Mag'de-burg Hem'i-spheres. Hemispheres of brass whose edges are carefully ground together to make an air-tight joint, and designed to illustrate the pressure of the atmosphere. The experiment originated with the worthy Otto Güericke, burgomaster of Magdeburg, about 1654.

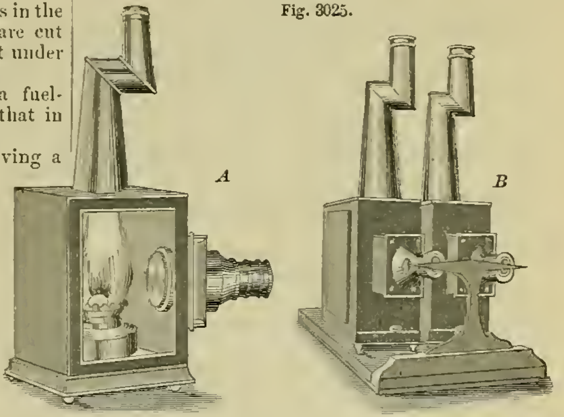
The edges of the hemispheres, being greased with oil or tallow, are brought together, the foot removed, and the stop-cock screwed into the center of the air-pump plate. The cock being opened and a few strokes of the pump made, the sphere is thus exhausted of contained air, and on being removed from the plate and affixed to a duplicate handle is ready for the illustration. Nearly fifteen pounds of force to the square inch will be required to draw them asunder. To separate them readily, it is only necessary to open the stop-cock and re-admit air.

Mag'ic Lan'tern. A dioptric instrument by which the images of small figures painted in transparent varnish are exhibited, considerably magnified, upon a wall or screen.

Its invention has been attributed to Roger Bacon about the year 1261, but it was first generally made known by Baptista Porta in his "Natural Magick," and by Kircher, 1669–70, who described it in his "Ars magna Lucis et Umbræ."

"Comes Mr. Reeves bringing me a lanthorn with pictures in glass to make strange things appear on a wall, very pretty." — Pepys's *Diary*, 1666.

Fig. 3025.



Magic Lanterns.

As at present constructed, the instrument *A* consists of a case having a projecting tube in front, in which are two lenses, the inner for illumination and the outer for magnifying. A strong light is placed in the center of the box, and behind it a concave mirror. A widened space between the two lenses in the tube permits the insertion of the slips of glass on which the objects are painted. These are highly illuminated by the mirror and lens; and the magnifying-lens, which is adjustable to a proper focus by sliding it back and forth in the tube, throws a magnified image of the object on the screen placed to receive it. The magnitude of the image depends on the distance of the image from the screen, being greater the farther apart they are separated; this distance must not, however, be too great, or the image will be indistinct.

When the screen is transparent the exhibitor may be behind it, the picture being exhibited by transmitted light. With a white opaque screen, or a whitewashed wall, the camera is placed in a suitable position among the audience, and the picture, being thrown upon the screen, is viewed by reflected light.

The oxy-calcium light, in which a jet of oxygen gas passing through a spirit-flame is thrown on a cylinder of lime, or the electric light, are used in the magic-lantern, affording an illuminating power vastly greater than that of the ordinary oil lamp.

Fig. *A* represents a single lantern, and *B* a double lantern, the latter arranged for exhibiting dissolving-views. The lanterns are placed side by side, so that the sliders may be readily slid from one to the other. Their foci and the screen being properly adjusted, a picture is placed in each; in front of both tubes is a slider, by which the image of either is gradually shut off from the screen, so that one image will appear to dissolve into the other.

Mag′is-ter′y. A fine substance deposited by precipitation.

Mag′is-tral. 1. (*Metallurgy.*) Made from copper pyrites (or raw magistral), which is found in many parts of Mexico. These ores, according to Napier, contain from 7.47 to 13.75 per cent of copper. It is reduced to powder by dry stamping and grinding. It is used especially in the *patio* process of amalgamation. Some authorities state that the copper pyrites are *roasted* and ground, but this would seem to detract from their activity, which is due to the action of their sulphuric acid upon the salt, liberating muriatic acid. So say Sonneschmid and Phillips. See AMALGAMATOR, p. 76.

2. (*Fortification.*) The line where the scarp, if prolonged, would intersect the top of the coping or cordon. — MAHAN.

The guiding line which defines the first figure of the works of a fortification.

Mag-ne′si-an Lime′stone. A mineral which crystallizes in the rhombohedral system.

Mag-ne′si-um. Equivalent, 12; symbol, Mg.; specific gravity, 1.743. A malleable metal the color of silver.

As a silicate or carbonate, it enters into the composition of many rocks and soils; steatite, serpentine, talc, meerschaum, etc.

The oxide, sulphate (epsom-salts), and carbonate are used in medicine.

It is also used in lamps. See MAGNESIUM-LAMP.

Mag-ne′si-um-lamp. One in which burning magnesium is employed for purposes of illumination.

This metal, in a state of combustion, emits a light which is unendurable to the naked eye, but at the same time gives forth a cloud of its oxide which eventually fills the apartment in which it is burned.

Various attempts have been made to obviate this difficulty, and it is found that by alloying with zinc the quantity of light is undiminished while the fumes are more readily removed. An alloy with thallium has also been successfully tried.

As the flame possesses, though in a much inferior degree, the actinic power of the sun's rays, it may be employed in photography.

Broad thin strips, presenting a proportionately greater surface to the oxygen of the atmosphere than those of equal weight which are narrower and thicker, burn more steadily and surely, and are preferable for giving light.

A long strip of this kind is coiled about a drum and fed by clock-work into the flame of a small alcohol lamp. There may, of course, be various modifications of the mechanism employed.

In one form of magnesium-lamp the metal is employed in a pulverized state, and may be used either alone, mixed with sand, or with a material as nitrate of strontia, to give color to the flame. It is placed in a funnel-shaped reservoir, from the lower part of which proceeds a long, narrow tube, at the lower extremity of which is a small spirit-lamp. This serves to ignite and maintain the flame of the powdered magnesium, the flow of which is regulated by means of a small finger-tap, so as to increase or diminish the light as required. The spirit-lamp also prevents the end of the tube from being fouled or stopped up by the oxide, which would otherwise form within and around it.

Such lamps may be made of convenient size for portability.

The light emitted by a magnesium wire one thousandth of an inch in diameter is equal to that of seventy-four stearine candles of five to the pound; three feet of it are burned per minute, or a quarter of an ounce per hour, the cost of which, at the present price, would be about 60 cents. Seventy-four stearine candles would, however, in the same time consume 2 pounds of stearine, which would cost 50 cents; 40.4 cubic feet of coal-gas of twelve candles power would be required to produce the same effect, and would cost about 5 cents. The dearness of magnesium arises from the high price of sodium required in obtaining it. Magnesium gives off $\frac{1}{265}$ of the heat obtained by combustion of gas of equivalent lucid effect. Gas and candles vitiate the air by the production of watery vapor and carbonic acid: magnesium is free from this objection, but it has an inconvenience of its own; a large quantity of calcined magnesia is thrown off as a fine powder, as stated above.

Mag′net. The attractive power of the loadstone or magnet was early known, and is referred to by Homer, Aristotle, and Pliny.

Says Pliny: "The magnet-stone is found in Cantabria." We read that the architect Dinochares was employed by Ptolemy to roof a temple at Alexandria with "magnet-stone," by means of which an iron image of his sister Arsinoe might remain perpetually suspended. Both the architect and the king died before the completion of the work.

This was probably the original of the popular fable of the suspension of the coffin of Mahomet at Medina between two magnets.

The name is derived by the imaginative Greeks from one Magnes, a shepherd on Mt. Ida, whose iron crook being casually laid against a block of magnetic iron became attached thereto, and directed attention to the mysterious attraction.

Thales, B. C. 640, discoursed on amber and the magnet, and supposed them to be living because they had a moving force.

"From Eastern Asia has been handed down the knowledge of the directive force and declination of a freely suspended magnetic bar; from Phœnicia and Egypt the knowledge of chemical preparations (as glass, animal and vegetable coloring substances, and metallic oxides); and from India the general use of *position* in determining the greater or less value of a few numerical signs." — HUMBOLDT.

Ætius, A. D. 500, refers to the use of the magnet for the cure of disease. He says: "We are assured that those who are troubled with gout in their hands or their feet, or with convulsions, find a relief when they hold a magnet in their hand."

Several eminent physicians of the fifteenth century affirmed its virtues as a cure for toothache, and a little later we read of magnetic toothpicks for the same purpose.

The deviation of the compass was known before Columbus, but it was assumed to be uniform. The first voyage of the great discoverer was nearly brought to an abrupt conclusion by the discovery of this error. See Mariner's Compass.

The *dip* of the magnet was discovered by Robert Norman, 1576. See Magnetometer.

The magnet worn by Sir Isaac Newton in his ring weighed only 3 grains, yet was able to take up 746 grains, or nearly 250 times its own weight.

Artificial magnets were made by Dr. G. Knight in 1746.

A natural magnet is the loadstone, which possesses polarity like a magnetic needle.

A magnetized needle is a piece of steel or iron to which polarity has been imparted by contact with a loadstone, or by other means. A manuscript of A. D. 1206, in the Royal Library of Paris, states that a black stone, called *marinière*, was rubbed by sailors upon a needle, which was then placed on a straw set afloat in a basin of water, when the point would indicate the north. See Mariner's Compass.

A nicely balanced piece of steel, suspended by its middle by a piece of untwisted silk, will, when magnetized, turn in one direction and rest there.

Its deviation from the true meridian is its *variation* or *declination ;* its deviation from a horizontal position is its *dip* or *inclination.*

Polarity may be conferred upon a bar of steel by different means : —

1. A steel bar held in the natural direction of a needle, and struck several blows with a hammer, will become magnetized.

This occurs on a large scale in building iron ships. It is found that the constant hammering, in closing the seams and swaging the rivets, confers polarity upon the vessel, and the effect is much dependent upon the magnetic bearing of the ship while on the stocks. See Mariner's Compass.

2. If the end of a steel bar be placed in contact with one of the poles of a magnet, it will become permanently magnetic by induction. A better plan is to place the bar in a line between the two opposite poles of two magnets of great intensity. — Brande.

3. Take a smooth bar of iron, place the middle of it on the north pole of a magnet, and draw it to the end, repeating the stroke always from the middle to the end, that is, rubbing the same way every time. Then place the middle of the bar on the south pole of the magnet and rub it to the opposite end of the bar, repeating as before.

Or take two magnets and lay them horizontally upon the bar, having their north and south poles in contact over its midlength. Then slide each toward the end of the bar. Repeat.

4. Place a horseshoe-magnet in the middle of a needle to be magnetized, with the poles turned in a direction the reverse of the poles intended to be given to the needle ; then move the magnet backward and forward over and along the surface of the needle, taking care to pass over each half of it an equal number of times, and repeating the same operation on the other side ; the needle is speedily and permanently rendered magnetic. — Brande.

We are indebted to Faraday for the comprehensive classification of all substances into *magnetics* and *diamagnetics.* A compass-needle made out of a diamagnetic would point east and west, where an ordinary compass-needle would point north and south.

In telegraphy the magnets are known by their duty or their places in the circuit, as the *sounding, relay, receiving* magnets, etc. See Electrical Apparatus.

Mag-net'ic Bat'ter-y. A combination of bar magnets acting together.

Mag-net'ic Com'pen-sa'tor. An apparatus of iron plates, invented by Barlow, and placed near the binnacle for neutralizing the effect of ship's guns and other iron in deranging the bearings of the compass. It is superseded by the apparatus of Professor Airy, which consists of two magnets placed at right angles to each other below the compass, and a box of small iron chain. These are placed by experiment. See Mariner's Compass.

Mag-net'ic Guard. A respirator with a gauze of magnetic iron to arrest particles of steel dust when dry-grinding cutlery. Invented by Abraham of Sheffield, England.

Mag-net'ic Nee'dle. A slender, poised bar or plate of magnetized steel.

The forms of magnetic needles are varied, according to fancy. Some have their greatest breadth in a vertical, others in a horizontal, direction. In surveying-instruments, $\frac{1}{20}$ of an inch broad and $\frac{1}{60}$ thick is a fair proportion ; length from 4 to 7 inches, usually from $5\frac{1}{2}$ to 6. The needle is suspended by a metallic or jeweled center upon a hardened steel pivot. The test of delicacy is the number of horizontal vibrations which it will make before coming to rest. See Mariner's Compass ; Magnetometer.

Mag-net'ic Tel'e-graph. See Magneto-electric Telegraph.

Mag'net-o-e-lec'tric Ma-chine'. One in which an electric current is generated by the revolution of one or more soft iron cores surrounded by coils of wire, about the poles of a magnet or magnets ; or an armature (*keeper*) may rotate before the poles of stationary coils.

The first notice we find of exciting electric action by the revolution of a magnet is in a manuscript work, written in the year 1242, by an Arabian named Bailak, a native of Kibdjak. The work is called "The Merchants' Guide in the Purchase of Stones." He states : —

"Among the properties of the magnet, it is to be noticed that the captains who sail in the Syrian waters, when the night is dark, take a vessel of water, upon which they place a needle buried in the pith of a reed, and which thus floats upon the water. Then they take a loadstone as big as the palm of the hand, or even smaller. They hold it near the surface of the water, giving it a rotary motion, until the needle turns upon the water ; they then withdraw the stone suddenly, when the needle, with its two ends, points south and north."

Faraday's discovery of magneto-electricity was announced in 1831. In 1833, Saxton constructed a machine of this kind, employing a commutator to cause the current to flow continuously in the same direction. The coil of wire of the armature was wound transversely to its soft iron core.

In 1857, Siemens constructed a magneto-electric machine, in which an elongated cylindrical armature, wound with insulated wire in the direction of its length, was made to revolve between the poles of a number of parallel horseshoe magnets. By this means much more powerful currents were obtained.

In 1866, Mr. Wilde of Manchester, England, conceived the idea of passing the current developed by an apparatus of this kind through the insulated wire of an electro-magnet of larger size. He found that the force of the magnetism thus excited was far greater than that of the series of steel magnets employed to generate the magneto-electric current. In one case where these would support a weight of but 40 pounds, the electro-magnet which they excited sustained 1,088 pounds.

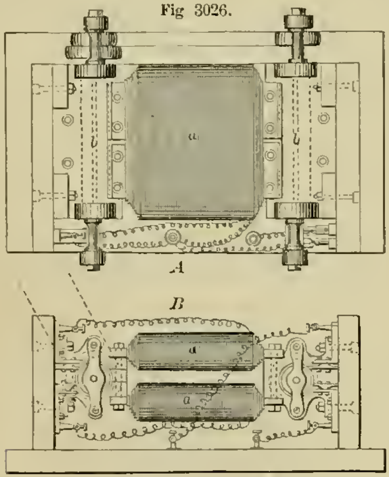
He next constructed a machine of much greater power, consisting of a series of permanent steel magnets, fifteen inches long, each weighing three pounds, and capable of sustaining a weight of 20 pounds. Their common armature is 16 or 17 inches long and $2\frac{1}{2}$ inches in diameter. It is wound with 50 feet of copper wire of $\frac{1}{16}$ inch diameter. By means of a pulley it is driven at the rate of 2,500 revolutions per minute, causing 5,000 changes of polarity in that time. The currents thus generated are turned in a common direction by means of a commutator, and sent through the wires of a large electro-magnet, which forms the base of the apparatus.

This electro-magnet is formed of two soft iron plates, 3 feet long, over 2 feet wide, and 1 inch thick, placed parallel to each other and separated at one end by a bundle of iron plates more than a foot thick, the whole secured together by bolts. At the other end is the armature, a cylinder of 7 inches diameter, deeply grooved in the direction of its length, and wound with copper wire nearly $\frac{1}{4}$ inch in diameter. More recently, Mr. Wilde has substituted insulated copper ribbon for the wire.

The armature turns in a hollow iron cylinder lined with brass, and is driven at the rate of 1,700 revolutions per minute. This machine maintains in full incandescence carbon points nearly an inch in diameter. It weighs $1\frac{1}{2}$ tons, and requires a three-horse-power engine to drive it. The currents induced by this apparatus have been passed through a second electro-magnet of still larger size, producing still more powerful effects.

Subsequently, Siemens and Wheatstone discovered means of greatly intensifying by means of its own action a very small amount of magnetism, by the rotation of a secondary coil with cores of soft iron around the poles of a magnet of very feeble power. The induced current will also be feeble, but by being sent around the electro-magnet which produced it, its magnetism will be intensified, so that it will generate a stronger current. This again is passed through the secondary electro-magnet, and so on, the current alternately passing from the coil of the primary to those of the secondary magnet until it is intensified to a very high degree.

Fig 3026.

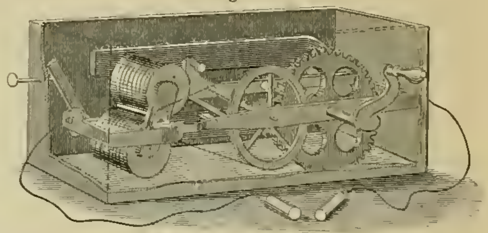


Ladd's Magneto-Electric Machine.

Ladd's machine, of which a plan *A* and an elevation *B* are shown in Fig. 3026, comprises two magnetic iron plates *a a*, surrounded by coils of wire, and having an armature *b b* at each end. The wires of one armature are connected with a commutator, and the extremities of the wire which envelops the plates are connected with tangents resting upon the commutator.

The currents generated by the revolution of the armature pass by the commutator into the wire enveloping the plates, thus tending to reinforce their magnetism ; and the current, feeble at first, quickly acquires strength with the rapid rotation of the armature.

Fig. 3027.

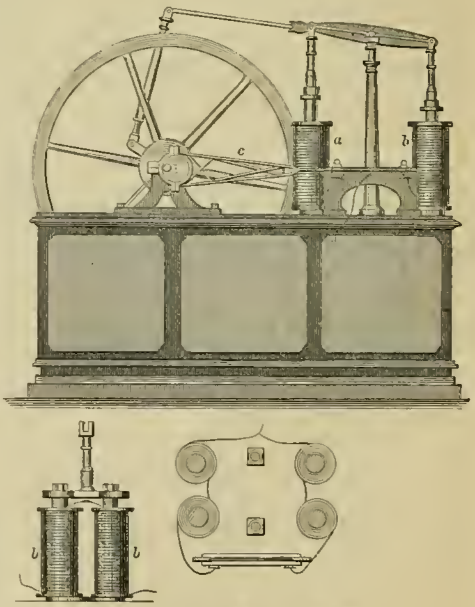


Magneto-Electric Machine.

If the other armature be now set in rapid motion, and the extremities of its helix connected with the conductors of an electric lamp, a light of intense brilliancy is produced ; or platinum wire, $\frac{1}{20}$ inch in diameter, may be instantly ignited.

Fig. 3027 is a machine for medical purposes. The armature of the two magnets is rotated by a cord or belt on a small pulley, driven by a larger one which is set in motion by a hand-crank and gearing. Two conducting-wires with insulators convey the current to the parts under treatment.

Fig. 3028.



Froment's Electro-Magnetic Machine.

Fig. 3028 represents an electro-magnetic engine, invented by M. Froment and employed by him for actuating his dividing-engine.

Four hollow cylinders *a a*, *b b*, encircled by coils of insulated wire, surround an equal number of reciprocating cores connected to the beam of the engine. Each pair of cores is connected by a transverse bar. The cylinders *b b* have their lower halves occupied by two other iron cylinders also connected together. The opposite poles of the upper and lower cylinders, which form two distinct magnets, are in reverse directions, so as to mutually attract each other. Under the influence of a voltaic battery, by suitable connecting wires, the core of the upper magnet is brought in contact with that of the lower, depressing that end of the beam, and at the same time, through the medium of an eccentric on the fly-wheel and rod *c*, actuating an ivory slider with a metallic slip on one of its surfaces, breaking the circuit thus formed, and bringing the slip in contact with a wire communicating with the electro-magnets *a a*, closing the circuit on that side and depressing the other end of the beam, which movement again opens the circuit on that side, and brings the metallic slip in contact with the circuit-wire attached to *b b*, which is again brought into action, depressing its end of the beam. A continuous reciprocating motion is thus kept up, rotating the fly-wheel through an ordinary crank and connecting-rod.

Mag′net-o-e-lec′tric Tel′e-graph. An apparatus for transmitting messages by means of an electric current excited by the rotation of one magnet about the poles of another, instead of a current excited by the voltaic action of a battery.

Professor Wheatstone's apparatus for private use in offices and manufactories is of this character, requiring no battery or chemicals.

By one of his instruments the message is printed on tin-foil in Roman characters, and dropped into a locked box till the arrival of the owner.

By another instrument the needle points to the letter itself on a dial.

Mag-net′o-graph. An instrument which registers automatically the condition and changes of terrestrial magnetism.

That in use in the Greenwich Observatory is the invention of Mr. Brooke. Two of the magnets are suspended by untwisted silk for observation in *variation*, and one upon knife-edges on agate plates for observation of the dip ; and the duty of visiting the magnets and observing their variations is attended to every two hours.

Mr. Brooke introduced an automatic plan, which is as follows : —

Around the magnets are cases of zinc which exclude the light. Inside each case is a lamp which casts a beam of light upon a mirror soldered to the magnet. This ray directed to a sheet of sensitive photographic paper records the motion of the magnet, the sheet being moved by clock-work.

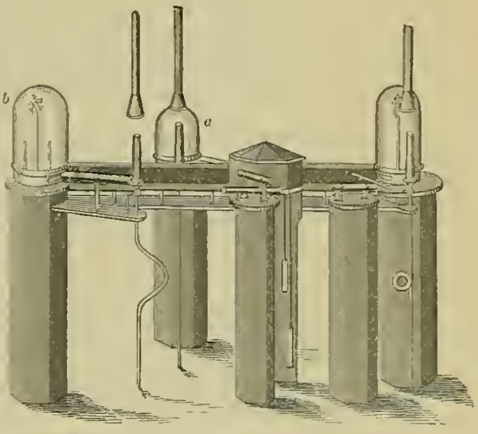
Once in twenty-four hours an assistant darkens the room, and then, with a lantern giving only a yellow ray, he removes the photographic paper, fixes the picture, and places another sheet in the case.

Fig. 3029 is a view inside of the magnetic observatory of Stonyhurst College, England, and will give an idea of the disposition of the instruments.

The instruments record the oscillations of three magnets suspended under the glass shades, and thus show completely all the changes, both as to direction and intensity, in the earth's magnetism. The magnet which is to the right in the sketch is suspended by a silk thread in the magnetic meridian, and, by the aid of a mirror attached to it, describes on a cylinder, which is put in motion by the clock on the center pier, all the variations in the magnetic declination. The other two magnets give the two components of the total magnetic force of the earth. The one *a* which records the variations of the vertical component rests on two agate edges, while the horizontal component magnet *b* is suspended by a double steel thread, and is held nearly at right angles to the magnetic meridian by the torsion of the thread.

Under the clock-box are the three cylinders covered with sensitive paper. To each magnet is attached a semicircular mirror, which sends the rays from a jet of gas to one of the cylinders in the clock-box, and thus describes, by a curved line, all the oscillations of the magnet. A second semicircular mirror is fastened to the pier on which the instrument stands, and, describing always a straight line on the cylinder which is opposite to it, gives the zero line for the curve.

Fig. 3029.



Magnetographs (Stonyhurst College, England).

Mag′net-om′e-ter. An instrument for measuring any of the magnetic elements, as the *dip*, *inclination*, and *intensity*. — Webster.

A magnetized needle, isolated from all disturbing influences and suspended by untwisted silk, is used to detect the declination, and the delicate mode of adjustment permits any variation in this element to be observed.

For observing the *dip* or *inclination* the magnetized needle is balanced by knife-edges upon agate planes, so as to vibrate like the beam of a pair of scales.

The buildings appropriated to this purpose at the Greenwich Observatory, England, are built in the form of a cross, of materials from which iron is rigidly excluded. In two arms of the cross are magnetized needles suspended by silk, for observations in declination or *variation ;* and in another arm of the cross is a balanced needle, for observations in inclination or *dip*. The arrangements were under the control of Mr. Glaisher, and the observations were originally made by himself and two assistants, until Mr. Brooke introduced his adaptation of photography to the purpose of recording observations. By means of mirrors attached to the arms of the magnets, reflected light is cast upon highly sensitized photographic paper wound round cylinders moved by clock-work, and the slightest variation of the magnets is registered with the greatest accuracy. See MAGNETOGRAPH.

We shall have occasion to show that the mariner's compass originated in China, and came thence through India and Arabia to Europe. The Chinese annals show that it was used by them nearly 3,000 years ago, — first on land, then on water. Humboldt remarks the singular fact. It was used at sea by the Chinese as early as the era of Alexander the Great. No mention is made by his historians of the wonderful instrument, although they have not forgotten to note that he was met by a people with storms of lightning and thunderbolts; another Chinese invention, — gunpowder.

The original mode of suspending the needle was by flotation, several devices being used for this purpose, such as burying it in pith, laying it on a couple of floating sticks, etc. These plans gave the needle freedom of motion in a horizontal plane and sufficed apparently for many ages. The same plan was adopted in Europe for several centuries. See p. 1371.

About the twelfth century of our era, or earlier, the Chinese introduced the mode of suspending the needle by a silken string. This delicate adjustment allowed other elements of terrestrial magnetism to be observed; and during the thirteenth century the Chinese philosopher, Keou-tsoung-chi, observed the variation of the needle from the cardinal points to the extent of 2° to 2° 30′. The French savans in Pekin, a few years since, determined it to be about the same. In common with all European nations the variation was spoken of by the Frenchmen as a variation from the north towards the west; but the Chinese, who respected the south more than the north, considered that the needle pointed south, and counted from that pole of the magnet, calling the declination a variation to the east of south. This is the same thing in effect. The order of the Arabic words *zoron* and *aphron*, *south* and *north*, show whence the Arabs derived the invention. See MARINER'S COMPASS.

The variation was again noticed by Columbus in 1492, and Sebastian Cabot in 1540.

It does not appear that the other element of terrestrial magnetism, the inclination or dip, was known to the Chinese, though they must surely have noticed that a needle which hung in perfect equipoise before magnetizing was thrown out of balance when touched by the loadstone.

Robert Norman of London, a maker of compasses, was the first, so far as we know, to detect the *dip* and publish the fact; 1576. He contrived the *dipping-needle*, suspended on a horizontal axis, and found the *dip* at London to be 71° 50′.

Robert Halley, in 1700, published a chart, having lines passing through points of equal magnetic variation. His remark was that of a philosopher: —

"The nice determination of the variation, and several other particulars in the magnetic system, is reserved for a remote posterity All that we can hope to do is to leave behind us observations that may be confided in, and to propose hypotheses which after-ages may examine, amend, or refute."

Magnetic changes made Halley's chart obsolete in forty years, and it was reconstructed by the joint efforts of the English navy, East India Company, and Hudson's Bay Company. This chart was not satisfactory, and its discrepancies became positive inaccuracies as time wore on.

About 1756, John Canton, in England, made about 4,000 experiments for discovering and explaining the cause of the diurnal variation of the needle.

La Perouse sailed from France with instructions and instruments, intending to make special observations at remote stations in regard to the *variation* and *dip* of the needle. The lamented death of the Admiral and destruction of his vessels in 1788 prevented the results from being communicated to the scientific world.

M. Hansteen of Denmark undertook the subject in 1811, and in 1819 published his celebrated work "Upon the Magnetism of the Earth." He treated the matter historically and scientifically, making a variation chart for 1787.

The *agonic line*, or line of no variation, where the magnetic and geographical lines coincide, was discovered by Columbus in 1492, about 100 miles west of the Azores. Like other magnetic lines, it appears to have shifted. Hansteen's observations confirmed in great detail the position of Halley, that "the whole magnetical system is in motion; that the moving force is very great, extending its effects from pole to pole; and that its motion is not sudden, but gradual and regular."

The western line of no variation in Hansteen's chart, calculated for 1787, begins in latitude 60° to the west of Hudson's Bay, proceeds southeast through the North American lakes, passes the Antilles and Cape St. Roque till it reaches the South Atlantic Ocean, where it cuts the meridian of Greenwich in about 65° south latitude.

The eastern line of no variation (1787) is extremely irregular, having curious curves and contortions, indicating the action of local magnetic forces. It begins in latitude 60° south, below Australia; crosses that island, extends through the Eastern Archipelago with a double sinuosity so as to cross the equator three times; first passing north of it to the east of Borneo, returns, passing south between Sumatra and Borneo, and crossing the equator again south of Ceylon, from whence it passes to the east through the Yellow Sea. It then stretches along the coast of China, making a semicircular sweep to the west till it reaches the latitude of 71° north, when it descends again to the south, and returns north with a great semicircular bend which terminates in the White Sea.

Captain Sir James Ross reached the magnetic pole, latitude 70° 5′ 17″ north, and longitude 96° 46′ 45″ west, on the 1st of June, 1831. The amount of *dip* was 89° 59′. Horizontal needles refused to work, showing no sensitiveness. He erected a cairn of limestone rocks, inclosing a tin case with the record. The cairn may remain, unless the Esquimaux have removed it in search of plunder, but the magnetic pole has moved away.

The illustrious Humboldt gave the first start to a regular, systematic mode of recording magnetic observations, taking a large number in the course of his extensive travels and explorations, and calling the attention of the scientific world to the mode and importance of so doing.

Observatories, provided with magnetometers and meteorological instruments, and with apparatus for ascertaining the time and true meridian, are now working in concert in many distant stations: Berlin, Paris, Freiburg, Greenwich, Gottingen, Montreal, Melbourne, Cape Town, St. Helena, Simla, Madras, Bombay, Singapore, and probably many other places.

It is understood that the observations are made at the same instant of absolute time. Each day is divided into 12 equal periods of 2 hours each, termed the magnetic hours. The mean time at Gottingen is adopted; a tribute to the energy and skill of M. Gauss of the observatory in that city.

Mr. Brooke's system of photographic registry is adopted throughout.

Mag'net-o-mo'tor. A voltaic series of two or more large plates which produce a great quantity of electricity of low intensity, adapted to the exhibition of electro-magnetic phenomena. — Brande.

Mag'ni-fy-ing-glass. A popular term for a convex piece of glass or a lens which has the property of magnifying. See Optical Instruments.

Mag'nus-hitch. (*Nautical.*) A kind of knot used on board ship.

Ma-goo'tee. An instrument used by the Pambatees or snake-charmers of the East Indies.

It is composed of a hollow calabash, to one end of which is fitted a mouthpiece similar to that of the clarinet. To the other extremity is adapted a tube perforated with several holes, which are successively stopped by the fingers, like those of the flute, while the player blows into the mouthpiece. In the middle of the instrument is a small mirror, on which the serpents fix their eyes while dancing.

Ma-ho'vo. An adaptation of the fly-wheel to the conservation of power during the times of light strain, to be used during periods when a greater power is needed. The invention of Captain C. Von Schubersky of Russia. See Fly-wheel.

Maid'en. A machine for beheading.

The Scotch guillotine, in use from 1550 to 1680, was copied from one at Halifax, England. It was sometimes called the *widow.* Both terms of grim and gross pleasantry.

The Halifax machine was an importation (as to design) from Italy, where it was used in the thirteenth century. Conradin of Swabia was decapitated by the *mannaia* at Naples, 1268.

The machine is supposed to have originated in Persia.

It was used in the execution of the Duc de Montmorenci at Toulouse, 1632. By the Germans during the Middle Ages, and by the Dutch in their colonies.

The Scotch *maiden* was imported into Scotland by the Regent Morton, who died by its axe, 1581. The murderers of Rizzio were executed by it in 1566; and the Marquis of Argyle, 1681.

The *maiden* was not as complete an instrument as the *guillotine*, which has a turning plank and track, with other devices for an artistic performance of tragedy. See Guillotine.

Mail. 1. (*Weaving.*) One of the small brass eyes through which the *end* or worsted yarn passes in a *Brussels carpet-loom*, and by which it is lifted in order to form the loop which distinguishes the surface of that variety of carpet. See Brussels-carpet.

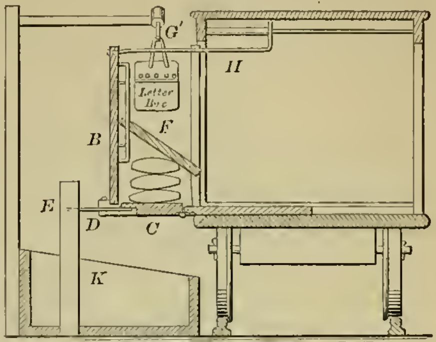
2. (*Nautical.*) A device consisting of interwoven rings, like mail-armor, used for rubbing off the loose fibers on cordage.

3. (*Armor.*) A flexible armor of rings or scales, covering the body or body and limbs, according to its extent.

Mail-bag. A letter-bag, usually of leather, but made of canvas, for containing newspapers and other printed matter for conveyance through the post-office. When of leather, the joints are closed with rivets; when of canvas, the seams are felled. The fastening of the mouth is by staples on one portion, which project through slits in the other, a strap being rove through the staples and locked.

Mail-bag Re-ceiv'er and Dis-charg'er. A device for receiving mail-bags from or delivering them to railway-cars in motion at stations along the road. Fig. 3030 shows one form of the device, in which the rod H attached to the car strikes the suspended mail-bag and draws it from the hook G', when it falls upon the hinged incline F and is delivered into the car. In this way the mail is received by a car while under full headway, and simultaneously mail is delivered from the car by means of the trap-door C. The door C is disengaged by an arm D, which comes in contact with a post E, and the bags fall into the box K. When the receiving and delivering are done, the section B is slid back into the car.

Fig. 3030.



Mail-Bag Receiver and Discharger.

Worsdell's apparatus for receiving and delivering mail-bags and express matter to and from railway-cars, English patent, January 4, 1838. The bags to be delivered are suspended by their loops from two pins in a bar projecting from the carriage, from which bar also projects a prong or hook, and the bags to be received at the station are suspended from similar apparatus attached to a lamp-post. By the passage of the carriage past the lamp-post, the hook on the latter passes through the loops of the car bags and bears them off the pins, while the hook on the car in like manner carries off the bags from the station.

Other plans have scoops or cylinders on the car which pocket the mail-bag suspended from a crane or lying upon a support from which it may be shoveled, picked, or shot by the device on the car. A somewhat similar converse arrangement deposits at the station the bag carried by the car.

Mail-coach. A carriage chartered by the post-office department or hired to carry postal matter.

Mail-coaches were introduced by Robert Palmer of Bristol, England, in 1784.

Mail'ing-ma-chine'. A machine for attaching addresses to newspapers, etc., for transmission by mail. See Addressing-machine; also, Ringwalt's "Encyclopædia of Printing," pp. 226, 227.

Mail-net. (*Fabric.*) A form of loom-made net, which is a combination of common gauze and whip-net in the same fabric. The whole fabric is a continued succession of right-angled triangles, of which the *woof* forms the basis, the *gauze* part the perpendiculars, and the *whip* part the hypotenuse. The gause and whip parts are stretched on separate beams.

Main. A principal part or portion.

1. (*Hydraulics.*) *a.* A large or principal water or gas pipe. The smaller are termed *supply* or *service* pipes or branches.

b. A large channel or ditch.

2. A banker's shovel for coin.

3. (*Nautical.*) The middle or principal mast, hatchway, etc., in a three-masted vessel.

In all *two-masted* vessels, except the *yawl* and *ketch*, the main is the aftermost mast. A *brig* or *schooner* has a fore and a main mast.

With a *yawl* or *ketch*, the forward mast is the larger, and is called the *main*-mast, the other being the mizzen.

In all rigs the main-mast is the principal and tallest mast.

The term *main* characterizes the sails, yards, booms, standing and running rigging, and other furnishing of the main-mast; such as *main sail* and *yard*, *main-topsail* and *yard*, *main-topgallant*, *main-royal*, *main-boom*, *main-stay*, *main-top*, *main-sheet*, etc.

The term is also applied to objects in the vicinity of the mast; as, the *main-hatchway*, *main brace*, *stay*, *keel*, etc.

Also to principal parts which are of central position, greater size, prominence, or importance; as, *main-deck*, *main-keel*, *main-breadth*.

In other than nautical matter the word is similarly characteristic.

Main-breadth Line. (*Shipbuilding.*) A line on the surface of the vessel cutting each of the cross sections at the point where its breadth is greatest.

In vessels having a "straight of breadth" vertically, there are two main-breadth lines, at the upper and lower boundary of the straight of breadth respectively.

Main-cen'ter. (*Steam-engine.*) In side-lever engines, the strong shaft upon which the side-levers vibrate.

Main Check-valve. (*Steam-engine.*) A valve belonging to the Giffard injector, to prevent water running out of the boiler should anything go wrong with the injector.

Main-coup'le. (*Carpentry.*) The principal truss in a roof.

Main-deck. (*Shipbuilding.*) The deck next below the *spar-deck* in frigates and 74's.

Main-ham'per. A large hand-basket.

Main-in-clos'ure. (*Fortification.*) The body of the place.

Main-links. (*Steam-engine.*) The links in the parallel motion which connect the piston-rod to the beam of a steam-engine.

Main-piece. (*Shipbuilding.*) *a.* The principal piece of the head. It is stepped into the stem-piece, and is notched for the reception of the heel of the bobstay-piece. See STEM.

It is also called the *lace-piece.*

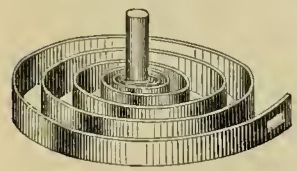
b. The longest piece of the rudder, to which the helm is attached.

Main-pin. (*Vehicle.*) A *bolster-pin*; *king-bolt.*

Main-plate. The principal plate of a lock.

Main'spring. 1. (*Horology.*) The going spring of a watch, spring-clock, musical-box, alarm, or other spring-driven instrument.

Fig 3031.



Mainspring.

In the watch, it is termed main, because of its major importance, and to distinguish it from the pendulum or balance-spring, which gives the recoil movement to the balance.

2. (*Fire-arm.*) The spring in a gun-lock which drives the hammer.

Main-work. (*Fortification.*) The enciente or principal works inclosing the body of the place.

Mait'land Cord. (*Weaving.*) A cord extending along the wooden shafts of leaves, to which the heddles are fastened with knots.

Ma-jol'i-ca-ware. A species of fine pottery, composed of clay thickly and opaquely enameled, suitable for receiving brilliantly colored figures; fabricated at Ferrara (1436) and at Passaro (1450). It is sometimes called "*Raffaelle* ware"; this may be from the fact that Raffaelle Sanzio d'Urbino furnished designs for the ornamentation of some specimens, or from one Raffaelino del Colle, a skillful workman at Urbino. The name is a corruption of *Majorca*, into which island (in the twelfth century) the Moors introduced the manufacture of a species of ware decorated with brilliant colors.

Majolica, until the time of Lucca della Robbia, was glazed with a plumbiferous glaze (*mezza majolica*), but Robbia invented a beautifully white, durable, enameled, stanniferous glazing. Giorgio, by the combination of mineral colors, succeeded in producing beautifully iridescent ruby and golden tints. Existing specimens of his manufacture are very costly. After the time of Fontana (about three hundred years ago), who carried the manufacture to perhaps its highest perfection, the art began to decline, the production finally ceasing altogether.

Of late years, the Staffordshire potters have succeeded in reproducing this ware, and slabs, friezes, tablets, vases, flower-pots, and other articles are now made of it.

Make-up. (*Printing.*) To break matter in columns or galleys into suitable length for pages.

"Mak'ing"-felt. (*Paper.*) That felt of a cylinder paper-machine on which the web of pulp is taken from the *making*-cylinder, at the point where the couching roller bears upon the latter. In contradistinction to a mere *carrying*-felt.

Mak'ing-i'ron. (*Shipbuilding.*) A large calking-iron with grooves lengthways of its face, used for the final driving of oakum into the seams. The iron is held by one man, and driven by another by means of a beetle; the process is called *horsing-up.* A *horse-iron.* After the making-iron, the seams are payed with melted pitch.

Mal'a-chite. *Mountain green.* A native carbonate of copper.

Ma-lax'a-tor. A mixing-mill. A cylinder having a rotating shaft and stirring-arms to incorporate materials.

Coignet's *malaxator* for incorporating the ingredients of his concrete (see BÉTON) is supplied with the materials in graduated proportions, the energetic working permitting the use of a much smaller quantity of water than usual.

Mortar-mills, *pug-mills*, and many other machines come under this description, e. g. machines for mixing the ingredients of pills.

Hyde's soap-making machine, 1870, is an instance in which the grease, resin, and lye are incorporated by a revolving stirrer in a cylinder, the operation being continuous.

Mal'kin. A sponge with jointed staff for ordnance.

Mall. A heavy beetle. See MAUL, and Fig. 3031.

Mal'le-a-bil'i-ty. The quality of adaptedness to be drawn into thin plates by hammering; as *ductility* is the wire-drawing capacity. See DUCTILITY for comparative statement.

Mal'le-a-ble Cast-i'ron. Iron cast from the pig into any desired shape, and afterwards rendered malleable, or partially so, by annealing.

A great variety of articles are thus produced in a more economical and correct manner than they could be by forging. Such are bridle-bits, snuffers, parts of locks, various forms of builders' and domestic hardware, some kinds of culinary and other vessels, pokers, tongs, and numerous other things. Many of these are subsequently case-hardened and polished.

The art of softening cast-iron and working it, and afterwards hardening it again, appears to have been found out by Reaumur, though we have no record of the process by which it was effected.

Malleable-iron castings are rendered externally soft by the abstraction of carbon, by which they are reduced nearly to the condition of pure malleable iron, but do not possess the fibrous structure which is acquired by hammering and rolling.

In England they are made from the rich Cumberland iron, and are at first extremely brittle. To render them malleable, they are inclosed in iron boxes and surrounded with pounded iron-stone, or some of the metallic oxides, as scales from the forge, common lime, or some absorbent of carbon, used either together or separately. The boxes are placed in the furnace, subjected to a strong heat for about five days, and allowed to cool gradually within the furnace.

The time and other circumstances determine the depth of the effect; thin pieces become malleable entirely through, admit of being readily bent, and may be slightly forged; thicker pieces retain a central portion of cast-iron, but in a softened state, and not so brittle as at first. On sawing them through, the exterior coat of soft metal is perfectly distinguishable from the remainder.

The inventor of the process of rendering articles of cast-iron malleable was Samuel Lucas of Sheffield, by whom it was patented in 1804.

As described in his specification, his process was nearly identical with that above described, except that the castings were placed directly in the furnace, instead of being inclosed in boxes.

The Siemens regenerative gas furnace is largely used in England now for heating the annealing-oven in which the crucibles containing the cast-iron articles are placed.

As arranged for this purpose, the furnace has four longitudinal main flues divided by partitions into a number of smaller flues. The two exterior flues receive the heated gas and the two interior ones hot air. Over these is a closed arched muffle, in which the annealing-pots are placed. The hot gas and hot air, being kindled, pass beneath at the sides and over the top of the arch of the muffle.

The furnace is never permitted to cool entirely. The pots are allowed to cool on the floor.

The German makers of malleable-iron castings are said to use a pig-iron measurably free from sulphur and phosphorus, which they melt in plumbago crucibles with porcelain covers, containing about 30 kilogrammes (66 pounds). No blast is used; the natural draft of the furnace-chimney being considered sufficient. A high heat at the moment of pouring is essential to a successful cast, and the precise moment for this operation is ascertained by plunging a bar of red-hot iron into the crucible. The crucibles are raised by tongs, and the pouring performed as quickly as possible. When sufficiently cool, the castings are placed in boxes alternately with layers of red hematite, and subjected to the heat of the furnace for from 3 to 5 days, according to size, and removed after the furnace has been allowed to gradually become cool.

An approved mode in the United States of rendering castings malleable is as follows: —

When taken from the mold they are washed with dilute sulphuric acid to remove the rough coating of vitrified sand from their surfaces, and the ragged burrs sometimes left at the junction of the two parts of the mold are chipped off, after which they are packed with the "scale," derived from iron bars in the process of rolling, in square iron boxes (technically called *pots*) of the dimensions of about 15 × 18 inches, of which one is placed on top of another, the joints carefully luted. They are inserted into the furnace in pairs, and subjected to a cherry-red heat for about eight days; the heat is somewhat slackened toward the latter part, after which the doors are thrown open to allow them to cool. When removed from the pots the castings are coated with a rough crust, which is removed by abrasion in tumbling-boxes.

Mal'le-a-ble I'ron. Iron sufficiently pure to be drawn out into bars and welded.

Iron, in the ore or roasted, is in the state of oxide, and (omitting from the consideration the presence of foreign matters) to obtain it pure merely requires the separation of the oxygen. This may be done as a chemical process by heating the oxide to a heat below redness in a glass tube through which hydrogen is then passed; the hydrogen and oxygen unite to form aqueous vapor, and pure iron remains. This is measurably true of certain qualities of ores, but pig-iron is sometimes found to contain 10 to 18 per cent of foreign matters, — principally manganese, carbon, and silicon, — also phosphorus and sulphur, both of which latter it is almost impossible to entirely remove by puddling.

All these have to be got rid of to produce pure malleable iron, unless the ore is of extraordinary purity.

At a moderate red heat, a mixture of finely pounded charcoal and oxide of iron will have the effect of eliminating the oxygen, and this process is believed to have been in use in ancient times in the island of Elba. The ore is remarkable for its freedom from earthy impurities, and after breaking into small pieces was imbedded in charcoal on the floor of a reverberatory furnace. After the oxygen was separated by the action of the charcoal, the temperature was raised to a welding heat, and the pieces of ore, now in the state of porous iron, were caused to adhere by hammering, and were drawn into bars. This is a process of obtaining malleable iron direct from the ore, and has been repeated by Mushet.

There is considerable analogy between this and the native East-Indian practice, where the broken ore or magnetic-iron sand is placed in alternation with bamboo charcoal, and a pasty mass of crude iron obtained, whose malleability is sometimes sufficiently great to enable it to be hammered into small bars without a second operation. The bellows used are made of skin, are worked alternately, and discharge by separate holes through the clay tuyere which is introduced at an angle near the bottom of the upright furnace.

These Indian furnaces are miniatures of those in Styria, described in the work of Jars, a French metallurgist, 1750. The ores there worked have a notable percentage of manganese, which affects the result, being seemingly favorable to the retention of a certain amount of carbon, but resisting the combination of the larger amount necessary to make cast-iron.

Styria was not the only European country in which the simple furnace just described was used for smelting iron ore, for those of Sweden and Norway, 300 years ago, were of substantially the same character. The iron obtained from them was a spongy mass, which was drawn out at intervals by tongs, hammered gently and cautiously, and then more energetically, to press the particles of iron into contact and squeeze out the intermixed slag. The mass thus obtained was cut up into smaller pieces, which were repeatedly heated and hammered till a sound bar of nearly pure iron was obtained.

The size of the furnace, and especially its hight, was increased in order to save fuel, as the ore and flux piled in above were heated by the outgoing caloric current, preparatory to being subjected to the direct action of the blast. The bellows were also proportionately increased in power. This change, probably adopted from motives of economy, changed the result, and rendered necessary new processes to bring the iron to a malleable state. As the iron descends through the furnace for 30 feet it is subjected to the action of the fuel, and has time to part with its oxygen, and also absorb from 3 to 5 per cent of carbon and 2 to 4 per cent of silicon. This addition renders it more fusible, and it sinks to the bottom of the crucible in a carbonized state, differing in respect of its greater proportion of carbon from the spongy and less fusible mass of iron, such as was produced by the processes above referred to as carried on in ancient times in Elba, both anciently and more lately in India and Styria, and elsewhere.

This clears up much of the difficulty in the reading of the ancient records, where iron always appears in a malleable form, the tools used by the workers in iron consisting invariably of the bellows, hammer, and anvil. It appears that fusible cast-iron was first considered immediately useful after the size of the furnaces had been so increased as to prevent the production of the more or less malleable and purer article incident to the furnaces on a small scale, which we have just above cited.

The new production, instead of remaining a spongy mass in the midst of the coal and slag, to be hauled thence by tongs and be subjected to the hammer to clear it of foreign matter and condense it, ran down like a fluid to the bottom hearth, and found its way out of a hole, running into a form according to the shape of the hollow in the ground which received it. By this means the smelter found he could withdraw the iron, without tearing out the front of his furnace for each bloom.

This new form, cast-iron, being brittle under the hammer and unsuitable for almost all the known uses of iron at the day when the discovery was made, it became necessary to subject it to a farther process, in order to burn out the greater portion of the carbon and silicon and render it malleable. The refining process observed by M. Jars in Sweden, in 1750, is identical with that described by Aiken in 1836 as having been used in India for a length of time not now readily ascertained.

The block of crude iron is laid, covered with charcoal, on the floor of the furnace, with one end projecting over the crucible, a little above the mouth of the tuyere. In this situation the block softens and soon falls down in a state of half-fusion ; a man with an iron bar then draws the remainder of the iron block forward, advancing it from time to time, till the whole has fallen into the crucible.

It is then dragged out, glowing hot, and hammered on an anvil to separate the scoriæ ; being divided, it is again heated and hammered until it is rendered quite malleable.

A modification of this process was adopted in Sweden, being derived from the puddling process of Cort, and consisted in covering the metal in the crucible with scoriæ and stirring it continuously with an iron bar. Jets of flame arose, and the metal solidified. Berzelius explained the action in this way : The scoriæ contained oxide of iron vitrified with silica and other earthy substances containing oxygen, which, reacting on the carbon of the iron, separated it in the form of carbonic oxide.

More modern forms of refining have superseded the Indian and Swedish plans above cited, the broken pig-metal being placed on the hearth of a furnace, covered with coke and slag, and a blast turned on till the metal is melted. It is run into slabs, and the metal obtained is white, hard, compact, and brittle.

The puddling-furnace was invented by H. Cort of Sheffield, England, his patent being dated in 1784. See Puddling-furnace.

One process of converting pig into malleable iron, as practiced in England, is as follows : —

The pigs are melted in the fining-furnace, by which the iron is deprived of part of its carbon and a larger portion of its silicium. The molten metal collects in a cavity at the bottom of the hearth, and is drawn off into a cast-iron trough in which it speedily cools. By this process it is converted into a white cast-iron termed *fine metal.* This is broken up and transferred to the puddling-furnace, in which the decarbonization is completed.

The puddling-furnace is of the reverberatory class, and is provided with openings for working the metal while in a fluid or semi-fluid state, and for charging and clearing the furnace.

The charge of *fine metal* is piled up on the sides of the hearth, the center of the sole being left clear for working and allowing a circulation of air around the charge. A portion of rich slag and iron scales is added. As the metal melts, it is stirred with an iron rod, so as to expose fresh portions to the air until the whole mass is brought into a uniform pasty condition, when the fire is lowered. The metal is constantly stirred with an iron paddle, gradually losing its consistency, until it becomes sandy or *dry,* as it is termed by the puddler, who continues to work it until it becomes uniformly granular.

The heat is then increased, causing the particles to agglutinate. A part of the slag is drawn off, when the workman proceeds to *ball up,* that is, to form the iron into balls. This is effected by taking up a small portion on the end of the paddle, which is manipulated so as to cause other portions to adhere to it until a ball has been formed weighing 60 or 70 pounds. This is detached from the paddle, and other balls formed in a similar manner until the whole charge has been balled. When this has been done, each ball is moved into the hottest part of the furnace by means of a kind of rake called a *dolly,* and the fire is urged in order to weld the particles together. The balls are then removed from the furnace by means of tongs and conveyed to the *shingling-hammer* or the *squeezer,* by which the slag is pressed out and the metal consolidated. In this state the ball is called a *bloom ;* and while it is still at a red heat it is passed between two sets of rolls, the first called the *roughing*-rolls and the second the *finishing*-rolls, which latter are grooved corresponding to the section to be given to the bar.

The iron in this state is adapted for railway rails, which are made by successively drawing the bar through rolls of section similar to that of the rail, but gradually decreasing in size. To produce good bar-iron, the bars from the roughing-rolls are cut into short lengths by shears, and *piled* or *fagoted* together in a reverberating furnace until they are at a welding-heat, when they are drawn through a series of finishing rolls of section adapted to the required shape of the bar. See Puddling-furnace ; Rolling-mill ; Iron, Angle, etc.

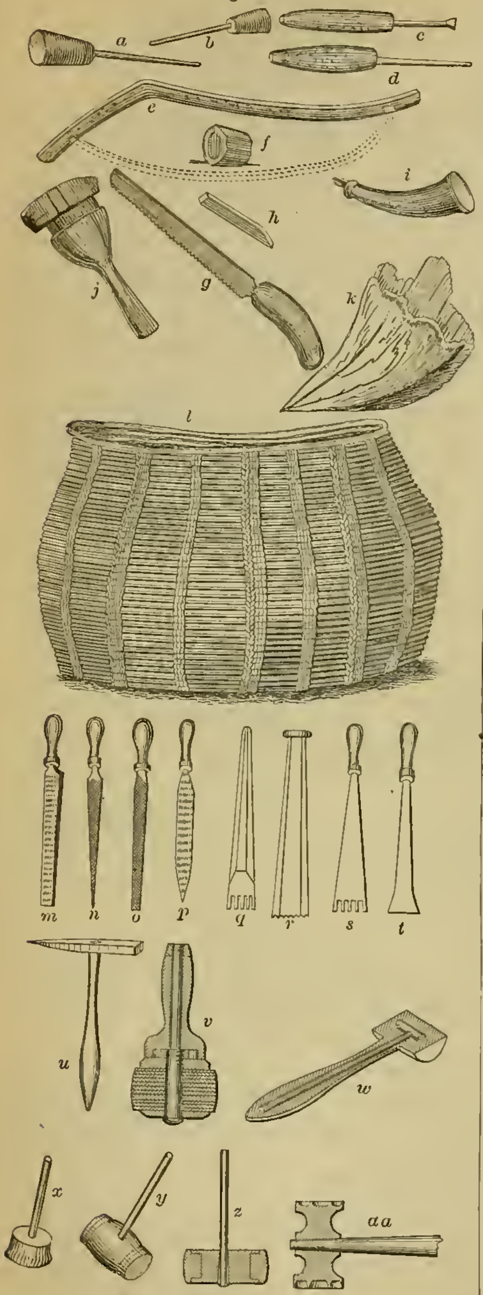
Mal'le-a-ble-i'ron Cast'ings. Small cast-iron articles are made malleable, their brittleness being thus removed, by packing them in powdered hematite (peroxide of iron) in tight fire-brick cases, and subjecting them to a continued red heat for about a week. They are then allowed to cool slowly.

The oxygen of the hematite combines with and removes a part of the carbon of the iron.

It is the converse of the process in which wrought-iron is closely packed with charcoal in a converting furnace, in order that its deficiency in carbon may be supplied, converting the bar-iron into steel. See Malleable Cast-iron; Cementing-furnace.

Mal'let. 1. A hammer of wood, smaller than a maul. Formerly, in the absence of metal, *celts* or hammers of stone were used. Mallets and wedges of stone were used in ancient Egypt, and were found in the pyramids of Cheops and Ghizeh.

Fig. 3032.



Mallets, Mauls, and allied Tools

Among other remnants of other centuries, gathered by Mr. Burton in Egypt, he found an old mallet in Thebes; it was in a basket along with drills, bow, chisels, an oil-horn, a saw, and a nail-bag, and had been locked up in a dry and dusty tomb at a time when Greece had not felt the light of science, and centuries before Romulus and Remus. Perhaps the workman had been putting the finishing touch to some of the fittings of the tomb, and accidentally left it inside when the door was closed, as they supposed, forever, or until the shell of the body was revived to receive its old tenant. The successors of the carpenter in the twentieth generation may have suffered from the wrath of Cambyses.

a b c d are chisels and drills.

e a drill-bow, the leather string lost.

f, whorl of the drill. *g*, saw; *h*, hone.

i, oil-horn; *j*, mallet, much worn.

k, skin nail-pouch. *l*, the basket in which the tools were contained.

The collection belonged to Mr. Burton, and is now in the British Museum.

The modern mallet is preferably of boxwood, but apple-tree, pear-tree, dogwood, gum, beech, or locust makes good mallets. *v* is a mallet made of thicknesses of raw-hide firmly pressed together by the center bolt. *w* has a rubber body upon a metallic skeleton.

2. (*Nautical.*) *a.* A *calking-mallet* is one used with a *calking-chisel* or *making-iron* to drive oakum into the seams of a vessel.

b. A *serving-mallet* is a cylindrical block of wood, by which spun-yarn is tightly coiled around a hawser or rope.

3. (*Dentistry.*) A plugger for compacting filling in carious teeth. See Dental-plugger, Figs. 1610, 1611.

4. A striker for balls in games. A *croquet* mallet.

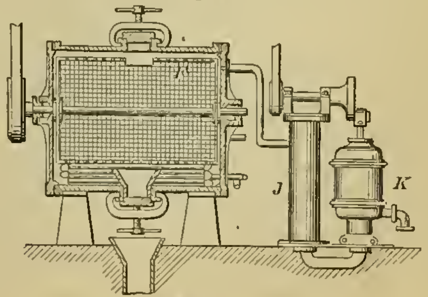
The *electric mallet*, in which the impulse is given by means of a galvanic circuit acting upon a magnet to oscillate an armature, or to move the magnet itself to and from an armature which forms the punch, is described under Plugger.

5. (*Surgical.*) A hammer used with a gouge in cutting bones.

Malm-bricks. The name given to those bricks, made in the neighborhood of London, in which the clay is pulped, mixed with cream of lime, and incorporated with breeze before molding. Breeze is a casual mixture of cinders, ashes, and fine coal, such as is gathered by the dustmen of London, and forms a part of the combustible material by which the bricks are burnt in the clamp. See Brick.

Malt-dry'er. A device to hasten the drying of malt by artificial heat. Fig. 3033 shows a machine in which the malt is agitated and overturned in an

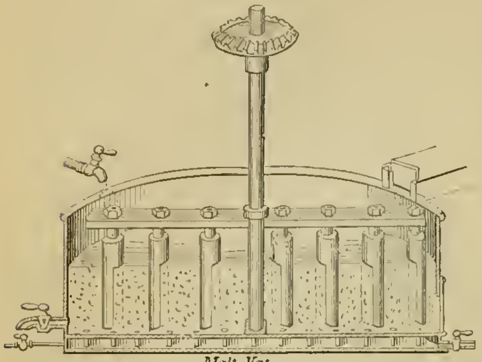
Fig. 3033.



Malt-Dryer

air-tight vessel from which all moisture is withdrawn by an air-pump, while its contents are exposed to heat. The wire-gauze cylinder *F* is within the air-tight vessel, and is caused to revolve, and so stir and mix its contents. *K* is the air-pump and *J* a condenser. The air-tight vessel has man-holes above and below, secured by man-hole covers and bridges, through one of which the malt is received, and discharged into the hopper below by the other.

Fig. 3034.



Malt-Vat.

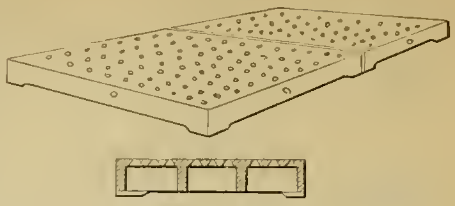
Malt-floor. The floor of an *oast* or malt-drying room.

Malt'ing-ap'pa-ra'tus. (*Brewing.*) A vessel in which ground malt is steeped to make the infusion known as *wort*; this, with the addition of decoction of hops and fermentation, becomes beer. The malting-vat shown in Fig. 3034 is provided with a false bottom, forming a steam-chest. Within the vessel revolves a shaft armed with blades. A portion of the blades are so set as to move the grain towards the circumference, and the other blades are so arranged as to move the grain towards the center.

Malt-kiln. A heated chamber in which malt is dried, in order to check the germination of the grain after having undergone the preliminary processes of *steeping*, *couching*, and *flooring*. An *oast*.

In the first of these processes, the barley is placed in a cistern, and sufficient water let in to cover it. This water is changed after having remained a certain time, to avoid fermentation. When the grain has steeped until it has imbibed the proper quantity of moisture, — in England the law requires that it shall remain in steep forty hours, — during which time it greatly increases in bulk and weight, on an average nearly fifty per cent, it is removed from the cistern and arranged in a rectangular heap called the *couch*. Here it remains about 26 hours, gradually increasing in temperature and parting with its moisture. During this process small roots begin to make their appearance. The growth of these is checked and the temperature of the heap lowered by *flooring*, or turning and spreading it out into a thinner layer, gradually reducing its depth from 16 to 3 or 4 inches. The flooring occupies about 14 days. About a day after the sprouting of the roots, the stem begins to make its appearance, and is allowed to grow until it reaches the end of the seed, when its farther progress is stopped by drying in the kiln.

Fig. 3035.



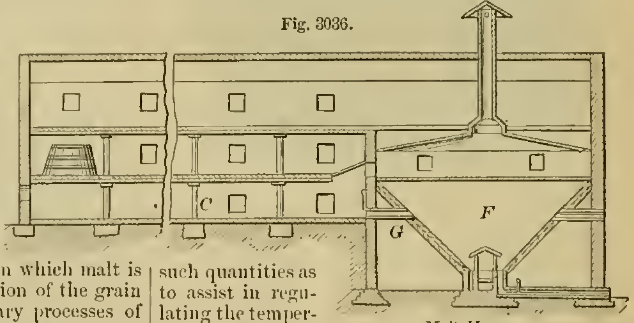
Malt-Kiln Floor.

The ordinary kiln is a chamber floored with a perforated iron plate, and having a vent in the roof for the escape of fumes. This is heated by a furnace in an apartment below, the hot air rising through the holes in the iron plate and passing through the malt. The temperature is at first about 90°, which is afterwards increased to 140° or more. For the completion of this process about two days should be allowed, during which the roots fall off and are separated from the grain by allowing the latter to run down a shoot, at the end of which is a screen which does not permit the grain to pass. The malt is then spread out to mellow or become soft and mealy by a slight absorption of moisture.

Fig. 3035 shows part of a floor composed of plates made of malleable cast-iron, strengthened on their under side by ribs crossing each other at right angles and uniting with a marginal ledge surrounding them, so as to be bolted together to form the floor.

In the kiln, Fig. 3036, air for supply of the furnace is drawn through the malting-chamber *C* in such quantities as to assist in regulating the temperature, by means of draft pipes or tubes *G* connecting the chamber with the heating-chamber *F* of the kiln.

Fig. 3036.



Malt-House.

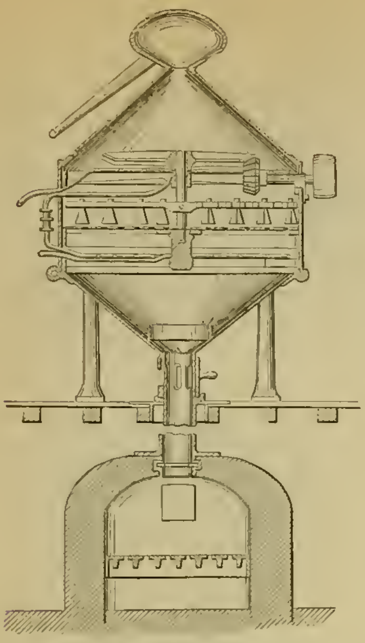
In the apparatus, Fig. 3037, the grain is stirred and turned by mechanical means, while exposed to the heat of the kiln. A furnace below and layers of steam-pipe within heat the kiln, and the vapor generated is condensed in a separate chamber, which connects by a pipe with the dome.

Man'a-cles. Handcuffs or *nippers* for criminals. The two pieces of metal are hinged together, the upper portion of which is curved so as to fit the wrist, and the lower portion is straight except at a point near its outer end, where it is slightly bent. Fig. 3037.

Man'da-rin'ing. Giving an orange color to silk or wool by the action of nitric acid, which partially decomposes the surface of the fiber.

Man'do-lin. (*Music.*) A stringed instrument played by the hands. It has 4 double strings, that is to say, four times two strings in unison and tuned in fifths like the violin. It is written on the G clef. The E strings are of catgut; the A strings of steel; the D strings of copper; and the G strings of catgut covered with silver-wire. The compass is about 3

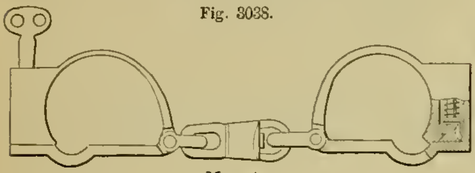
Fig. 3037.



Malting-Apparatus.

octaves. The strings are put in vibration by a plectrum held in the left hand. See *Mandola*, Bonanni, *Istromenti Armonici*, Roma, 1776; plate LV.

Fig. 3038.

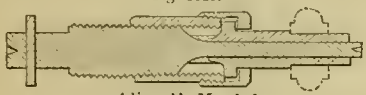


Manacles.

Man'dore. (*Music.*) A four-stringed lute.

Man'drel. 1. (*Lathe.*) Often incorrectly spelt mandril, which unfortunately is a short-tailed baboon with a red and blue face. The *cynocephalus. a.* An arbor or axis on which work is temporarily placed to be turned. The arbor which revolves in the headstock of a lathe and carries the upper pulley, and also the chuck or face-plate, if one be used. The example is an adjustable mandrel, having keys which fit in inclined longitudinal seats in the mandrel, and which are adjustable therein by a screw-sleeve on the shank.

Fig. 3039.



Adjustable Mandrel.

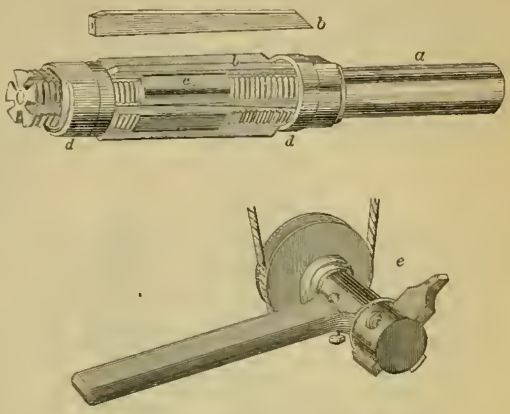
Traversing mandrels *e* are used in connection with a lathe, and are driven by gearing from a countershaft overhead. The one illustrated may be screwed into the tool-post of the slide-rest, and the belt from the countershaft carried on the small pulley, which runs at 1,500 revolutions per minute.

The use of the tool is to make ornamental designs or circular carving on all kinds of turned work.

2. (*Boring.*) The arbor *a* of Critchley's expanding mandrel for reaming has five grooves fitted with keys, cutters, or expanding tools *b*, according to the nature of the work or the office of the tool.

A screw-thread is cut on the body of the mandrel, and a portion of it is left in the center, as at *c*, to strengthen and prevent springing. The cutters are beveled at each end and confined in their places by nuts *d*, so that it is only necessary to slacken them off and slide the cutters down in the tapered grooves to expand or counteract their outside diameters, and thus adapt them to various dimensions of work.

Fig. 3040.

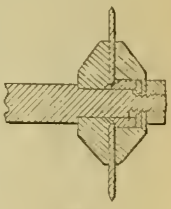


Expanding Reamer and Traversing Mandrel.

3. The revolving spindle of a circular saw or a circular cutter.

As the annular bush slips upon the mandrel, its conical face penetrates the central orifice in the saw, and maintains the concentricity thereof; an elastic packing intervenes between the bush and the end collar.

Fig. 3041.



Saw-Mandrel.

4. (*Forging.*) A round rod of any desired diameter, used in giving an interior cylindrical form to a forging, as a *nut* or hollow spindle.

5. (*Casting.*) A plug around which a body of metal or glass is cast.

Man'drel-lathe. A lathe adapted for turning hollow work, which is clasped by a chuck on the end of the mandrel in the head-stock; or for turning long work which is supported by the head and tail centers. It is the usual form of well-made lathes for metal and wood turning. See LATHE.

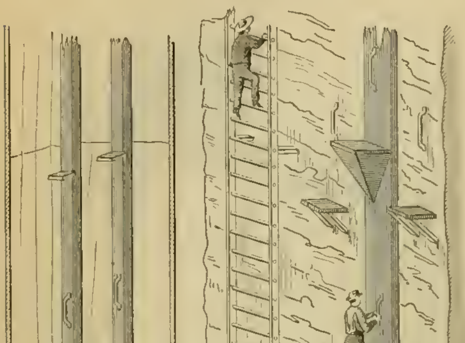
Man-en'gine. A mechanical lift for raising and lowering men in the shafts of mines. The same device is used in factories, and in some hotels.

The modes of construction vary; the most secure is an application of the screw or the piston; the most rapid, a platform raised by rope and drum. (See CAGE; WATER-ENGINE; ELEVATOR.) One of the simplest is the reciprocating vertical rod with platforms at intervals.

The latter form is specifically known as the man-engine, and was invented in the early part of the present century by Bergmaster Dörrell of Clausthal, in the Upper Hartz, who used two pump-rods, which, side by side, went up and down a shaft, and fixed to them small platforms and handles at all those points of the rods which came opposite after every stroke. So, by simply changing his stand after each stroke, from one rod to the other, a man would be lifted up to the surface. The plan was adopted in Germany, Belgium, France, England, but the "engine" was driven by special machinery, that at the deep silver-lead mines of Przibram in Bohemia having, since 1854, a steam-engine with two cylinders and cataract gear. The man-engine reaches a depth of 2,400 feet, and 3,000 men go up and down it daily, in three shifts of 8 hours each. It has a stroke of 10 feet. A similar engine at another shaft in the same mine has a stroke of 12 feet.

At the Trevesan mine in Cornwall, which is 300 fathoms deep, a man-engine has been constructed for lifting the miners and lowering them to their work, a depth of 240 fathoms. It has two parallel vertical rods, which are provided with stages or platforms and are reciprocated past each other. The stages are 2 fathoms apart, and each rod receives a motion through the same distance.

Fig. 3042.



Man-Engine.

A man stepping on to the lower platform, say No. 1 of the left-hand rod, is raised by the lifting of the rod which brings him to the level of platform No. 2 on the other rod, which is at its lowest position ; on to this he steps. When platform No. 2 rises he reaches the level of platform No. 3 on the opposite rod, and so he keeps stepping from one side to the other, rising 12 feet between each step. The platforms are opposite to each other at the dead points of the engine-crank, and thus pause for a slight space of time while the miners step off one and on to the other. A string of men thus ascend with merely the labor of stepping from one platform to another. The descent is the converse operation, in such case the man stepping on to the platform which is about to descend.

In a modified form, one set of steps is on the vertically reciprocating rod and the other set fixed on the side of the shaft. This plan is only half as fast as the other, the miner pausing half his time and ascending at intervals.

In the "Devon Great Consols" mine, England, the shaft of 1,020 feet depth has landings at intervals of 12 feet, and openings through which the timber rod of 8 inches square descends, having on it steps 18 × 15 inches, the openings in the landings being 27 × 24 inches. See left portion of Fig. 3042.

The men in ascending occupy one side of the landings, whilst those descending use the opposite side, which obviates any confusion in stepping on and off. It is evident that as the stroke of the engine is 12 feet, and as it makes five strokes per minute, a man descends at the rate of 60 feet per minute, and therefore takes 1,020 seconds to descend 170 fathoms ; and if 100 men require to descend to that depth, the hundredth man will necessarily be 1,188 seconds behind the first, and the time requisite for the whole will be 1,188 + 1,020 = 2,208 seconds, or 36.8 minutes. Thus, when the engine is working full, each step in rising carries a man and in descending carries a man, a man landing on one side of the platform and giving place to a man on the other side who steps on to descend, as the shifts of men pass each other in the shaft.

Man'ga-nese'. Equivalent, 27.6 ; symbol, *Mn.* ; specific gravity, 8 ; fuses at the same heat as wrought-iron. It is a grayish-white, brittle, hard metal, resembling cast-iron. It is used in arts and manufactures in several ways.

It is the *glass-maker's soap*, used to correct the green color of glass, which is owing to the presence of protoxide of iron, converting it into the comparatively colorless peroxide.

It is also used in the Bessemer and similar processes, to decompose the oxide of iron. *Spiegeleisen*, which contains a notable quantity of manganese, is used for this purpose where conveniently attainable. See BESSEMER PROCESS, p. 277.

Man'ger. 1. (*Shipwrighting.*) A space abaft the *hawse-holes* on the working-deck, bounded by planks lying athwartships, and serving to prevent the water that comes in at the *hawse-holes* from flooding the rest of the deck.

2. (*Husbandry, etc.*) A feeding-trough for grain ; usually accompanied by a rack for hay.

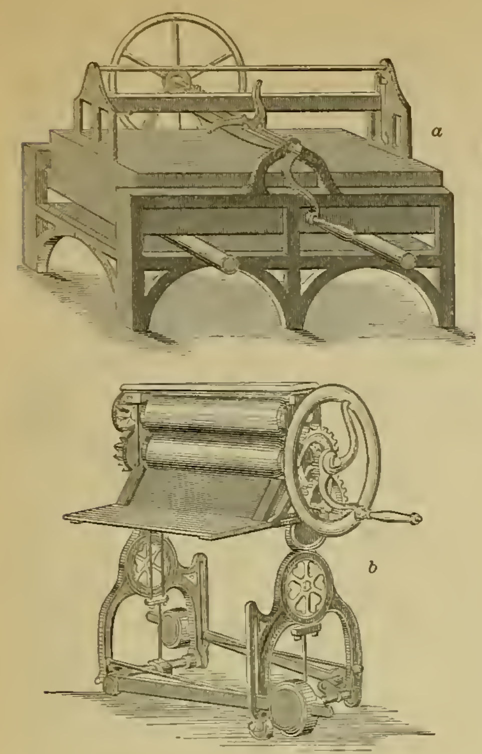
Man'gle. A machine in which damp clothes are smoothed by roller pressure. *a* represents the old-fashioned mangle, which had a box weighted with stones and reciprocating upon rollers which ran back and forth upon the clothes, spread upon a polished table beneath.

b is an improved form of mangle on the principle of the wringer. The clothes are passed between pressure-rollers driven by gearing.

In Fig. 3044, a series of rollers is disposed around a central drum, so that the garments are not subjected to undue pressure at but one or two points, as in the case of mangles having only two rollers.

On the frame axis of the large roller is an open wheel gearing into pinions on the axes of the smaller rollers ; each of the latter has a rubber spring which

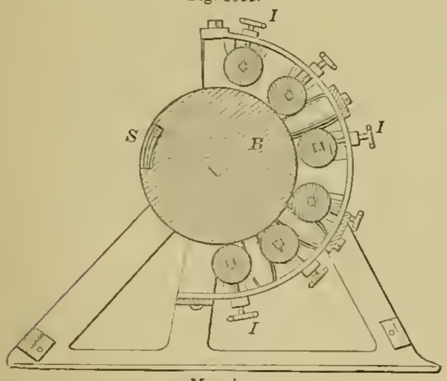
Fig. 3043.



Mangles.

presses it towards the large roller, and the pressure of the spring is regulated by a thumb-screw *I*. The large revolving roller has a clamp *S* for the edge of the clothes as they are fed between that roller and the series of rollers that abut upon it. This is to prevent the necessity of feeding the clothes at the throat between the roller *B* and the first small roller.

Fig. 3044.



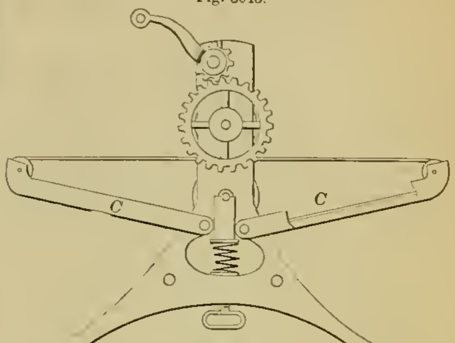
Mangle.

The improved mangle for smoothing and stretching woven goods previous to starching and calendering, has a number of rollers fixed in a strong frame, and capable of being forced together by levers or screws. In some mangles, the bottom rollers have grooves diverging from the center, so as to spread the cloth outwardly towards each edge as it passes through, removing the creases. The cloth is fed to the mangle floating on the surface of water in a cistern.

Starch is applied in a somewhat similar machine, the cloth passing over a roller which dips into a starch trough, and the rollers arresting the superfluous portion as the cloth passes between them.

Fig. 3045 is a mangle in which the clothes spread upon an endless apron are passed between a pair of rollers, the upper one of which is driven and the lower one supported by springs to permit a yielding pressure. When not in use, the side pieces *C C* fold up against the standard for compact stowage.

Fig. 3045.



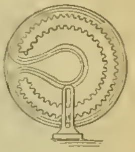
Folding-Mangle.

Man'gle-rack. (*Machinery.*) A rack having teeth on opposite sides, engaged by a pinion which meshes with the opposite sides alternately. Thus the continuous rotary motion of the pinion is converted into a reciprocating motion, as in some forms of the mangle. See MANGLE-WHEEL.

Mang'ler. A machine for grinding meat, to render it more easy to masticate or to stew. A *meat-mangler*, a *masticator.*

Man'gle-wheel. This is used in mangles for pressing clothes, the object being to obtain a reciprocating, rectilinear motion of the weighted box, by means of a continuous rotary motion of the driving-pinion, to whose shaft the hand-crank is attached. As the pinion is rotated, it passes from the inside to the outside teeth of the wheel alternately, giving a reciprocating rotary motion to the wheel, which communicates a reciprocating rectilinear motion to the box. The shaft of the pinion traverses a groove in the wheel as the pinion passes from one side of the rack to the other. The pinion-shaft has a vertical movement in a straight slot in the outside bar as it makes the change from its upper to its lower position, and *vice versa.*

Fig. 3046.



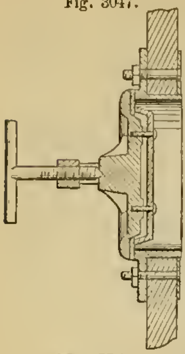
Mangle-Wheel.

Man'heim-gold. A brass used by jewelers, as an imitation of gold. Copper, 3; zinc, 1; tin, a small quantity. See also SEMILOR; ALLOYS, JEWELERS', p. 63.

Man-hole. A hole in a cesspool, drain, iron boiler, tank, or a chamber or compartment on an iron ship, designed to allow the entrance of a man for examination, cleansing, and repairs.

In boilers and tanks it is usually secured by a bridge and bolt, so as to render it water, steam, or

Fig. 3047.



Man-Hole.

air tight, as the case may be. In drains, the cover is a lid with a stink-trap joint.

Man-hole Door. The cover or lid of a man-hole in a boiler or tank. A *man-hole plate.*

Man'i-chord. (*Music.*) An instrument resembling the SPINET and HARPSICHORD (which see).

It was originally a monochord (*single string*), and is referred to by Giraud de Calanson, a poet of Provence (*manicordu, ab una corda*).

It was played by *quills*, operated by *jacks* and *keys* on a *key-board.* It was one of the predecessors of the piano-forte. See PIANO-FORTE.

Man'i-fold Writ'er. A device by which a number of copies may be written at once, the pressure of the stylus being communicated through a number of leaves of thin paper, between each of which is a greasy sheet of colored paper that imparts its color to the page with which it is in contact.

It was patented by Wedgwood in England in 1806. It has been much used by correspondents of the press, who thus write a number of letters to the various papers for which they cater.

Man'i-kin. An artificial figure representing the human body, and capable of being dissected to show the relative position and proportions of the parts of the body it is designed to illustrate. It is frequently of *papier-maché*, the detachable pieces being painted in imitation of the viscera and other organs.

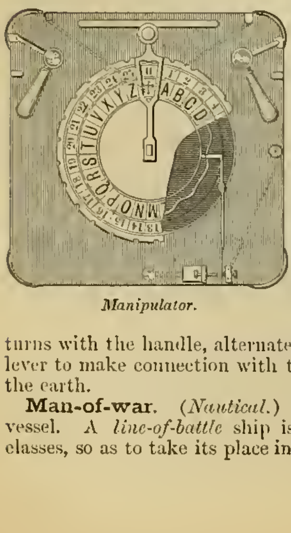
A manikin in illustration of obstetric subjects has an elastic perineum, uterus, and fetal head, so that the artificial parts may simulate the natural action of parturition.

Ma-nil'la-pa'per. Made from the fiber of a species of banana which grows in some of the East India islands. It is whiter than hemp, and the product is a stout, serviceable article. The fiber also forms cordage, sometimes known as *white rope.*

Ma-nil'la-rope. Rope made principally in the Philippine Islands, of the fibers of a species of banana.

Ma-nip'u-la-tor. The transmitting instrument attached to the dial telegraph.

Fig. 3048.



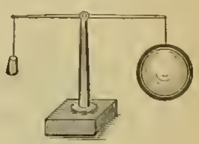
Manipulator.

Fig. 3048, Breguet's, has a dial corresponding to that of the receiving instrument, and an arm which is turned by a handle. The periphery of the dial has a notch at each letter, into which a pin attached to the handle falls to close the circuit. This is effected by an undulate wheel within the case, which turns with the handle, alternately causing a pivoted lever to make connection with the battery and with the earth.

Man-of-war. (*Nautical.*) An armed national vessel. A *line-of-battle* ship is one of the larger classes, so as to take its place in line of battle.

Ma-nom'e-ter. An instrument for measuring the elastic force of gases or steam. It consists of a graduated tube in which a body of confined air is compressed by the gas or steam under experimental test, a body of mercury intervening between the air in the tube and the gas or steam whose elastic force is to be ascertained. The tube containing the confined air, of a certain volume at a given temperature, is maintained at the said temperature by a bath, and is tested for the graduation of the tube by means of a column of mercury. It is then ready for the connection by a tube with the reservoir or boiler which contains the gas or steam whose elastic force is to be ascertained. A *steam-gage.* See also list under CALCULATING AND MEASURING INSTRUMENTS.

Fig. 3049.



Boyle's Statical Manometer.

Boyle's statical manometer consists of a bubble of thin glass, about the size of an orange, which, being counterpoised in an accurate pair of scales, rises and sinks with the alternations of the atmosphere. This instrument only proved a change of density, but did not detect the cause, whether arising from a change in its own weight or its temperature, or both.

Ramsden's manometer, used in the Arctic researches, had a tube of small bore with a ball at the end; the barometer being sp. grav. 2.97, a small quantity of mercury was placed in the tube to prevent communication between the external air and that contained in the ball, and that part of the tube below the mercury. A scale is placed on the side of the tube, which marks the degrees of dilatation arising from the increase of heat in this state of the weight of the air, and has the same graduation as that of Fahrenheit's thermometer, the point of freezing being marked 32°. In this state it performs the duty of a thermometer; but if the air become lighter, the bubble inclosed in the ball, being less compressed, will become dilated and take up a space as much larger as the compressing force is less; therefore the changes arising from the increase of heat will be proportionally larger, and the instrument will show the differences in the density of the air arising from the changes in its weight and heat.

Ramsden found that a heat equal to that of boiling water increased the bulk of the air from what it was at the freezing-point by $\frac{411}{1000}$ of the whole. The tube being graduated for heat, under a given barometric condition, the actual indications are compared with those of a thermometer, and the difference is what is due to barometric variation from the condition at which the instrument is adjusted. Thus, the manometer and thermometer readings being given, that of the barometer may be calculated.

Man'o-scope. An instrument for exhibiting the elastic force of gases or steam. See MANOMETER.

Man-pow'er. A *man* travels, without a load, on level ground, during 8½ hours a day, at the rate of 3.7 miles an hour, or 31¼ miles in a day. He can carry 111 pounds 11 miles in a day. A porter going short distances and returning unloaded carries 135 pounds 7 miles a day. He can transport in a wheelbarrow 150 pounds 10 miles a day.

The maximum power of a strong man, exerted for 2½ minutes, may be stated at 18,000 pounds raised 1 foot in a minute. — *Mr. Field's Experiments*, 1838.

A man of ordinary strength exerts a force of 30 pounds for 10 hours a day, with a velocity of 2½ feet in a second = 4,500 pounds raised 1 foot in a minute = *one fifth* of the work of a horse.

Man-rope. (*Nautical.*) A rope which forms a substitute for hand-railing at gangways, hatchways, etc. A *ladder-rope*.

Man-ropes are also used at the bowsprit, known as *bowsprit-horses*.

Man'sard-roof. Sometimes called the *French* or *curb* roof. First designed by a celebrated French architect, François Mansard, who was born in Paris in 1598. He designed many of the public buildings in the reign of Louis Quatorze.

It was invented to make the attics available for rooms, in consequence of a municipal law limiting the hight of front walls in Paris. It is also known as a *hip*-roof. See Curb-roof.

Man'tel. The ornamental facing and shelf around a fireplace; hence the terms *mantel-shelf*, *mantel-piece*, *mantel-tree*. See Fireplace.

Man-te-let'. 1. A movable blind constructed of planks, and sometimes plated, to cover a body of pioneers and protect them from small shot. A *sap-roller* is now used.

2. A protection of woven rope, etc., to protect gunners at embrasures.

Man'tel-piece. A beam across the opening of a fireplace, serving as a lintel to support the chimney-breast, or a *mantel-piece*.

Man'tel-shelf. A shelf above the facing of a fireplace. See Fireplace.

Man'tel-tree. The lintel of a fireplace.

Man'tle. 1. (*Founding.*) A covering of clay designed to form a matrix or mold for casting; as,

A porous clay covering of a basso-rilievo design in wax. The *mantle* and pattern are baked, the wax runs off, and the porous clay is a mold from which a casting is obtained in relief.

2. (*Building.*) *a.* The outer covering of a wall, of different material from its inner portion.

b. The enveloping masonry of a Blast-furnace (which see).

3. (*Hydraulic Engineering.*) An inclosed chute which leads the water from a fore-bay to a water-wheel.

4. A cloak or wrapper.

Man'tlet. (*Fortification.*) A bullet-proof shield which is suspended in an embrasure to protect the gunners, or used as a movable shield to protect sappers in the trenches. See Mantelet.

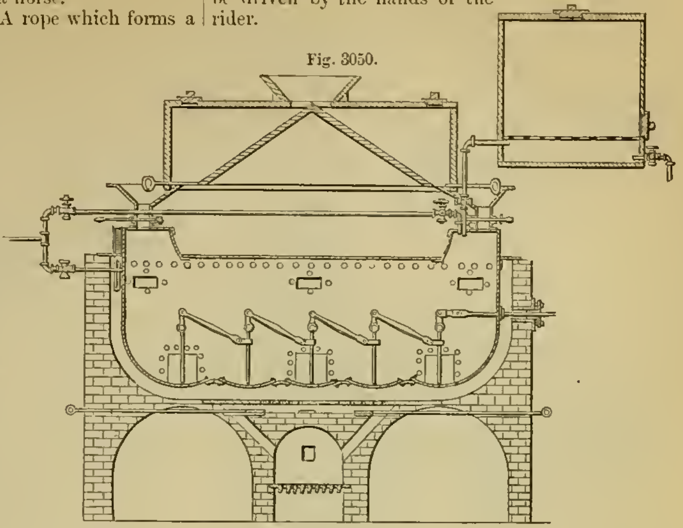
Man-trap. A trap for catching trespassers. It usually has two jaws, like a spring rat-trap, and those with smooth or toothless jaws are known as *humane* man-traps. It is not an American institution, either indigenous or imported.

Man'u-al. (*Music.*) The key-board of an organ, adapted to be operated by the hand, in contradistinction to the pedals, which are operated by the feet of the organist.

Man'u-al-key. An organ-key in the *manual*, played by the *hands*; the *pedal* keys are played by the feet.

Man'u-mo-tor. A wheeled carriage adapted to be driven by the hands of the rider.

Fig. 3050.

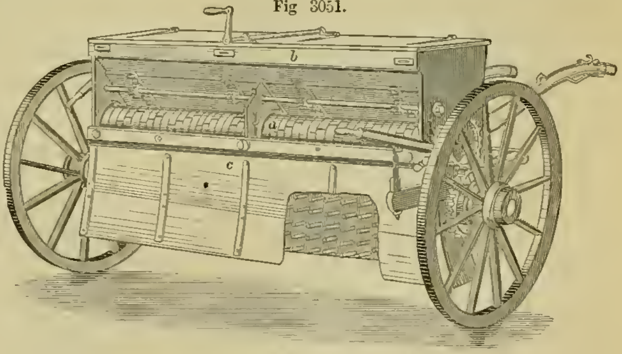


Manure-Desiccator.

Ma-nure'-des'ic-ca'tor. A furnace set within a brick chamber over which is an air-tight vessel forming a desiccating and mixing pan. Surmounting the mixing-pan is a hopper fitted with sloping bottoms provided with valves. Connected with the mixing-pan by a tube is a box provided with a false bottom, charged with some suitable absorbent, and into which the unabsorbed gases are conducted. Air is caused to circulate in the pan by means of an air-pump. The materials are stirred by oscillating paddles operated by a reciprocating rod passing through a stuffing-box.

Ma-nure'-dis-trib'u-tor. A machine (Fig. 3051) having a cylinder *a*, consisting of a series of rings with projecting surfaces, to which the manure is delivered from the box *b*. A series of scrapers below the box is arranged with springs which admit of adjustment to exert a graduated pressure on the rings, according to the quality of the manure used. The containing box *b* is provided with a stirrer, and rows of pins in the delivery-barrel *c* cause an equal distribution of the manure as it falls to the ground.

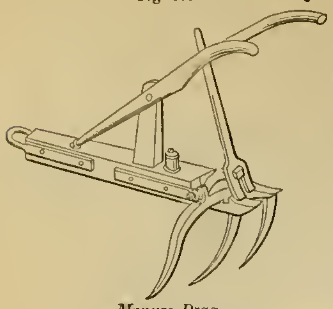
Fig 3051.



Broadcast Manure-Distributor.

Ma-nure'-drag. (*Agriculture.*) An implement drawn by a horse, and having teeth which catch into a bunch of manure, and drag it to a place where it

Fig. 3052.



Manure-Drag.

may be loaded or piled; on reaching the place the teeth are disengaged and the load dumped. Also used to scatter over the surface of a field manure which has been dumped in heaps.

Ma-nure′-drill. 1. An attachment to a grain-drill which deposits powdered fertilizer in the seed-row or broadcast, as it may be arranged.

2. A form of watering-cart to distribute in streams over the surface of a field the liquid carried in the box of the vehicle.

Ma-nure′-fork. A four-pronged fork for pitching manure, clearing stables, etc. The three-pronged dung-fork is mentioned by the Greek authors.

Ma-nure′-hook. A hand implement having three or four teeth bent at an angle with the handle, and used in dragging manure out of a stable, out of a wagon, or scattering manure-heaps in the field.

Ma-nure′-load′er. A form of horse-fork for loading into a wagon large bunches of stable manure.

Map. A representation of a portion of the earth's surface on a plane. This portion, except when Mercator's projection is used, cannot be greater than a hemisphere. There are several methods, known as "projections," employed in map-making for laying off the parallels and meridians, and locating the various positions of geographical points so as to, as far as possible, avoid relative distortion and exhibit a true likeness of the territory which the map is intended to embrace.

Anaximander of Miletus, 570 B. C., is credited with the invention of charts and maps. This is improbable, as the necessities of the Egyptians in measuring and dividing their Nile-irrigated and artificially irrigated lands must have made land-surveying and plotting a principal mode of determining the allotment of taxes. The revenue was derived from the use of water during the overflow of the Nile, and afterward of that which was stored in reservoirs during high water, — the simplest form of taxation upon property; the eminent domain of water being vested in the sovereign. The Egyptians, says Eustathius, "recorded their marches in maps."

Plate XXIX. has a representation of the popular idea of the earth in the time of Homer, 900 B. C. It consisted of a strip of land around the Pontus Pelagus, and even the boundaries were not known toward the northwest. Cimmerian darkness brooded upon the deep which surrounded the land.

Next is the world as known to Hecateus about 500 B. C., say about the time of Daniel. The borders of the Mediterranean are defined; the Iberi and Celtæ are known; the pillars of Hercules on the west and the Caspian on the east mark the longitudinal extent; back of Asia Minor is a greater Asia, which extends westward to the Nile.

In the world of Herodotus, the Caspian was changed from an indentation in the land to a lake. Asia extends to the Atlantic; Libya is a subdivision.

"Aristogoras, the tyrant of Miletus, showed to King Cleomenes of Sparta a bronze tablet, on which the whole circuit of the earth was engraved, with its seas and rivers." — HERODOTUS, V. 49.

In the geography of Democritus, 300 B. C., Europa, Asia, and Libya are acknowledged divisions.

In the maps cited by Herodotus and other geographers of his time, the grand division now known as Africa was called Libya. The term Europe is from a Semitic word *Ereb*, the *west*, *setting*, *darkness*, etc. Asia signifies the opposite, — the *east*, *rising*, etc. The origin of the term Libya is lost in obscurity. The same, except as to period, may be said of the Latin word Africa. Its derivation was a mystery 2,300 years ago.

"For my part I cannot conceive why three names, and women's names especially, should ever have been given to a tract which is in reality one, ... nor can I even say who gave the three tracts their names, or whence they took the epithets. According to the Greeks in general, Libya was so called after a certain Libya, a native woman, and Asia after the wife of Prometheus. The Lydians, however, put in a claim to the latter name, 'as being from Asius, the son of Cotys.' . . As for Europa, no one can say whether it is surrounded by the sea or not, neither is it known whence the name of Europa is derived, nor who gave it name, unless we say that Europa was so called after the Tyrian Europa, and before her time was nameless. . . However let us quit these matters. We shall ourselves continue to use the names which custom sanctions." — HEROD., IV. 45.

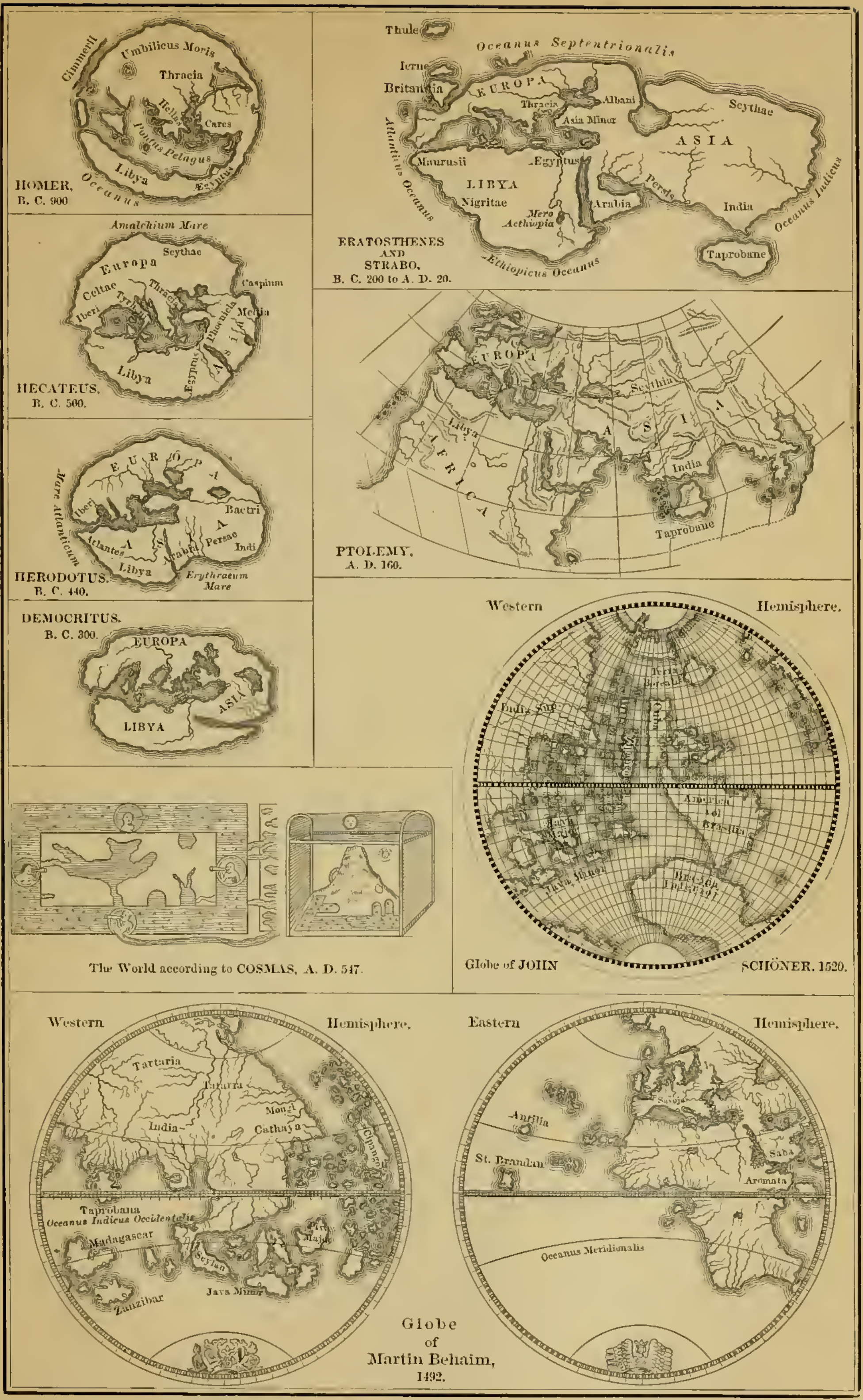
In former times the geographers were undecided where to draw the dividing line between Asia and Libya, as seen in the first four figures, Plate XXIX. The Egyptians were of known Asiatic origin, and it was considered more logical to include them in Asia. The eastern border of the land, abutting upon Libya, was for a time adopted. Afterwards the Tanais and the Nile were the limits of Asia, one half of Egypt being ascribed to Africa. Herodotus considered it absurd to divide the country of one people between two continents. Ptolemy, the geographer, defined the Red Sea and the Isthmus of Suez as the boundary between the continents.

Next is the map of the world according to Eratosthenes and Strabo. Eratosthenes (276 – 196 B. C.) of Alexandria was the discoverer of the obliquity of the ecliptic, and was the founder of geodesy. He determined the circumference of the earth by measuring a degree of the meridian. Measurements of an arc of the meridian have been made by the Chaldeans, by Eratosthenes, by Al Maimon, by Piré, and more lately by the French, English, Germans, and others; in Peru, Lapland, British India, and elsewhere. (See ARMIL; ARMILLARY-SPHERE; ASTRONOMICAL INSTRUMENTS; ODOMETER.) We regard Eratosthenes with profound respect as the author of the *science* of geography, and the name thereof. The extent of each zone he determined by the length of the solstitial day, and called them *climates*.

The "map of the world" by Hipparchus (150 B. C.) is founded on the discoveries of Eratosthenes, and is the first recorded attempt to assign geographical positions by longitudes and latitudes, obtained, the former from lunar eclipses, and the latter from lengths of the shadow measured by the gnomon.

In Strabo's time, about the Christian era, it was customary to draw a meridian and parallel for each important place whose position was considered as determined. Ptolemy, about A. D. 150, simplified the method, and probably introduced the regular plan of dividing the area by lines 5° or 10° apart, as the case might be. See cut, also "Ptolomæi Geographiæ," Roma, 1508. Congressional Library.

The maps of Eratosthenes and Ptolemy show a marked advance in geographical knowledge, especially in the bounds of Asia and Libya, the latter re-



PROGRESS OF MAPPING FROM 900 B. C. TO A. D. 1520.

PLATE XXIX. (2400 *Years.*) *See page* 1386.

ceiving in the map of Ptolemy its new name of "Africa." The old belief in a circumscribing sea is evident in the upper map, where Libya is apparently extended merely to balance the newly discovered extent of Asia, the insular character towards the south being assumed, as in the earlier maps. In the map of Democritus, the Mesopotamian rivers flow into the ocean and mark the extent of geographic knowledge, in an eastern direction, of the Mediterranean nations. In the next map these rivers debouch into the Persian Gulf; and India with its marginal rivers, the Indus and the Ganges, forms an eastern extension. Taprobane (Ceylon) is also shown. Britannia and Ierne come upon the scene with the Cassiterides or Tin Islands, which had been known to the Phœnicians for 1,000 years. There is also an indication of a land across the Baltic. It should also be mentioned here that this map of Eratosthenes was merely a plane exemplification, and that he was fully aware of the spherical form of the earth. Aristotle had said, 100 years before, that it was possible that Spain and India were only separated by the sea. Eratosthenes said that only the extent of the Atlantic Ocean prevented sailing from Spain to India along the same parallel. In the map of Ptolemy, the land grows toward sunrise, Burmah with the peninsula of Malacca comes into view, with some traces of an eastern archipelago, and a country beyond India of unknown and undefined extent; so much land in this direction, indeed, that the sea is suppressed. Taprobane is still there, but the old geographer who put upon his map the interior lakes of Africa where Livingstone found them to be, would not take the sea for granted on the southern confines of Africa more than he would on the eastern regions of Asia. Africa assumes large proportions, and the name Libya becomes local; indeed, a dotted line uniting a hypothetical eastern land with a possible extension of Africa is suggested as the termination of salt water southwardly.

Dr. Livingstone's last letter, dated from Lake Bangweolo, December, 1872, and published April 28, 1874, finishes by saying: "If the good Lord gives me strength and influence to complete my task I shall not grudge my hunger and toil. Above all, if He permits me to put a stop to the enormous evils of this inland slave-trade I shall bless His name with all my heart. The Nile sources are valuable to me only as a means of enabling me to open my mouth among men. It is this power I hope to apply to remedy the enormous evil, and join my little, helping hands in the great revolution that in His all-embracing providence He has been carrying on for ages, and is now actually helping forward."

Next we recognize the map of Cosmas of Alexandria, known as *Indico-pleustes.* His map was made about A. D. 547, and was regarded as conclusive by the Fathers of the Church. So said the doctors of Salamanca, in 1486, to Columbus, who proposed to reach the east by sailing to the west. The geographer of the Church represented the earth as a plane twice as long as it was broad, embracing the Mediterranean and indented by the Red Sea, the Persian Gulf, and the Caspian; around it was the ocean. It most resembled the map of Homer's time, 1,400 years before, and was a ridiculous burlesque in a city where Ptolemy had lived but four centuries previously. But Cyril and the monks intervening had undone in a few years the progress of ten centuries. The square shape of the land was probably in deference to the Scripture expression, "the four corners of the earth." In another view of the earth as understood by Cosmas, a vast mountain rises beyond the "Great Sea" (the Mediterranean), and when the sun emerges from behind the mountain, it is day; when he retires behind it, it is night. The circles represent the Creator looking down, the sun orient, the sun occident. The pear-shaped place half-way up the mountain is the Garden of Eden.

To come down farther in order of time, we notice the representations of the eastern and western hemispheres, as depicted on the terrestrial globe of Martin Behaim, 1492. This may be taken as representing the state of geographic knowledge out of Salamanca and the cloisters. Africa had been circumnavigated by Vasco da Gama; Asia is driven over to the eastward as far as Marco Polo is deemed to have gone in his months of weary travel. So large a proportion of the circumference of the earth was held to be embraced by the circuit of Europe and Asia, that the latter about fills the western hemisphere, the goodliest island of "Cipango" (Japan) lying off the coast of the "far Cathay." In the mid-Atlantic is the island of Antilia, a spot partly conjectural, and also the island of St. Brandan, which was purely imaginary. Thus was the globe depicted before the sailing of Columbus, and his projected voyage was not expected to be much greater than the length of the Mediterranean. He sailed and discovered what he considered to be the "Island of Antilia" (Cuba). An island under that name had appeared on the charts since 1425. Columbus was for discovering a western route to India in the interest of the Spaniards, that they might share in the rich Oriental trade then almost monopolized by the Venetians. He supposed himself to have reached the outlying islands of the Asiatic coast, and tried to worm his way among them to reach China and India. The voyage was repeated with the same intention. His third voyage carries him to the Orinoco, and the volume of water encourages a hope that the gap is found. During the next year, 1499, Vasco da Gama anchors in the Tagus with trophies from Calcutta; the Portuguese have turned the Venetian position, and the trade is their own. The western essays have yet been fruitless, for no India has been reached, and the fourth voyage of Columbus, in 1502, in which he reaches Central America, is yet barren to him, for no strait is found. Columbus died in 1506, supposing that he had discovered India, though surprised at not being able to make connection with the eastern voyagers and the land of Marco Polo's adventures. In 1500 he asserted that, "if any one does not give him credit for having discovered the remaining parts of India," it must be from personal hostility. In 1502 he writes to Pope Alexander, "I discovered 1,400 islands and 333 leagues of the coast of Asia."

Above is a representation of the western hemisphere of John Schöner's globe of 1520, fourteen years after the death of Columbus, and, no doubt, published in good faith. In it the terra-borealis forms the only trace of the North American continent, and might answer for Newfoundland. Cuba and parts of the South American continent are plotted as islands of the eastern coast of Asia, adjacent to Java major, Java minor, and Zipango, which more immediately fringed the Asiatic coast. Cuba, the Antilia of Columbus, and yet the "Queen of the Antilles," lies north and south, parallel with the coveted island of Zipango (Japan), which so persistently eluded the search of the man of Genoa, who tried to push his caravel through a continent.

Sea-charts were brought to England, 1489, by Bartholomew Columbus, to illustrate his brother's views respecting a western continent. The first tolerably accurate map of England was made by George Lilly, who died 1559.

Gerard Mercator published his Atlas in 1556. In this, as in the modern maps on the "Mercator Projection," the meridians and parallels are straight lines and cut each other at right angles.

The distance between the parallels is increased with the latitude, so as to be proportionate to the actual distance of the meridians apart.

The principles on which this projection is founded were first explained by Edward Wright, an Englishman.

It is universally employed in nautical charts.

"My Lord Barkeley wanting some maps, and Sir W. Coventry recommending the six maps of England that are bound up for the pocket, I did offer them." — Pepys's *Diary*, 1667.

The great geographical achievements which distinguished the close of the fifteenth and the early portion of the sixteenth centuries, or the thirty years from 1492 to 1522, consist in the discovery of tropical America, the rapid determination of its form, the passage round the southern point of Africa to India, and the first circumnavigation of the globe.

The triangular form of Africa is distinctly laid down in the planisphere of Sanuto as early as 1306; in the Genoese Portulano della Medicc Laurenziana of 1351, discovered by Count Baldelli; and in the map of the world by Fra Mauro. 1,700 years before this, Herodotus had characterized as incredible the statement "that those who sailed around Libya, in sailing from east to west, had the sun on their *right* hand," as in sailing eastwardly in the Mediterranean the sun at noon is always to the left. He farther states that Necho commanded the Phœnicians to make their return to Egypt by the pillars of Hercules. Strabo, while discrediting the accounts of circumnavigations previously said to have been accomplished, does not deny the possibility of the circumnavigation, but affirms that from the east to the west there was but little wanting to its completion.

Bartholomew Diaz reached and actually doubled the Cape of Good Hope in May, 1487, but, deterred by the storms, put back and reached Portugal in December of the same year, so that it was reserved for Vasco da Gama to first pass beyond the region of storms which surrounds the Cape and enter upon the waters, usually more placid, of the great Indian Ocean.

Humboldt says: "I have shown elsewhere how a knowledge of the period at which Vespucci was named 'Piloto Mayor' would alone be sufficient to refute the accusation first brought against him in 1533 by the astronomer Schöner of Nuremberg, of having astutely inserted the words 'Terra di Amerigo' in charts which he altered. The high esteem and respect which the Spanish court paid to the hydrographical and astronomical knowledge of Amerigo Vespucci are clearly manifested in the instructions which were given to him when, on the 22d of March, 1508, he was appointed 'Piloto Mayor.' But the name of 'Americi Terra' had been proposed for the new continent as early as 1507, by a person whose existence even was assuredly unknown to Vespucci, the geographer Waldseemüller (Martinus Hylacomylus) of Freiburg in the Brisgau, the director of a printing establishment at St Dié in Lorraine, in a small work entitled 'Cosmographiæ Introductio insuper quatuor Americi Vespucii Navigationes.' The map of the new continent drawn by Hylacomylus, and contained in this edition, presents the first instance of the name of 'America' in the editions of Ptolemy's Geography. It is a great error to regard the map of 1527, now in Weimar, obtained from the Ebner library at Nuremberg, and the map of 1529 of Diego Ribero, engraved by Güssfeld, as the oldest maps of the new continent. Vespucci had visited the coasts of South America in 1499 (a year after Columbus's third voyage), in the expedition of Alonso de Hojeda. He could not have had any motive in feigning a voyage in 1497, for he, as well as Columbus, was firmly persuaded until his death that his discoveries were a part of Eastern Asia. For more than 20 years after his death, which took place in 1512, and indeed until the calumnious statements of Schöner in the 'Opusculum Geographicum,' 1533, and of Servet in the Lyons edition of Ptolemy's Geography, in 1535, we find no trace of any accusation against the Florentine navigator. Columbus himself, a year before his death, speaks of Vespucci in terms of unqualified esteem; he calls him 'a very good man,' 'worthy of all confidence,' and 'always inclined to render me service.' The same good-will toward Vespucci is displayed by Fernando Colon, who wrote the Life of his father in 1535 in Seville, four years before his death, and who, with Juan Vespucci, a nephew of Amerigo's, was present at the astronomical junta of Badajoz, and at the proceedings respecting the possession of the Moluccas.

"The confusion of dates in the numerous versions of Amerigo's voyages is not to be attributed to him, as he did not himself publish any of these accounts; such mistakes and confusion of figures are, moreover, of very frequent occurrence in writings published in the sixteenth century."

The entire guiltlessness of the Florentine navigator, who never attempted to attach his name to the new continent, but the magniloquence of whose accounts unfortunately drew upon himself more of the attention of posterity than he deserved, is decisively shown by the fact that he was not even cited as a witness in the suit instituted by the fiscal authorities of Spain against the heirs of Columbus, from 1508 to 1527, with the object of withdrawing from them the rights and privileges which had been granted by the Crown to their father in 1492, in which it was to be decided what parts of the new continent were first seen by Columbus. In the course of this suit it was never pretended that he had preceded Columbus in the discovery of the continent. Amerigo died at Seville, February 22, 1512. In 1520 maps were extant, having in them the name of America, proposed by Hylacomylus in 1507.

Las Casas, in treating on the subject in an unpublished work, the "Historia General de las Indias," says that the statement that Amerigo sailed in the year 1497 appears to have been an error of the pen and not an intentional false statement, and adds that "the *foreign writers* call the country America. It ought to be Columba." Farther on he attributes intentional deceit to Amerigo, but considers it strange that Hernando Colon, who had had in his hands Amerigo's account of his travels, "remarked in them no deceit or injustice toward the Admiral."

Even Copernicus contributed to the erroneously obtained celebrity of Vespucci.

To Humboldt we are indebted for the graphic representations of complex natural phenomena by means of lines on maps, such as the isothermals, which unite places of equal mean temperature, hypsometric lines, which unite places of equal hight, etc.; or depicting, by circumscribing lines or by color, regions of equal average temperature or rainfall, population, mortality, illiteracy, wealth, race, etc. The following names are used for lines drawn upon maps to connect places of equal conditions, as follows: —

For an illustration, see Blodget's "Climatology of the United States," Philadelphia, 1857.

Isobarometric, having equal barometric pressure.
Isocheimal, having same winter temperature.
Isoclinal, indicating equal magnetic dip.

Isocrymal, having same extreme of cold.

Isodynamic, having same magnetic intensity.

Isogeothermal, passing through points beneath the surface which have the same average heat.

Isogonic, indicating equal variation of compass.

Isohyetose, having same mean annual rainfall.

Isotheral, of equal summer temperature.

Isothermal, having same mean annual temperature.

Isothcrombrose, where the quantity of summer rain bears the same proportion to the annual rain.

The surveys from which the data for the construction of geographical maps on an accurate and comprehensive scale are derived embrace both geodetical and astronomical observations; the former to determine the relative positions of geographical points and their distances from each other, and the latter to fix their absolute position on the earth's surface and establish the true meridian.

The geodetical part of the work is accomplished by first measuring with extreme accuracy on the most level surface that can be selected a base line of convenient length. In extensive surveys, embracing, for instance, a whole country, this is from five to ten or more miles in length. This serves as the basis of a system of triangulation, the length of the sides of the triangles being gradually increased as they recede from the base, until they are made as long as the nature of the country or the possibility of seeing the signals erected at the various stations will admit of; this may be as much as 100 miles, or even more in mountainous countries. The area covered by these primary triangles is subdivided by smaller triangles termed secondary, and these again by a still smaller system of tertiary triangles. This work is performed with the theodolite, the size of the instruments employed being proportioned to the character of the work, from those having a circle of 2½ to 3 feet diameter for the main triangulation to those of 6 inches for the tertiary. The filling in or determination of subordinate points, the outlines of the shores of bays and other bodies of water, may be effected with instruments of an inferior class. The plane table is used for this purpose by the United States Coast Survey. The data are now transferred to paper. A scale for the map having been determined on, the projection of the lines of latitude and longitude is made, and the positions of the different points laid down on the paper with a scale and circular protractor. The topographical features of the ground, the relative levels as ascertained by leveling during the progress of the survey, and such other details as are considered advisable, are represented by a peculiar system of shading and by symbols. The map is then ready to be transferred to copper, from which any number of copies may be printed. But a very small portion of the globe comparatively has been surveyed with an accuracy even approaching that above described. Africa, Asia, with the exception of British India, South America, a large part of North America, and even a considerable portion of Europe, afford no better data for the construction of maps than detached astronomical observations at different points and rudely measured or even estimated tables of distances. Points along the sea-coast have, owing to the requirements of commerce, been generally tolerably well determined, but our knowledge of the interior geography of several of the vast continents referred to is based largely upon mere report.

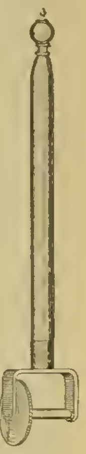
Maps in relief were first produced in Germany some time in the last century. From them Haüy conceived the idea of relief-printing for the blind.

Map-hold′er. A frame for the display of maps or charts. In one form the maps are on an endless web of cloth, which is rolled off from one roller and on to another, the display being in the space between the two. A *ribbon map*.

In another form the maps are hung from separate rollers in the manner of window-shades; either is pulled down as may be desired and is re-wound by a spring.

Map-meas′ur-er. An instrument with a little wheel of known circumference, which is made to roll along a line and indicate its length, the number of revolutions being counted, and the fraction, if any, observed by reference to the pointer and graduated perimeter.

Fig. 3053.



Map-Measurer.

Mar′a-bout. A peculiar kind of silk, generally containing 3 threads, and made from the white Novi raw silk. It is dyed without discharging the gum.

Ma-ram′ba. A musical instrument of Central America, consisting of a series of calabashes of different sizes set in a frame and having the tops cut off. Pieces of parchment or membrane are stretched over the openings, and are tuned so as to produce, when beaten with an implement resembling a drum-stick, the notes of the diatonic or other musical scale.

Mar′ble. 1. A granular and crystalline carbonate of lime. In sculpture the term is applied to several varieties of stone capable of receiving a high polish.

Statuary marble is known as saccharine limestone, having a texture resembling loaf-sugar. It belongs to the metamorphic rocks; and is non-fossiliferous, having been changed by heat.

Among the ancients the Pentelican and Parian marbles, the former a pure white and the latter having a creamy or waxy tint, were most valued for statuary purposes.

In modern times the best is derived from the quarries of Carrara.

The *Potomac marble*, so called, of which the pillars of the old House of Representatives, Washington, are formed, is a *pudding-stone* or *conglomerate*. It may be described as a gravel bound together by cement.

Alabaster is no marble, but is a species of gypsum. It is a *sulphate* and not a *carbonate* of lime.

There are many fancy varieties of marble used by marble-workers; these have names derived from the geographical position of the quarries, the color, markings, geological position, etc.

White marble has a specific gravity, 2.706; weight of a cubic foot, 169 pounds; weight of a bar 1 foot long and 1 inch square, 1.17 pounds; cohesive force of a square inch, 1,811 pounds; extensibility, $\frac{1}{1394}$ of its length; is crushed by a force of 6,060 pounds upon a square inch (Rennie).

Marble for tombstones, mantels, and generally where thin pieces are required, is divided by the saw. This is a plain, narrow plate of steel, and effects the division of the stone by attrition, being constantly supplied with sand and water.

After being sawn into slabs, its surface is ground down by a flat, coarse sandstone with water, or with an iron plate fed with fine sand and water, until all the marks of the saw are removed.

It is then rubbed with a fine sandstone and water, removing the marks left by the first operation. A still finer sandstone, pumice-stone with water and snakestone are then successively employed.

The final polish is given by means of rollers of woolen cloth or list, about three inches in diameter, charged with moistened flour of emery, which is worked uniformly over every part of the surface, and subsequently by a similar roller with putty-powder and water. Sometimes an old cotton stocking is used instead of the roller, and in some delicate works crocus is employed intermediately between the emery and putty-powder. The marble must be washed after each operation, to remove every particle of the polishing material, which would otherwise scratch the work. Turned works are similarly polished, using two or three thicknesses of cloth, held in the hand, instead of the roll. Other kinds of work, as statuary and hard varieties of marble, require a somewhat different treatment.

Rough marble is in the shape of blocks from the quarries.

Rough-hewn marble is cut with the saw or squared with the stone axe.

Outlined marble is blocked out in the rough for an architectural ornament or sculpture by the *double-point* or the chisel.

Pierced marble is worked to bring out the ornaments in relief.

Polished marble is that which has been worked by a succession of materials of gradually increasing fineness. See MARBLE-POLISHING.

Finished marble is that which is ready for its place.

2. A plate of stone used by painters. A slab on which substances are levigated by a *muller*.

3. A stone or iron plate on which glass is rolled to shape it. A *marver*.

4. A printer's imposing-stone.

5. A style of coloring, for paper and book edges. See MARBLE-PAPER.

6. Playing-marbles are made of clay, calcareous stone, marble, agate, etc. Some of stone were discovered at Pompeii.

Playing-marbles were first introduced into England from Holland, about 1650. They are made in great quantities in Germany, and constitute a not unimportant article of trade. The stone is broken into fragments, which are sorted into sizes proportioned to that of the marbles to be made. These are then ground between a lower and stationary and an upper revolving millstone to remove asperities. They are next roughly rounded by friction against each other and against two cylinders of hard stone, one of which is caused to rotate at the rate of 40 to 45 turns per minute.

The complete rounding of the marbles is effected in an oblong wooden cylinder or cask, having a double bottom, in which are one or more cylinders of hard stone. This is caused to revolve at the rate of 40 or 45 turns per minute. The dust formed during this operation is then removed and mixed with emery in pieces the size of a bean; by this the final rounding and polish are effected, in the apparatus just described.

A shining polish is obtained by revolving the marbles in wooden cylinders with fine emery.

If they are to be colored, this is done previous to their receiving the final polish, by pouring the coloring material upon them in a liquid state. They are then polished by rotation in contact with a small quantity of calcined tin-dust.

By another process the pieces of stone are rounded between a lower turning millstone and an upper stationary wooden tray, each grooved to correspond to one half the marble. A stream of water is constantly poured through an aperture in the tray, which is arranged to descend as the volume of the mass diminishes by attrition, so as to exert a constant gentle pressure. The marbles are polished between two wooden trays similarly arranged.

Clay marbles are molded and baked.

Mar'ble, Ar-ti-fi'cial. An indurated composition of gypsum, alum, isinglass, and coloring materials incorporated into a paste and molded into form.

In Mellen's patent, 1872, any of the hydraulic or marble cements may be used. The cement is mixed with the colors, each color separately to a consistence which will admit of its being poured from a vessel having a spout.

The mixture is poured from the vessels in small streams upon a smooth surface of glass, wood, metal, or plaster of paris, so as to imitate the veins in any particular kind of marble, the interspaces being filled in with a mixture of cement and color corresponding to the color of the body of the stone. A wind-blast, produced by bellows or otherwise, is employed to make the colors flow, so as to produce the mottled appearance of marble.

For producing delicate veins, threads of silk or other material are dipped in the desired color and laid upon the smooth surface; these are drawn out after the cement has been poured on. The cement absorbs the color from the thread, exhibiting a fine streak of the desired appearance. After the various colors have been laid on the smooth surface, the back is smoothed over and strengthened by a backing of cement, pieces of metal being employed to bind the two together and impart firmness to the slab.

The process of Pichler of Vienna is recommended for plastic decorations of all kinds: Take one pound of good glue and boil it down so that it will be quite thick; add then half a pound of resin, or, better still, Venice turpentine, and mix well. Prepare a mixture of fine chalk and such mineral colors, finely pulverized, as are required for certain imitations. The less the ingredients are mixed, the better will be the imitation. The paste formed by blending the two mixtures is then kneaded until of the proper consistence. A few drops of oil may be added to it. This mass can be immediately used, and becomes hard like stone. If desired to be kept for a while, it is only necessary to wrap it in a moist cloth.

Mar'ble-cem'ent. A composition of gum-lac, colored to suit the occasion.

The rust cement is also used, composed of hydrochlorate of ammonia, 2; flour of sulphur, 1; iron filings, 16.

For coating insides of cisterns, pulverized baked bricks, 2; quicklime, 2; wood-ashes, 2; olive-oil to make a paste.

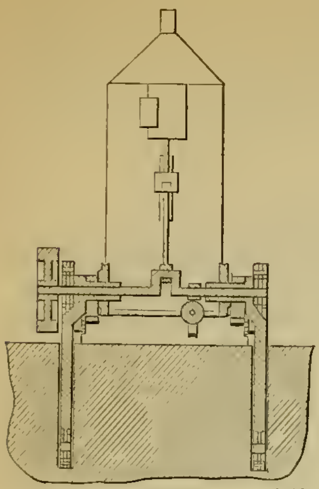
For stone seams and joints: pulverized tiles or hard brick, 6; white-lead, 1; litharge, 1; oil to compound.

Hydraulic cement, 12; triturated chalk, 6; fine sand, 6; infusorial earth, 1; all mixed with soluble soda glass.

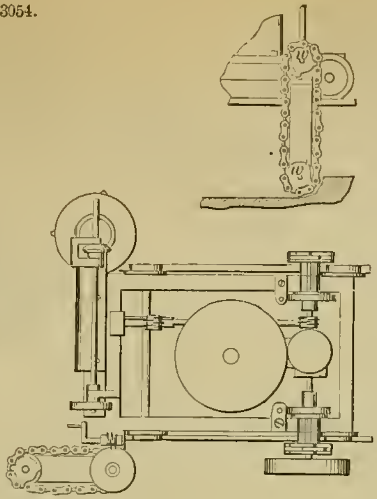
Mar'ble-cut'ting Ma-chine'. A machine for cutting marble in the quarry. A *channeling* machine, which cuts deep grooves in parallel lines. This is sometimes done by the impact of a gang of stamping-chisels, but in the example is effected by a chain-saw whose links are armed with diamonds. The diamonds are held in the ends of split screw-bolts or clamps, which are tapered and forced into tapering cavities, causing them to contract upon the diamonds. The diamonds are applied on the edge of a rotating disk, or the links of an endless chain, and the supporting standard of the disk or chain is so connected to the driving mechanism that it may have feed in any direction.

The chain-saws are carried by wheels *w w'*, which are driven by shafting from the steam-engine on the truck, whose proper motion feeds the saws to their work. Devices are afforded for changing of the saws to vary the direction of cut. The lower right-hand figure shows the mode of presentation of the diamond-chain for making a horizontal under-cut.

Fig. 3054.



Marble-Quarrying Machine.



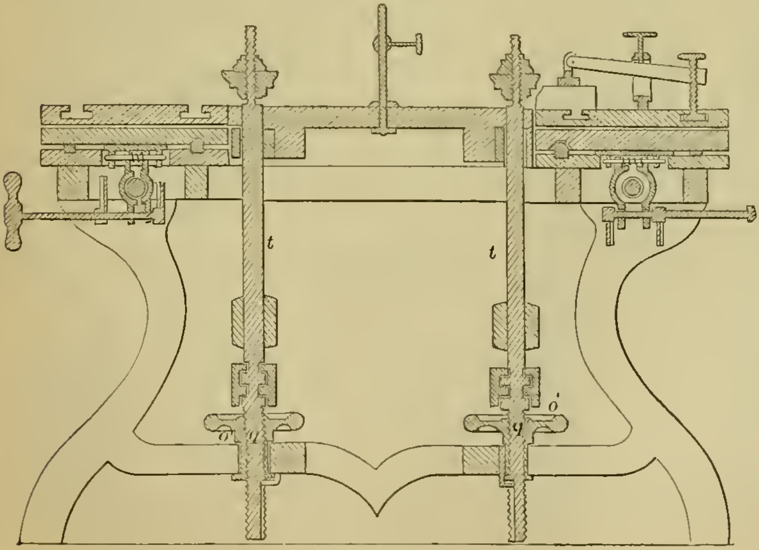
Mar′ble-edge. (*Bookbinding.*) A mode of ornamenting the edges of bound books. The process is described under MARBLE-PAPER (which see).

Mar′ble-fin′ish-ing Ma-chine′. One for truing and molding the edges of marble slabs for mantels, tables, etc. The molding-tools, having a contour the converse of the molding required, are keyed on the top of vertical, revolving mandrels *t t*, which are adjusted vertically by the hand-wheels *o′ o′*, which traverse on the screws *q q*.

The feeding-tables at each side of the machine present the marble in the required line of motion to the revolving-tool. The cutting-tools are changed as the work progresses, some having perforations to supply abrading material.

The feeding-table is susceptible of two motions, one tangential to the circle described by the revolving-tool, and the other at right angles to that of the first. The right-hand table has a block clamped in position.

Fig. 3055.



Machine for Cutting and Finishing Marble.

Mar′ble-grind′ing Ma-chine′. A machine in which the rubber stone is reciprocated or rotated over the marble slab by mechanical means. In the example, the rubber is attached to the free end of the pitman by means of connecting-forks *i i* (Fig. 3056). Other machines operate upon a series of slabs laid in an annular trough, the rubbers having a combined rotary and revolving, or planetary motion. See STONE GRINDING AND POLISHING.

Mar′ble Hand-saw. A blade without teeth, and having a block handle at the back. It is used with sand for cutting slabs into pieces or slips.

Mar′ble-iz-ing Slate. Coloring its surface in imitation of variegated marble.

The slab is rubbed with pumice, and then polished with pulverized pumice and afterward with felt. It is then painted with the groundwork color, and its surface dipped in a vat containing water, on which oil-colors have been sprinkled, manipulated with a brush and subjected to a fanning process, in order to cause a variegated appearance.

Imitations of various kinds of marble are produced by an appropriate application of the different colors. Successive bakings and polishings complete the process.

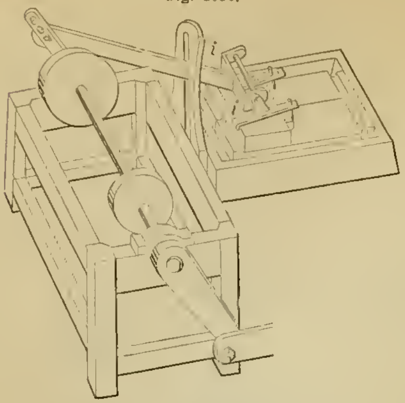
Mar′ble-pa′per. Paper ornamented with a colored pattern resembling marble; or ornamented by the same process with patterns bearing no analogy to those of marble, but assuming certain conventional forms, in which the colors are singularly blended and contrasted.

The process was invented in Germany about 1620, but was long maintained a secret.

The pulverized colors in a dry state are mixed with water and ground in a paint-mill, after which the chemicals used for giving them consistency are added, and the whole again passed through the mill.

Mineral colors only should be used, those of vegetable origin being apt to fade when exposed to the

Fig. 3056.



Marble-Grinding Machine.

light. For use, they are thinned with water and placed in wide-mouthed jars. The brushes ordinarily used for sprinkling the colors are small sash tools, the hairs of which are spread out into a circular form by driving a small nail with a leathern washer into the center of the handle.

A mucilage of gum, usually tragacanth or *gum-ogg*, is prepared, about the thickness of sweet-oil. This is placed in a trough, and the colors which are to form the pattern are sprinkled one at a time over its surface, those forming the veins first and that for the groundwork last. The paper, on a table to the left of the workman, is taken up, sheet by sheet, by the extreme corners, bent in the form of a bow, and gradually let fall on the composition in the trough. The colors, which float on the surface, and a portion of the mucilage, adhere to the paper, which is then taken up and hung on racks to drip, the color remaining and the mucilage falling into a trough below the rack.

The paper when dry is glazed by means of a piece of polished flint, semicircular in section, set in a block of wood, into the opposite side of which is inserted a pole 5 or 6 feet long, the upper end of which fits loosely in a groove in a spring-board above. The paper is laid on a grooved block, having a very smooth surface, secured to a strong wooden table; and the operator, using his right hand to propel the pole and his left to guide the paper, moves the flint-polisher back and forth over its surface, which operation, aided by the pressure of the spring-board on the end of the pole, effectually glazes the paper.

This primitive mode of glazing is now generally superseded by the process of calendering between two rollers of polished steel, which effects the result in a more perfect, durable, and rapid manner.

The edges of books may be marbled in a similar way. For this purpose a mucilage of linseed, allowed to simmer at a gentle heat for five or six hours, may be used instead of the more expensive gums.

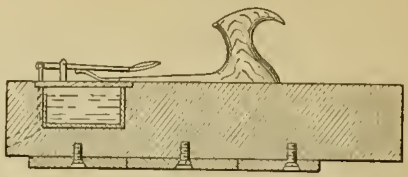
The varieties are thus cited by Cooley (Practical Recipes, page 753): *soap*, *thread*, *rice*, *tree*, *wax* marbling, according to the style of associating the colors, placing them on the mucilage, the use of combs, threads, etc., to dispose the colors, and the choice of materials.

Mar'ble-pol'ish-er. Marble is first rubbed with sandstone, and the beater, afterwards with pumice-stone. It is polished by hand with a linen cushion and emery-dust for colored marbles, and with the powder of calcined tin for white marbles, the emery being apt to redden them.

In Italy a piece of lead is used instead of linen.

A *rubbing-block* is used for carrying the grit or powder for grinding, surfacing, or polishing the faces of marble slabs. In the example, the polishing material of pulverized flint and gum-shellac is carried in a cistern in the rubber-block, and is allowed to escape at a hole in front of the block when the gate is raised by touching the trigger.

Fig. 3057.

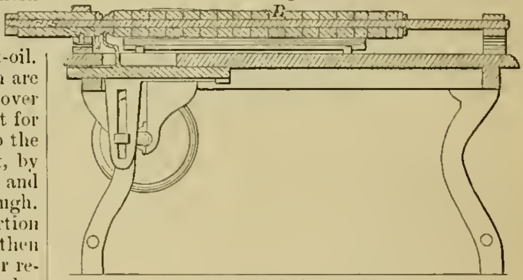


Marble-Rubber.

In Maloy's patent, the marble slab is placed on the slide and its edge polished by an endless belt, which is tightened by an adjustable idler.

In this machine, Fig. 3058, the grinding-cylinder *B* is made up of a number of collars slipped on to a mandrel. It is rotated and at the same time receives an endwise motion or a longitudinally reciprocating and intermittingly rotating motion above the table on which the slab of marble is placed.

Fig. 3058.



Marble-Polishing Machine.

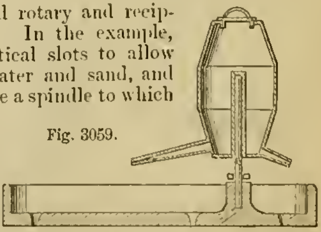
Mar'ble-re-lief' Work. One mode of making relief-work in marble is by painting the required ornament with varnish upon the surface of the marble, and then subjecting the exposed surface to acid. A mixture of hydrochloric and acetic acids has been used.

The varnish may be a solution of gum-lac in alcohol or the *ground* of the engraver, a resinous compound dissolved in turpentine.

This recipe is from the *Dictionnaire Encyclopédique*, 1785.

Mar'ble-rub'ber. A block or tray with a flat sole, moved above the marble slab with a combined rotary and reciprocating motion. In the example, the tray has vertical slots to allow the passage of water and sand, and a socket to receive a spindle to which the handle is attached, and which supports the water-vessel.

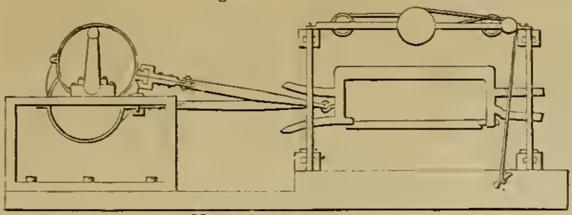
Fig. 3059.



Marble-Rubber.

Mar'ble-saw'ing Ma-chine'. A machine in which the saws are reciprocated by mechanical means. In

Fig. 3060.

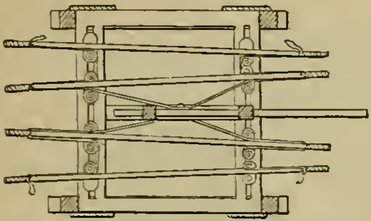


Marble-Saw.

the example (Fig. 3060) the saw is operated by pitmans and eccentrics.

Fig. 3061 is a plan view of a machine in which the saws may be adjusted to saw a block into pyramidal forms. Guide-blocks, provided with rollers over which the belts pass, are secured within slots on each side of the saw-frame, by which the saws are adjusted to operate at various angles and at different distances from each other.

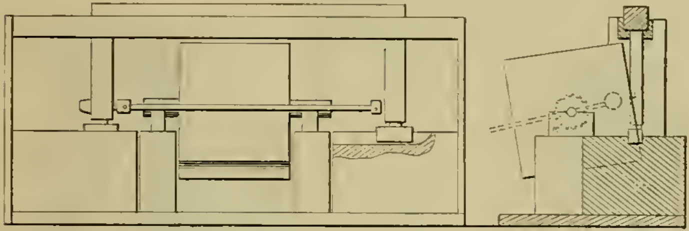
Fig. 3061.



Marble-Sawing Machine.

Fig. 3062 is a machine in which the block is adjusted on centers and rotated against the saw, so as to cut the block into a cylinder or a conical frustum. The rod or wire saw has a triangular cross-section.

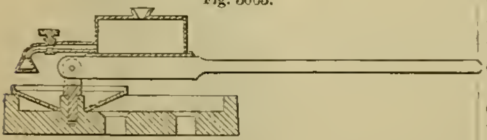
Fig. 3062.



Marble-Saw for Curved Forms.

Mar′ble-scour′er. A rubber for surfacing marble slabs. The metallic block has a handle by which it is moved backward and forward over the marble floor to be scoured. Sand is carried in the recessed top, which has holes communicating with the lower face. A box on the handle contains water, which is supplied to the working-face through a faucet and rose nozzle.

Fig. 3063.



Marble-Scourer.

Mar′ble-work′er's Files. The files and rasps (*m n o p*, Fig. 3032) of the marble-worker and sculptor are of various shapes and grades of fineness. Hiram Powers's *perforated file* has holes to allow the escape of the dust. See Stone-cutter's Tools.

Mar′bling. In the ordinary method of marbling book-edges, a trough about two inches deep is filled with a solution of gum-senegal water. Various coloring matters, ground in spirits of wine and mixed with a small quantity of ox-gall, are thrown upon the surface of the water and disposed in the pattern desired by means of a quill and comb. The book is now tied between two boards, and the edges being dipped into the trough the colors become attached ; the workman blows away the excess of gum and allows the colors to dry. They are afterward burnished. See Marble-paper.

March. (*Weaving.*) One of the short laths laid across the treadles under the shafts.

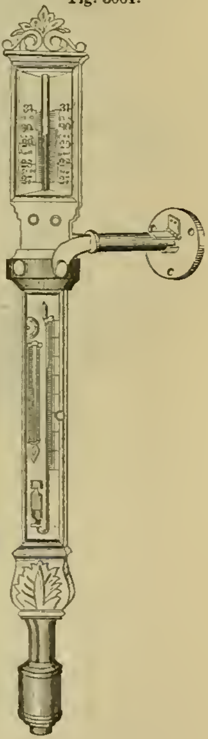
Mar′cus. A large iron-headed hammer.

Mar′gin. 1. (*Roofing.*) The exposed portion of a slate, tile, shingle, or clapboard, when secured on the roof. The width of the margin is the *gage.* The hidden portion is the *cover.* The amount which the slate or shingle of the second course above overlaps a given course is the *bond* or *lap.* Thus, —

A shingle 18 inches long and 6 inches exposed to the weather has a *gage* of 6 inches, a *cover* of 12 inches, a *bond* of 6 inches.

A slate 27 inches in length and a *gage* of 1 foot will have a *bond* of 3 inches.

Fig. 3064.



Marine Barometer.

2. (*Carpentry.*) The flat part of the stile and rail of framed work ; such as panel-doors. A *lock-rail.*

Mar′gin-draft. (*Masonry.*) A plain surface adjacent to the joints of ashlar, surrounding the pick or hammer dressed middle portion of the face.

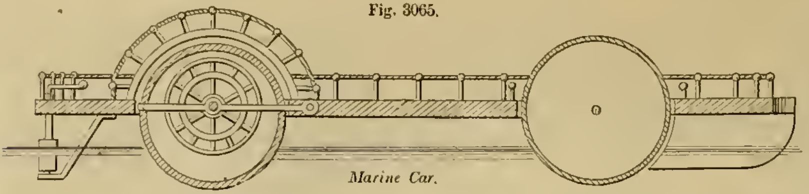
Mar′i-gold - win′dow. (*Architecture.*) A catherine-wheel window.

Mar′i-graph. An apparatus for registering the hight of the tides. A *tide-gage.*

Ma-rine′ A-larm′. See Bilge-water Alarm ; Fog-alarm. See also list under Alarm.

Ma-rine′ Ba-rom′e-ter. A barometer suspend-

Fig. 3065.



Marine Car.

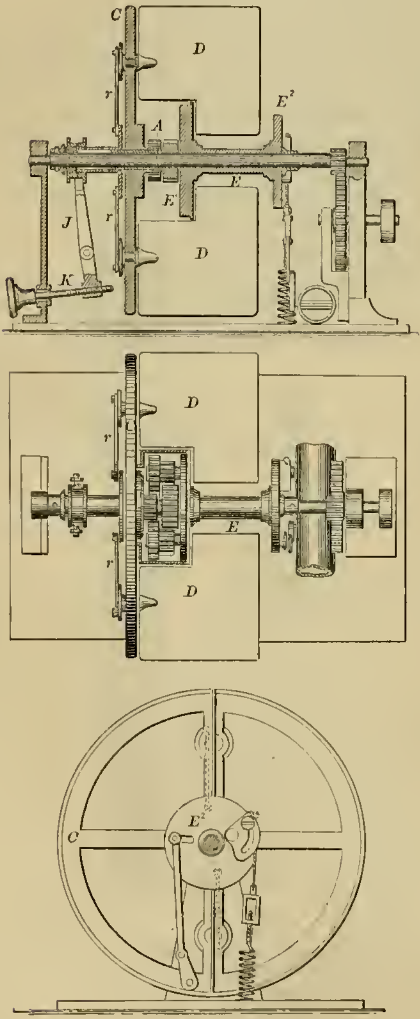
ed in gimbals, and attached by an arm to some upright fixture of the ship, enabling it to maintain a vertical position during the rolling and pitching motions of the vessel.

Ma-rine′ Boil′er. One adapted for the use of steam-engines on sea-going vessels. See MARINE STEAM-BOILER.

Ma-rine′ Car. A floating vessel with a platform supported upon flotative revolving drums and propelled by a paddle.

Ma-rine′ En′gine. A steam-engine to propel a sea-going ship. There are various kinds of them : the beam, direct-acting, oscillating, trunk, high-pressure, etc. See p. 1399.

Fig. 3066.



Silver's Marine Governor.

Ma-rine′ Glue. A composition of caoutchouc, shellac, and mineral oil.

Ma-rine′ Gov′ern-or. A governor for marine engines, intended to overcome the effects of the motion of a vessel on a governor of ordinary construction.

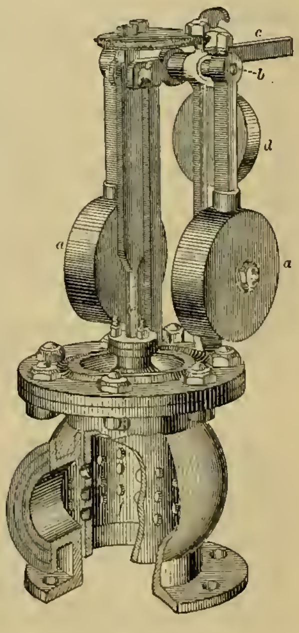
Silver's marine governor (American), in use in the British navy, is shown in Fig. 3066. It was patented in the United States, October 2, 1866. A somewhat similar governor was patented in England by Mr. Silver, May 23, 1857, and in the United States April 26, 1859, and reissued to him July 25, 1865.

In the form shown, the governor consists of a momentum or fly wheel *C*, revolving loosely on the shaft *A*. The fly-wheel carries vanes or fans *D D*, which may be adjusted to present a greater or less surface of resistance to the air, by means of the screw *K* and levers *J r r*. The sleeve *E* and its collar E' also rotate loosely upon the axis *A*, and parallel with the fly-wheel. This sleeve is drawn backward against the motion of the fly-wheel by a spring, which has a tendency at all times to open the throttle-valve. The tension of the spring is regulated by an eccentric segment bolted to the collar E^2 of the sleeve *E*.

The collar E' bears two gear-wheels on pins in its face extending toward the fly-wheel, which gear with a fixed wheel on the shaft *A*, and again, at a different speed, with a gear on the fly-wheel.

The vanes are set and gearing adjusted so that the fly-wheel will maintain a nearly uniform velocity. When the driving-shaft exceeds its normal rate of speed, the collar E' is carried forward relatively to the fly-wheel, and instantly closes the throttle-valve. A slackening of speed of the driving-shaft permits the spring to turn the sleeve in a contrary direction and open the valve, — the fly-wheel remaining all the time the unit of motion, and maintaining a nearly uniform speed, due to its momentum, the variable pressure of its fans, and its free attachment to the driving-shaft.

Fig 3067.

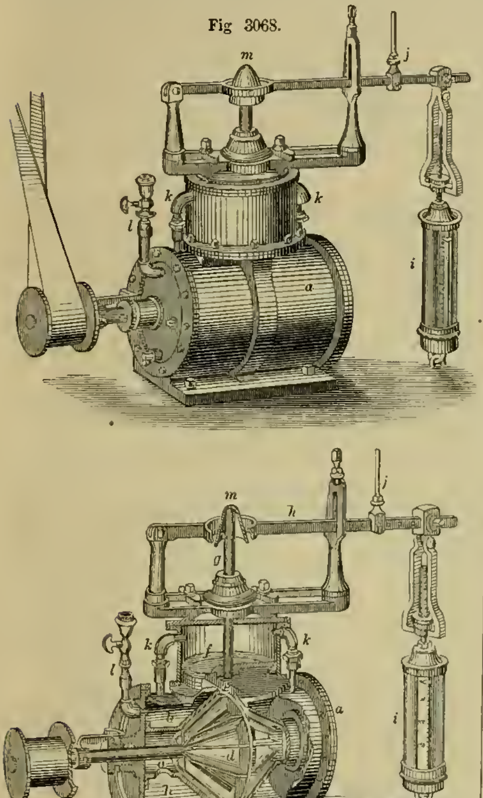


Cathcart's Marine Governor.

Osborne's marine governor operates by the force of a volume of mercury or other heavy, viscid fluid in a revolving vessel, acting upon a number of vanes held in position against a current of a given force by a spring. Any increase in the speed of the revolving vessel beyond its normal rate overcomes the force of the spring, turns the vanes, and closes the throttle-valve by a mechanical connection. *Per contra*, if the revolving vessel moves slower, due to a slackening of speed of the engine, the spring overcomes the vortex in the vessel and opens the valve.

Cathcart's marine governor is designed for screw-propellers, to prevent racing of the screw when the ship pitches. It is constructed with pendulous weighted arms *a a* depending from a rock-shaft *b*, on which is keyed a beam *c*, carrying at one end an adjustable counterbalance *d*, and connected at the other end by a rod *e* with a sliding-valve *f*, or a throttle of any form. As the arms *a* swing forward by the pitching of the vessel, the throttle-valve is partially closed, and by this means passage of steam is regulated in proportion to the immersion of the screw.

Fig 3068.



Duff's Marine Governor.

Duff's marine governor (Fig. 3068) operates by the force of a centrifugal pump in a vessel of oil. *a* is the exterior case, inclosing chambers *b b*, from which passages *c* lead to an inner chamber. In this chamber there is a centrifugal wheel *d*. The chamber in which this wheel revolves communicates with a piston-cylinder by means of an annular passage *e*. *f* is a piston which raises a stem *g*. Through this stem downward pressure is transmitted to the piston from the lever *h*, which is pressed downward by a spring-balance *i*. Through the rod *j* power is taken off to control the throttle-valve or cut-off valve-gear. Pipes *k* form the communication between the space above the piston and the chamber *b*. Through the pipe *l* oil is put into the outer chamber *b*. The lever *h* transmits its pressure to the stem *g* by means of a pivoted conical cap *m*.

The centrifugal wheel *d* being put in motion by a belt from the engine, the oil in the outer chamber passes in through passages *c* to the inner chamber, whence it is forced through the annular passage into the cylinder under the piston. The pressure on the piston depends upon the speed of the centrifugal wheel, which is much higher than that of the engine, and therefore much more sensitive to change in velocity.

In another governor for marine engines steam in regulated quantity is admitted to an auxiliary regulator-engine, whose rate is therefore constant. This engine is connected by mechanism with the main engine, so that discrepancies in rate will affect the admission of steam to the main engine. — *London Engineer*, Vol. VIII. p. 347.

The chronometric governor is one which has also been adapted to this purpose. In it a time-measurer, such as a clock, is set to work at a prescribed rate, and is so connected to some moving portion that any discrepancy in the respective rates shall act upon a third portion whose motion is communicated to the throttle. Mosman's is of this character: one of two shafts is regulated by a balance-wheel, and the other has motion directly from the engine. A variation in rate of motion causes a longitudinal motion of the shaft which is connected to the governor-valve.

The electro-magnetic marine-governor of Captain Wolcott, U. S. A., is intended to prevent the racing of the screw when the propeller rides out of water when the vessel pitches. The throttle-valve is under the command of a weight when a detent is removed by an armature on the breaking of an electric circuit. The poles of a pair of wires are conducted aft to a point, say a little above the level of the screw, and, when they are submerged, the electric circuit is complete through the water. When the vessel pitches and the poles ride out of the water the circuit is broken, the armature drops away from the magnets, the detent of the weight-pulley is released, and the throttle-valve is closed. When the poles of the wires again dip into the water, the armature closes and the valve is again opened.

Ma-rine' Rail'way. One on which a vessel is hauled up for repairs.

Mar'i-ner's Com'pass. The mariner's compass has a magnetized bar of steel, called the *needle*, having at its center a cap which is supported upon the sharp point of a pivot-post. To the needle is attached a circular card with the cardinal points and minor divisions marked upon it; the number of *points* or *rhumbs* being 32, and these being subdivided into *half* and *quarter points*. A point is 11° 15′, and outside the circle of points is a circle of degrees.

The pivot rises from the center of a box called the *compass-box*, and this is hung by *gimbals* in the *binnacle*, so that the box may always retain a horizontal position, notwithstanding the pitching and rolling of the vessel. The *needle*, the *card*, *rhumb-card*, *compass-card*, or *fly*, is free to float around according to its magnetic impulse, and a mark on the front side of the circumscribing ring shows the direction of the ship's head. The *dab* is the socket of the needle on the pivotal pin.

A is a vertical central section of the compass, as hung in gimbals.

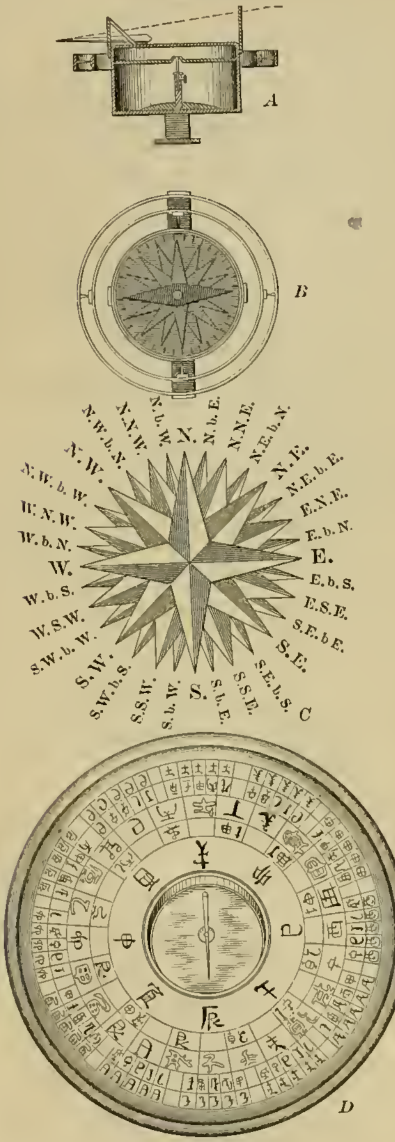
B is a view looking down upon the same.

C is a chart showing the compass notation. The marks are known as cardinals, N. S. E. W., and intervening are the other 28 points.

D is the Chinese compass-card.

The needle of the Chinese compass is very short and light, not exceeding an inch in length, and so much of its weight is below the point of suspension, that it is but little affected by the *dip* or inclination. The means of suspension is a steel point rising from the bottom of the wooden compass-box and entering a hemispherical copper cup attached by copper strips to the needle.

Fig. 3069.



Mariner's Compass.

Sir George Staunton, who accompanied Lord Macartney in his embassy to China, describes it in his account of the embassy: "Upon the upper surface of the box are drawn several concentric circles, distinguished by different Chinese characters. The eight marks on the inner circle mark the cardinal points, south, north, east, west, and the bisecting intermediate points. The same eight characters also signify equal divisions of the natural day, so that the instrument answers to some extent the purpose of a dial, each division marking three hours. The Chinese character for *sunrise* is the same as that for *east*, and in this form was the first compass which found its way to Europe in the beginning of the fourteenth century. Other circles have 12 and 24 divisions, with characters which mark corresponding portions of the heavens and of the natural day. Each of the latter portions embraces 15° of the 360° into which the circle has been arbitrarily divided in correspondence with the supposed number of days in which the sun performs his apparent course. The remaining circles around the compass contain the characters of the cycle of 60 years, by which this nation regulates its chronology, and other characters expressive of their philosophical and mythological doctrines. The ornamented end of the needle is the south pole, to which this nation gives the preeminence. *South* and *north*." The compass is known as the *Ting-nan-ching*, or "needle pointing to the south." The Chinese were acquainted with the declination of the needle, and were aware that it is not the same in all countries nor invariable in the same place.

The Chinese compass is probably the first portable time-indicator; not absolutely accurate, especially in the different latitudes of that country, but still possessing value as an approximation to correctness.

The mariner's compass originated in China.

The Chinese word *Tchi-nan* (*the southern pointer*), indicates the Chinese practice of considering the *south* the principal cardinal point. The Emperor's throne and all government edifices in China are made to face the south, and the needle is said to point south and north, the former having the preeminence in expression.

Among the Chinese, Thibetans, and Mongolians the *south* is mentioned before the *north*, and in Chinese and Mongolian the *west* before the *east*. In Mongolian the word *south* means *front*, *north* is *behind*, *west* "to the *right*," *east* "to the *left*." The Chinese character for *north* is two men turned back to back, and originally meant "to turn the back upon." The Hebrew practice was different; with them the words *before*, *behind*, *right*, *left*, are used, but the *east*, the rising sun, is in front; a distinct trace of the Baal (sun) worship to which they so constantly recurred, in sympathy with the Phœnicians and Canaanites. "The sea" was sometimes used as a term for the west, meaning the Mediterranean, which was behind when the sun was faced. With us, the north is supposed to be faced in giving the points of the compass in their order; *boxing the compass*. The Hawaiians front the west, and call north *right*, south *left*.

The Chinese chronicles of Szuki of Szumathsin, written in the second century before our era, state that 900 years before, Tsching-wang, the Emperor of China, gave "*magnetic cars*" to the ambassadors of Tonquin and Cochin China, in order that they might "not miss their way on their return home."

In the forward part of the magnetic car was a floating needle, the motions of which were communicated to a small figure whose outstretched arm and hand pointed toward the south. It was used as late as the fifteenth century A. D., and the cars, carefully preserved in the imperial palace of China, were used in determining the point toward which the main sides of the public buildings should be directed.

It thus appears that the compass was first used by land travelers, which, as Humboldt remarks, is a singular fact. It was, however, used on board vessels in the Chinese seas in the fourth century A. D. and probably much earlier. The effect of the loadstone on iron is noticed in a Chinese dictionary, A. D. 121; and another work states that "fortune-tellers rub the point of a needle with a loadstone to give it the power of indicating the south." The Japanese say that at a time corresponding to A. D. 543, the "wheel which shows the south" was sent to the Mikado from the court of Petsi in Corea.

From China to India was in the natural order of trade, a route which has been followed by many arts, such as the glazing of tiles and pottery, the manufacture of sonorous bronze, gunpowder, etc. When Mahmoud of Ghazni invaded India, several arts were scattered abroad and found their way still farther to the westward; the immediate introducers into the countries bordering on the Mediterranean being the Arabs, whom many have credited with the invention of arts which they derived from the farther East. The Arabic designations of *Zoron* and *Aphron* (south and north), which Vincent of Beauvais gives to the two ends of the magnetic needle, indicate the source whence the compass was directly obtained; and the influence of this people in the science of astronomy is also indicated in the Arabic names of many stars which are still retained.

"The dwellers in the West received, through the Macedonian settlements, accurate accounts of Indian productions of nature and of art, of which little more than the names were previously known by reports derived either through more ancient commercial connections, or through Ctesias of Cnidos, who had lived for seventeen years at the Persian court as the representative of Artaxerxes Mnemon. Such were the watered rice-fields, of the cultivation of which Aristobolus gave a particular account; the cotton-shrub, and the fine tissues and paper for which it furnished the materials; spices and opium; wine made from rice, and from the juice of palms, the Sanscrit name of which, *tala*, has been preserved by Arrian; sugar from the sugar-cane, which, indeed, is often confounded by the Greek and Roman writers with the *tabaschir* of bamboo stems; wool from the great Bombax trees; shawls from the wool of the Thibetian goat; silken (*Seric*) tissues; oil of white Sesamum (Sanscrit, *tila*); oil of roses and other perfumes; lac (Sanscrit, *lakscha*, and in the vulgar tongue, *lakkha*); and, lastly, the hardened Indian *wootz* steel." — HUMBOLDT.

During or before the twelfth century A. D., the mode of suspending the needle had been improved in China, by hanging it upon a silken thread instead of floating it on water. At this period the Chinese philosopher, Keon-tsoung-chi, observed the variation of the needle, which was again noticed by Columbus in 1492, and by Sebastian Cabot in 1540. The Chinaman says: —

"A point of iron touched by the loadstone receives the power of indicating the south; still it declines towards the east, and does not point exactly towards the south."

French observations at Pekin confirm this, only stating it to be a variation from the north of 2° to 2° 30′ to the west; while the Chinese, insisting on their mode of stating it, set it down as being from 2° to 2° 30′ to the east.

Columbus first noted a line of no variation about 100 miles west of the Azores.

It is a remarkable fact that the earliest European writer on terrestrial magnetism, William Gilbert, whom we cannot suppose to have had any knowledge of Chinese literature, regards the mariner's compass as a Chinese invention which had been brought to Europe by Marco Polo.

The compass of the Phœnicians is believed to have been a needle buoyed by a slip of pith and floating in a cup. That of the Arabs was described in 1242 by the Arabian Boulak Kibdjaki.

"Among the properties of the magnet, it is to be noticed that the captains who sail in the Syrian waters, when the night is dark, take a vessel of water, which they shelter from the wind, upon which they place a needle buried in the pith of a reed, and which thus floats upon the water. They then take a (*magnes*) loadstone as big as the palm of the hand, or even smaller; they hold it near the surface of the water, giving it a rotary motion until the needle turns upon the water; they then withdraw the stone suddenly, when the needle with its two ends points north and south. I saw this with my own eyes on my voyage from Tripoli in Syria to Alexandria in the year 640 [640 of the Hegira, 1240 A. D.]. I heard it said that the captains in the Indian seas substitute for the needle and reed a hollow iron fish, so magnetized that when placed in the water it points to the north with its head and to the south with its tail. The reason that the fish swims, not sinks, is that metallic bodies, even the heaviest, float when hollow and when they displace a quantity of water greater than their own weight."

Worthy Arabian; we have here a description of a magneto-electric needle used in the Levant; a magnetized floating needle used in the Indian Ocean; and a correct statement of the Archimedean discovery of specific gravities. This was written about the time of Roger Bacon, 250 years before Da Vinci, 350 years before Porta, and more than 400 years before Galileo and Newton.

The Phœnicians circumnavigated Africa in the seventh century B. C., as we learn from Herodotus. .

Strabo (writing about A. D. 18) says: —

"If the extent of the Atlantic Ocean were not an obstacle, we might easily pass by sea from Iberia [Spain] to India, still keeping in the same parallel."

So Christopher Colon reasoned. See MAP.

It thus appears that the Arab needle had only temporary polarity, and this was probably the case with the Phœnician. It was consulted by the captain, and not kept in a binnacle like the Chinese and the modern needle.

Hercules, the symbol of Phœnician enterprise, in his colossal statue at Tarentum, referred to by Pliny, is represented with a key in one hand and a bowl in the other. The cup he is fabled to have received from Apollo, and in it he floated his polarized needle. The name of Hercules is given to the stone *magnes*. The needle is probably the "arrow of Abaris." This supposition adds interest to this ancient classical symbol.

In 1190, Guyot of Provence wrote a satirical poem, called "La Bible," in which he refers to the use of the magnetic needle.

Between 1204 and 1215, Jacobus of Vitry, Bishop of Ptolemais, referred to it in his description of Palestine, as follows: —

"The loadstone is found in India, to which, from some unknown cause, iron spontaneously attaches itself. When an iron needle is touched by the stone, it at once points towards the North Star; from whence it has become useful to those who navigate the seas."

Latini of Florence, the preceptor of Dante, in a work published in Paris in 1260, entitled the "Treasure," wrote thus: —

"When I was in England, Friar Bacon showed me a magnet, — an ugly black stone to which iron doth willingly cling. You rub a needle upon it;

the which needle, being placed upon a point, remains suspended and turns against the star, even though the night be stormy and neither star nor moon be seen; and thus the mariner is guided on his way."

The Italian Riccioli, in his work upon Geography and Hydrography, states that before 1270 the French mariners used "a magnetized needle, which they kept floating in a small vessel of water supported on two tubes so as not to sink."

The magnetic needle is mentioned by Peter Adsiger in a Latin essay in 1269, in which the south pole is said to vary a little to the west; and by Raymond Lully of Majorca, in his "Fenix de las Maravillas del Orbe," published in 1286.

A passage in the Spanish "Leyes de las Partidas" of the middle of the thirteenth century runs as follows: "The needle which guides the mariner in the dark night, and shows him how to direct his course both in good and bad weather, is the intermediary between the loadstone and the North Star."

Dante, about 1300, refers to the needle "which points to the star."

Marco Polo, the great traveler, was in the service of Kublai Khan, the conqueror of China, from 1274 to 1291, and was concerned in the introduction of the compass from China to Europe direct. It had previously arrived by the good old channel, India and Arabia; but Marco Polo did not know that, and his services can hardly be exaggerated.

The Arabs sailed by the compass during the Khalifate of Cordova, which lasted till A. D. 1237, when it was subdued by the Moors. An authority states that it was known in Norway previous to 1266.

Dr. Gilbert, physician to Queen Elizabeth, states that P. Venutus brought a compass direct from China in 1260.

See Klaproth's work on this subject, Paris, 1834; Sir Snow Harris's "Rudimentary Magnetism"; the researches of Biot, Stanislaus Julien, etc.

About 1320, Flavio Gioja, a pilot of Positano, not far from Amalfi in the Kingdom of Naples, was instrumental in the improvement of the compass, and for a time passed as the inventor thereof. Such a claim is fully disposed of by the facts above cited.

It is probable that Gioja was a skillful mechanic, and improved upon the popular modes of supporting the needle (which were by floating it, or suspending it by a cord), and placed it upon a pivot-post in the center of a marginal strip, which was marked with the cardinal points and minor divisions. This rendered it more convenient for reading, and gave a certain steadiness to the needle.

Vasco da Gama, who circumnavigated Africa, doubling the Cape of Good Hope, November 20, 1497, testifies his surprise at meeting in the Indian Ocean seven small Arab vessels provided with the compass, quadrants, sea-charts, and other instruments, equal to the Portuguese. We do not wonder, for the China seas had been navigated by their aid over 1,000 years when the brave navigator repeated the feat of the mariners of Pharaoh Necho, about 610 B. C.

The gimbal-joint and compass-box were invented by the Rev. William Barlowe in 1608.

The *dip* of the needle was discovered by Robert Norman of London, 1576; the diurnal variation, by Graham, a London watchmaker, in 1722.

An azimuth compass is one used at sea for finding the horizonal distance of the sun or a star from the magnetic meridian.

Lord Caithness has substituted for the gimbals a pendulum and a ball; the latter working in a socket in the center of the bottom of the compass-bowl.

Albini's self-registering compass is an instrument by which a continuous record is kept of the course steered by the vessel on board which the compass is placed. The compass-card carries on its under side, and near its periphery, a number of types or letters, which correspond with those denoting the points of the compass on the upper surface of the card. A continuous strip of paper, moved by clock-work, passes under the card at that side which is next the bow of the vessel, and between this paper strip and the card itself is an inked tape, which also travels slowly. At frequent regular intervals the compass-card is tilted, so as to bring the type which happen to be immediately above the paper strip at the time down upon the inked tape, bringing the latter in contact with the paper, and marking upon the latter the letters denoting the course which the vessel is steering at that moment.

When iron ships were first introduced, great difficulty was experienced in regard to the disturbance of the compass, owing to the vicinity of large bodies of iron. It was also shown by Grantham in 1842, and Scoresby in 1851, that the direction of the ship's head on the stocks, the effect of riveting in that position, the magnetic direction while fitting, each had an influence in determining the magnetic condition of the vessel.

Compasses are sometimes carried on the masts of iron vessels as a means of removing them from the disturbing influence of the iron of the hull. In this position they serve as standards of comparison for the binnacle compass.

The amount of deflection of the needle from its proper direction frequently varies on each point of the compass; while on one course it may indicate correctly, on another it may err from one to two points. The amount of this deviation is ascertained by anchoring the ship in a smooth and sheltered place with a very short scope of cable, and carrying out kedges so that she may be swung round and held in any required position.

The magnetic bearings of one or more conspicuous objects, at a sufficient distance to obviate any sensible parallax, are taken from the map or chart; the ship is swung, by the means before indicated, so that her head shall point successively to every point of the compass, and as the ship's head, during the operation of swinging, is brought in line with the object above mentioned, the compass bearing is noted, and at the same time angles are taken with the sextant to other distant objects on shore, whose position is known. A comparison of these angles with the bearings indicated by the compass shows at once the error of the latter.

Local deviation is not exclusively confined to iron ships; it is frequently quite perceptible in wooden men-of-war, occasioned by the attraction of the guns, and in vessels laden with iron the amount is often very great.

Professor Airey's method of adjusting compasses in iron ships is essentially as follows. Directly under the spot where the compass is to be placed two lines are drawn on the deck, one parallel with and the other perpendicular to the line of the keel. Two or three powerful magnets and one or two small boxes for holding chain are provided. The vessel's head is brought in the direction of one of the cardinal points, as ascertained by a compass on shore free from disturbing influences, and she is held in this position by hawsers. If the ship's compass indicates any deviation from the true bearing, one or more of the magnets is placed upon the deck at right angles to the magnetic meridian and moved backward or forward until the compass-needle indicates correctly. The ship's head is then turned 90°, and the operation repeated until the compass-needle again points correctly. A similar process is employed to bring the needle into coincidence with the meridian at each of the other cardinal points indicated by the cross lines on the deck, and its correctness at each of the four rhumb points, N. E., N. W., S. W., S. E., is assured in like manner, using the boxes of chain before mentioned to correct the deviation of the needle. When these adjustments are made the compass should be sufficiently correct for all practical purposes. The deviations, if any, may be ascertained by swinging the ship.

Gray's apparatus for adjusting compasses is based on the foregoing method of Professor Airey. The regulating magnets are caused to approach or recede from the compass by screws, so as to admit of very accurate adjustment.

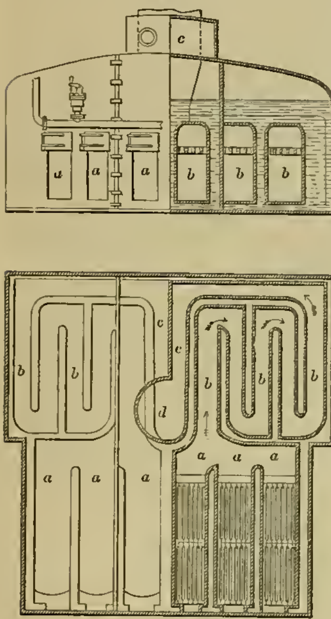
Great care must be taken that the magnets are brought, by turning the ship at right angles, to the magnetic meridian before moving them, in order to regulate the compass.

Ma-rine' Steam-boil'er. Marine steam-boilers are composed of an external shell or casing, with rectangular sides, stayed together by tie-bars. Within it are contained the furnaces, the flues and ash-pit, the whole being surrounded by water except at the furnace front.

In some cases, the front is also water-jacketed, and the doors themselves are filled with water, circulation being maintained through the tubular hinges.

The flues for the passage of flame and smoke are deep rectangular channels, which, after making many turnings, unite in one common chimney or funnel.

Fig. 3070.



Marine Steam-Boiler.

The marine boiler shown in the illustration is composed of three parts, the sides of the middle boiler serving as a side to each of the outside boilers. At some distance above the water-line, large apertures are cut in the sides of the middle boiler, to form a steam communication between the three compartments, and a water communication is established below by a pipe from each boiler, opening into the blow-off main. The upper figure is an elevation, one half in section; *a a* are the fire-doors and *b b* the fire-chambers, *c* is the steam-dome.

Each boiler has two fireplaces, and the flues *a a* (lower figure) of the side boilers branch into the flues *b b* of the contiguous fireplaces of the middle boiler, immediately at the back of the bridge; and, after taking the circuitous course shown in the plan by the arrows, they unite at the back of the boiler and form one large flue *c*, from which the chimney *d* rises at about the middle of the length of the boiler. The flues are not divided horizontally, but extend the whole depth from *b* to *b*, as shown in the vertical section.

Towards the forepart of the middle böiler is a steam-chest, from whence proceeds the main steam-pipe, which conveys the steam to the cylinders. The feed-pipe and feed-valves are shown in the sectional view.

The separation between the boilers extends a considerable distance above the water-line, in order that their contents may not all be collected on one side of the vessel when she careens or rolls, uncovering some of the weathermost flues.

At the bottom of the boiler are pipes passing through the vessel's sides, and furnished with stop-cocks or valves, by which sediment or brine may be blown out of the boiler.

Mud-holes are used for cleaning out scale or sediment, and at other times are closed by doors.

In the *marine* steam-boiler the fire and flues are all contained within the boiler itself, and are surrounded by water in every direction as a precaution against fire. There are many varieties, known as *flue*-boilers, *tubular* boilers, *sheet-flue* boilers, etc.

Ma-rine' Steam-en'gine. A form, or one of the forms, of steam-engines adapted to use on shipboard.

The objects to be gained in the modification of the land engines to suit the change of circumstances are, —

Compactness, to save room on board and secure protection below decks.

A *low center of gravity*, to increase the stability of the vessel.

Napier's side-beam engine is the form which has been extensively adopted in paddle-wheel vessels, and is the one selected for illustration.

A modification of this is found in the *lever-engine*.

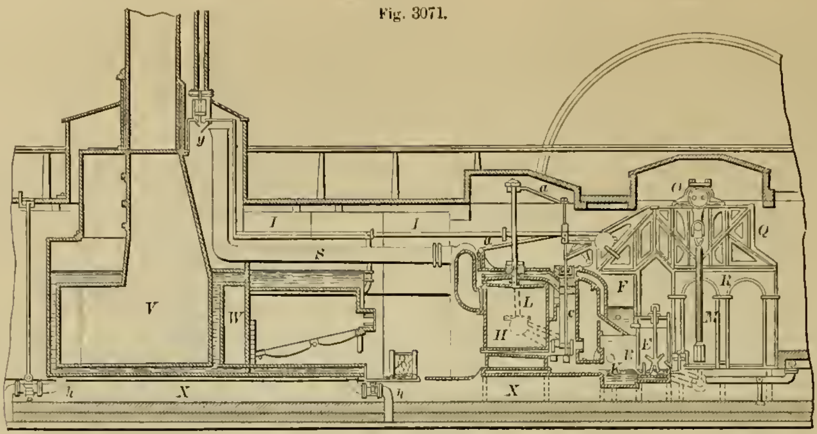
An endeavor to dispense with the beam has originated a variety of *direct-action engines* and *oscillating-cylinder engines*.

The figure represents in section a *side-beam engine* with a flue boiler as placed in a steam-vessel.

The sleepers supporting the engine are represented at *X*, and the base of the engine is secured to these by *holding-down bolts* passing through them. *S* is the steam-pipe leading from the steam-chest in the boiler to the slides *e*, by which it is admitted to the top and bottom of the cylinder. The condenser is represented at *B*, and the air-pump at *E*. The hot-well is seen at *F*, from which the feed is taken to the boiler. *L* is the piston-rod connected with the beam *H*, working on a center *K* near the base of the engine. The other end of the beam *H* drives a connecting-rod *M*, which extends upward to the crank on the paddle-shaft *O*. *a a* are the rods of the parallel motion. The framing by which the engine is supported is represented at *Q R*.

The beam exhibited in the figure is shown in dotted lines, as being on the farther side of the engine. A similar beam, similarly placed and moving on the same center, must be understood to be on the near side also, connected with the cross-head of the piston in like manner by a parallel motion, and with a cross-tail attached to the lower end of the connecting-rod and to the opposite beam. The eccentric which works the slides is placed upon the paddle-shaft *O*, and the connecting arm which drives the slides may be easily detached when the engine requires to be stopped. The section of the boiler, grate, and flues is represented at *W V*. The safety-

Fig. 3071.



Marine Steam-Engine.

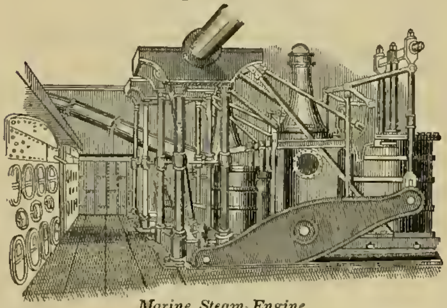
valve *y* is inclosed beneath a pipe carried up beside the chimney, and is inaccessible to the engineer. The cocks for blowing off the salt-water from the boiler are represented at *h*, and the feed-pipe at *I*.

Fig. 3072 is a view of a similar engine, looking down the alley between the boilers and the working parts.

The side-beam engine is very compact compared with the elevated working-beam engine, such as the *Cornish*, for instance, but the tendency of late years has been to direct action, dispensing with the beam.

The general adoption of the screw propeller has also much changed the general conditions required, and oscillating engines of large diameter and comparatively short stroke are now the order of the day.

Fig. 3072.



Marine Steam-Engine.

The following list includes most of the varieties of engines specially adapted to marine purposes. See under the respective heads: —

Annular-cylinder steam-engine.
Direct-action steam-engine.
Double-cylinder steam-engine.
"Gorgon" steam-engine.
Inclined-cylinder steam-engine.
Inverted-cylinder steam-engine.
Inverted double-cylinder steam-engine.
Lever steam-engine.
Oscillating-cylinder steam-engine
Propeller steam-engine.
Screw propeller steam-engine.
Side-beam steam-engine
Sliding-cover steam-engine.
Steeple steam-engine.
Trunk steam-engine.

Mar′i-no-ra′ma. A picture of a sea-view.

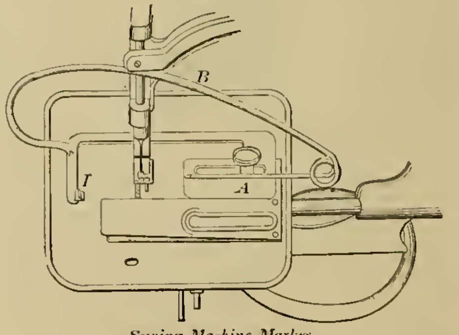
Mark. 1. Marks of manufacturers, sometimes termed trade-marks, or marks of merchandise. These marks are protected by all modern civilized nations, and, in fact, by the whole commercial world. The mark of the artisan is found upon the most ancient fabrics that have come to light. The Chinese, the Persians, the Egyptians, all had their distinctive manufacturers' signs, symbols which were intrinsic evidence of genuineness of origin of the articles of merchandise to which they were affixed. In the ruins of Herculaneum and Pompeii they are found. The Romans brought them to Britain, where the practice of using them has continued, probably without any intermission, from their time to our own. Antique pieces of pottery found in England furnish example. All nations protect the manufacturer in the exclusive use of his private emblem, and, by treaties, statutes, and judicial decisions, the most stringent penalties are inflicted upon one who pirates such a mark for his own fraudulent gain. The mark is, in fact, the commercial signature of the maker. All the early printers had their trade-marks, generally monogrammatic.

2. (*Nautical.*) One of the notifications of depth, on a sounding-line. See MARKS AND DEEPS.

Mark′er. An attachment to a sewing-machine for forming creases in or marks on fabric, so that it may be folded in line with such crease or mark for a tuck, and in a line parallel with, and at any desired distance from, another tuck.

Fig. 3073 shows a good form of the appliance. The plate *A* has an arm surrounding the feed-opening and presser; on the end of the arm is the spur *I*. An arm *B*, notched at its forward end, is bent to form a spring, and is bent down by the needle-bar to form a crease in the cloth lying on the point *I*. For varieties of *tuck-creasers* and *markers*, see "Sewing-Machine Attachments," G. W. Gregory, Washington, D. C.

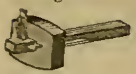
Fig. 3073.



Sewing-Machine Marker.

Mark'ing-gage. (*Carpentry.*) The marking-gage has a stem which carries a scribing point and a head or fence, which is adjustable on the stem and secured in adjustment by a set screw or wedge. As the scribe is drawn along on a board, the *fence* slides on the edge of the latter, and causes the mark to be parallel with the edge and at the regulated distance.

Fig. 3074.

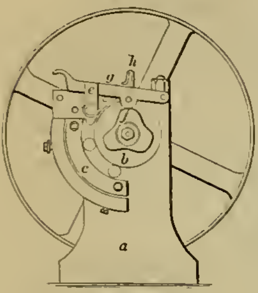


Marking-Gage.

Mark'ing-ink. An indelible ink for marking clothes. See INK.

Mark'ing-ma-chine'. (*Coining.*) A machine used in the mint, to swage the edges of planchets for coin, raising the edge of the blank preparatory to *milling*. *a* is an iron frame in which is a horizontal shaft carrying a driving and a loose pulley and a fly-wheel; *b* is a flat, circular plate with a grooved edge; *c* is a plate with corresponding grooved edge, adjustable to the plate *b* by screws, and *e* a hopper in which the blanks are placed; *f* is a cam which, as it revolves, pushes back the feeder *g*, allowing the blanks to fall from the hopper. The spring *h* brings down the feeder *g*, which pushes a blank from the bottom of the hopper. The blanks slide down an inclined plane until their edges come between the plates *b* and *c*, and as the plate *b* revolves, the pressure of its edge carries them forward, and at the same time raises their edges all around, increasing the thickness by about one third.

Fig. 3075.



Marking-Machine.

Mark'ing-plow. (*Agriculture.*) One for running slight furrows in plowed land as a mark for planting corn, or, at greater distances, for sowing broadcast. Also used in crossing out land for planting an orchard.

Marks and Deeps. (*Nautical.*) The mode of indicating lengths on the hand lead-line. The *marks* have certain indications. The *deeps* are the estimated fathoms in the intervals of the *marks*.

Mark 2, leather.
Mark 3, blue bunting.
Deep 4.
Mark 5, white bunting
Deep 6.
Mark 7, red bunting.
Deep 8.
Deep 9.
Mark 10, leather.
Deep 11.
Deep 12
Mark 13, blue bunting.
Deep 14.
Mark 15, white bunting.
Deep 16.
Mark 17, red bunting.
Deep 18.
Deep 19.
Mark 20, two knots.

Marle-stock. An English name for a kind of brick. A *cutter*.

Mar'line. (*Nautical.*) A small cord composed of two strands slightly twisted and used for lashing, sewing, and tricing. Used either white or tarred.

Marl'ing. (*Nautical.*) Wrapping a rope with spun-yarn or twine, having a knot at each turn to secure it if it become cut at one or more places. It differs from SERVING (which see).

Mar'lin-spike. (*Nautical.*) A pointed iron pin suspended by a lanyard, and used to make an opening between the strands of rope in splicing.

Mar'mo-ra'tion. (*Architecture.*) A casing of marble to a building.

Mar'mo-ra'tum; Mar'mo-re'tum. A cement made of pounded marble and lime for architectural purposes.

A cement of tin-foil and mercury, formerly used for filling decayed teeth.

White of egg and quicklime incorporated in a mortar.

Mar-o-quin'-leath'er. A leather, generally dyed red or yellow, and prepared at Astracan and vicinity. It is made from the skins of bucks and goats. See SAFFIAN.

Mar-quee'. A field tent or covering made of strong canvas to keep off the rain. Generally with a second canvas or *fly* a little above the tent proper.

Mar'quet-ry. Inlaid work. It includes *parquetry*, *reisner* work, *buhl*, *mosaic*.

The first of these is employed in the ornamentation of cabinet and furniture work. In buhl, the patterns are usually more elaborate, consisting of scrolls and similar curvilinear figures, and the works comparatively small, while marquetry proper is used for floorings, etc. The general manner of executing these varieties of work is, however, entirely similar, consisting in cutting the designs out of pieces of wood or plates of metal and inserting pieces of a different color.

The woods employed in marquetry may be of their natural color or stained to any desired tint. The pattern may include figures or devices of any kind. Even pictures or portraits may be produced by the contrast in color or arrangement of the grain of the woods. When the inlays are inserted, the work is reduced to a level surface with the toothing-plane, and then scraped with the joiner's scraper applied obliquely to the joints of the wood. This is sometimes so skillfully done that the work may be polished with its own shavings, but ordinarily the use of glass-paper is required to produce the requisite polish. Works in wood and metal or in pearl, ivory, or tortoise-shell and metals require the use of the file, followed by sand or emery-paper. (See BUHL; PARQUETRY.) This species of ornamentation was much in vogue during the past century, but is now comparatively rare.

The art of inlaying different pieces of wood to resemble mosaic is of great antiquity. It was practiced in Egypt at a remote period, and is shown in very successful condition about 1355 B. C. See the chairs, boxes, mummy-cases, and furniture of Rameses III. in the "Description of Egypt," by the French savans, about 1812. The book is in the Congressional Library.

The art was very popular in India in times of whose dates we can only guess. The Chinese, also, were early in the field, and excelled in this as they did and do in whatever requires patient toil and persistent, careful manipulation.

The Egyptian antiquities referred to embrace many different colored woods and metals. Among the Italian artists, black and white woods were first used, and were called *morescoes*. John, Abbot of Verona, introduced stained woods, and thereby added to the variety. He also introduced buildings and attempts at perspective representation.

Mar'ron. (*Pyrotechnics.*) A paper box strongly wrapped with twine and filled with powder; it is intended to imitate the report of cannon, and is fired by a piece of quickmatch projecting externally.

Mar-seilles'. (*Fabric.*) A heavy cotton goods, embossed in the loom.

Mar-sel'la. (*Fabric.*) A kind of twilled linen.

Mar-sil'ly-car'riage. A naval gun-carriage having no fore trucks, the front transom resting immediately on the ship's deck. It is used in the

United States Navy for mounting the 9-inch gun in broadside.

Mar'tel-de-fer. A hammer and pick forming a battle-axe, and used in the Middle Ages.

Mar'te-line'. A small stone-hammer (*u*, Fig. 3032) used by sculptors and marble-workers. It is pointed at one end and square or diamond-shaped at the other.

Mar'te-line'-chis'el. A sculptor's chisel, driven by a mallet or hammer, and used by artists or workers in marble. *q r s t*, Fig. 3032, show several forms.

Mar-tel'lo-tow'er. (*Fortification.*) A circular, isolated tower of masonry, named from Mortella Bay, Corsica, where a tower of this description was taken by an English naval force in 1794, after a prolonged resistance.

The capacity for defense excited so much surprise and admiration, that numerous towers were planted along the English, Irish, and Jersey coasts, in anticipation of the invasion of Napoleon I.

The tower is usually about 40 feet in hight, having two stories, and a shell-proof roof with a 4½-foot parapet. The walls are 5½ feet thick; the lower story is for stores, magazine, and retreat; the second is a casemate with embrasures; the roof is armed *en barbette* with a traversing gun, under a bomb-proof. The towers were erected on the coasts of Kent within range of each other.

The entrances are at a considerable hight above the ground, and the tower has a ditch and glacis.

Two of these towers are on the plains of Abraham, as outworks of the citadel of Quebec.

Mar'tin. A grinding-tool consisting of a brass plate with a flat stone facing. An opening through the plate and lining allows sand to pass through and insinuate itself between the *martin* and the stone which is being ground. A *runner*.

Mar'tin-et'; Mart'net. (*Nautical.*) A small line on the leach of a sail, to assist in handling it in furling.

Mar'tin-gale. 1. (*Nautical.*) *a.* A lower stay for the *jib-boom* or *flying jib-boom*.

The *martingale* of the former passes from the end of the jib-boom to the *dolphin-striker*, and is *set up* by *setting taut* the back-ropes of the latter.

The *flying jib-boom martingale* passes from the end of the spar, is rove through the end of the *dolphin-striker*, and is set up in the head of the ship.

b. A perpendicular spar under the bowsprit end, for guying down the headstays of a ship.

2. (*Harness.*) A strap from the nose-band to the girth, to keep a horse from throwing the head or rearing.

Or, a strap passing from the girth or belly-band and forking in front of the chest; at the ends of the bifurcations are two rings for the reins.

Mar'tin's Shells. (*Ordnance.*) Cast-iron spherical shells, lined with loam and cow-hair and filled with molten iron. Used as an incendiary shell.

Marv'er. (*Glass-making.*) From the French *marbre*, marble, a slab of that material being formerly used. A slab of marble or cast-iron, with a polished surface and supported by a stand. Upon it glass is rolled to give it a cylindrical shape. See Glass-blowing. It sometimes has concavities for shaping glassware when blowing.

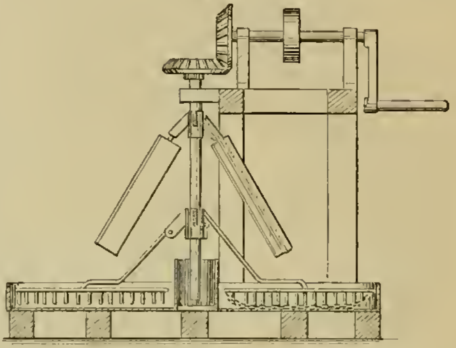
Mash. Crushed or ground grain, malt, or a mixture of the two, steeped in hot water so as to obtain an infusion consisting of the saccharine portions. The resulting solution is *wort*, and when decocted with hops and fermented it becomes beer; when simply fermented, it is *wash* for distillation.

The *mash* of the Scotch distillers is made of 40 bushels of ground barley, and 20 of crushed malt; this is infused in 750 gallons of water, at 150° Fah., for from 1 to 4 hours, and stirred. 500 gallons of water at 190° to 205° are admitted at intervals, to keep up the heat. After mashing, the infusion is allowed 2 hours to settle, and is then decanted.

The grains are repeatedly washed to extract soluble matter, the resulting liquid being boiled down or used as a steeping liquid in future boilings.

Mash-cool'er. A stirring-trough in which mash or wort are stirred to expedite the cooling. The rotary vertical shaft has its fans and stirrers; the former cause a circulation of air, and the latter stir the contents of the shallow circular tub.

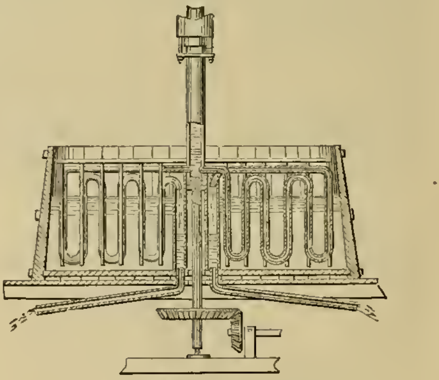
Fig. 3076.



Mash or Beer Cooler.

In Fig. 3077, coils of cold-water pipes are supplied from an axial pipe, and discharge into an annular chamber around the axis. The constant stream of water keeps the coils cool as they revolve in the mash.

Fig. 3077.



Mash-Cooler.

Mash'ing. Making an infusion of malt (called *wort*) by steeping and stirring in hot water. In the manufacture of vinegar, the cooled *wort* is fermented to form *malt-wash* or *gyle*, which is acetified by *fielding* or *stoving*.

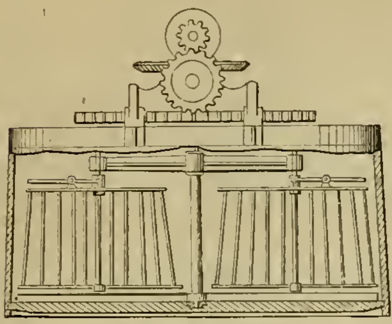
Mash-tun. (*Brewing.*) The vat or cask in which malt is steeped, and from which the saccharine solution is drawn. A mash-tub.

Pliny tells us that the Egyptians made barley wine, because their country, being subject to periodical overflow, was not suitable for grapes. The Gauls also made beer, and, the same historian informs us, were the first to use yeast for raising dough for bread. The "froth of their barley wine," he calls it. This was probably twelve or fifteen centuries before the people added an infusion of hops to the wort.

Yeast is said to have been first used in England for bread-making in 1550.

Fig. 3078 shows a form of mash-tub which has rotating and revolving stirrers at the ends of an arm which is revolved by means of gear-wheels.

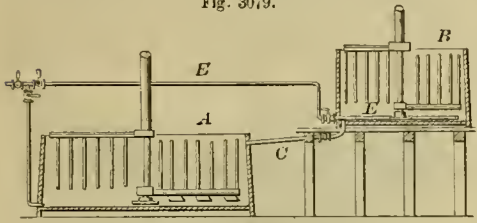
Fig. 3078.



Mash-Tun with Stirrers.

Fig. 3079 shows a compound tub for the use of corn-meal with malt in making beer, or for mashing corn-meal to make wash for distilling.

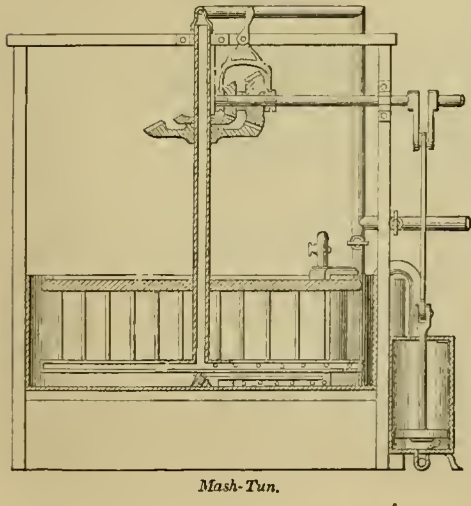
Fig. 3079.



Compound Mash-Tun.

The small tub *B* is placed higher than the large tub *A*, and is filled with water containing a quantity of corn-meal equal to the quantity of malt in the large tub *A*. Steam is admitted to *B* through perforations in the coiled pipe *E* at its bottom, until the corn-meal is entirely dissolved and the liquid is clear, like sirup. The liquid is then drawn off into *A* through pipe *C*, the fluid mass being kept all the time in motion by the stirrers.

Fig. 3080.



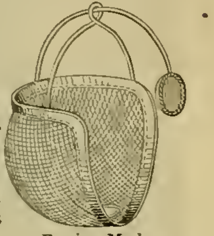
Mash-Tun.

In Fig. 3080 the vertical shaft of the rake is hollow, as are also the arms; through perforations in the latter a current of air and steam is poured for the purpose of boiling the wort, and subsequently a refrigerated stream of air for the purpose of cooling it. A stationary perforated pipe in the vat may be the medium of conveying the currents aforesaid.

Mask. 1. A face covering.

a. A wire cage to protect the face from a stray cut or thrust with a foil in fencing.

Fig. 3081.



Fencing-Mask.

b. A face covering of a humorous or other character as a disguise.

c. A face protection to be worn in glass-works or foundries, to protect against radiant heat.

d. A face covering with a means of arresting particles of metal in dry grinding.

e. A form of inhaler which covers the face and affords a wholesome atmosphere to miners or firemen in positions of danger. See INHALER.

2. (*Fortification.*) A cover of gabions or earth to protect workmen in constructing a battery; or a screen for a battery.

Masked Bat'ter-y. (*Fortification.*) A battery concealed from the view of the enemy by mantlets, bushes, or other screen.

Ma'son-ry. The art of so arranging stones or brick as to produce a regular construction.

The masonry of the ancient Egyptians was remarkable for the large size of the stones employed, sometimes as much as thirty feet in length. They were laid without mortar.

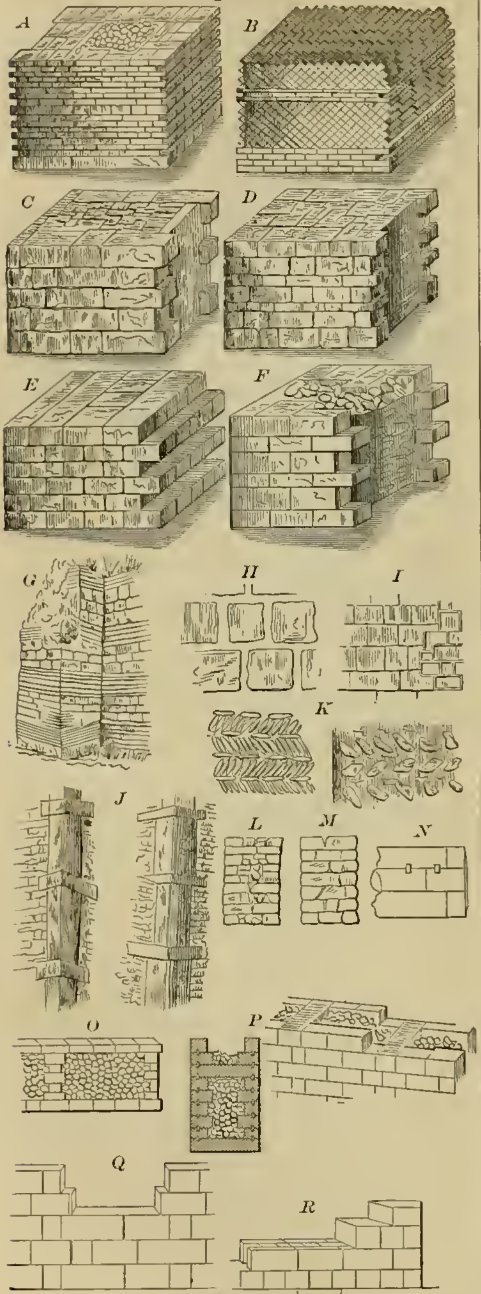
The Cyclopean or earlier masonry of the Greeks, some remains of which exist in the walls of Mycenæ and Tiryns, was formed of large and irregularly shaped masses of stone, the interstices being filled with smaller stones. Tyrrhenian or Etruscan masonry is also composed of similar stones, but so fitted together as not to admit of smaller stones between them. The more ancient remains of Greece and Italy afford examples of this kind of masonry. Peru also affords remarkable instances of cyclopean masonry.

To this succeeded the practice of making the beds horizontal or nearly so, but the vertical joints were irregular. All the preceding were laid without mortar. The Phœnician ashlar masonry is known by its bevel, and the specimens uncovered at Jerusalem are of surpassing interest.

The Greeks and Romans used several methods for walling, as the *opus incertum*, *A*, Fig. 3082; *B*, *opus reticulatum*, formed of square stones laid diagonally; *C*, *isodomon*, in which the courses were of equal hight; *D*, *pseudisodomon*, in which they were unequal; *E*, Greek *emplectum*; *F*, Roman *emplectum*, of coursed work on the outside, the interior being of rubble. In these the stones were small and laid in mortar. Where large stones were used, no mortar was employed. The Roman emplectum found in England has sometimes courses of tiles built in, as shown at *G*. *H* represents wide-jointed masonry, and *I* a combination of wide and close joints.

In a few of the earlier English buildings, considered by some to be Saxon, the quoins, the door and window jambs, and occasionally some other parts, were formed of stones alternately laid flat and set up endwise; the latter were usually much longer than the others. This is termed *long and short work* (*J*).

Fig. 3082.



Masonry.

In the Norman period, *herring-bone work* (*K*) was frequently employed in rubble walls.

The stones used during the Middle Ages were seldom larger than could be lifted by two or three men.

The various kinds of masonry employed in modern practice may be divided into three principal classes:

Rubble work (*L*), in which the stones are not squared.

Coursed work (*M*), in which the stones are squared more or less and set in courses.

Ashlar (*N*), when each stone is squared and dressed to given dimensions.

O, rubble with cut-stone plinth, quoins, piers, and coping.

P, ashlar facing filled in with rubble.

Q. The stones of equal thickness laid alternately header and stretcher. The length of each stone is double its width.

R, a kind of masonry met with in Italy, composed of alternate courses of headers and stretchers.

The following are some of the technical terms employed to designate various species of mason-work.

Dressing is the working on the faces and beds.

Plane-ashlar; rubbed smooth.

Hammer-dressed; squared and picked by the hammer.

Broached; hewn by mallet and chisel.

Tooled or *drove;* the surface worked in parallel flutes.

Random-tooled; the tooling irregular.

Boasted or *chiseled;* wrought by a narrow chisel.

Nigged; dressed with a pick or pointed hammer.

Rough; axed on the face.

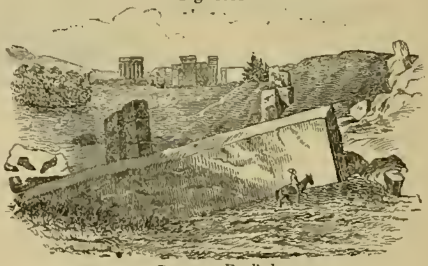
Rubble; a filling in with irregular stone.

Bowlder; made up of rounded unwrought stones.

Parpoint; squared stones laid in courses, with courses of *headers* at intervals of say five feet.

The largest stones ever placed in a wall by the hand of man are probably those in the foundations of the west and north sides of the temple of Baalbek. Thompson says: —

Fig 3083.



Stone at Baalbek.

"The first tier above ground consists of stones of different lengths, but all above 12 feet thick and the same in width. Then come three stones, each more than 63 feet long. One of them lies in the quarry, where it can be viewed all round and measured easily. It is 14 × 16 and 69 feet long. It is 1½ miles distant from the temple." The stones are so well squared and jointed that it is difficult to find the crack, which indeed will not admit the blade of a knife. Dr. Thompson states he quite overlooked it at first, and supposed the stone to be 120 feet long.

The foundation is much older than the Greek temple which was built upon it and occupies a portion only of the area. The stones of the former building are believed to have been cut up to form the shafts, capitals, etc., of the Corinthian temple subsequently built. The original was probably the work of that great Asiatic nation of which the Phœnician people was an outlying branch, and possibly Arabia the home.

Ma'son's and Brick'lay-er's Tools and Work.

Abaciscus.
Abamurus.
Abreuvoir.
Abutment.
Acisculus.
Aiguille.
Alabaster.
Amandola.
Ancon.
Arch.
Archivolt.
Ashlar.
Assize.
Backer.
Backing
Badigeon.
Banker.
Barge course.
Bari
Barrel vault.
Bat
Batter.
Beam-filling.
Bed
Bedding-stone.
Belt.
Béton.
Blocking-course.
Blue turquin.
Boaster.
Boasting-chisel.
Bond.
Bond-stone.
Bond-timber.
Border-stone.
Boss.
Bossage.
Bow.
Bowlder-wall.
Breast-wall.
Breccia.
Brick-axe.
Bricklayer's hammer.
Brick-nogging
Brick-trimmer.
Bridge-stone.
Broad-stone.
Brocatelle.
Burin.
Bush-hammer
Camber-slip.
Cantilever.
Cement.
Chain-bond.
Chamfreting
Channeling-machine.
Channel-iron.
Charring-chisel.
Chisel in marteline.
Ciborium.
Ciper-tunnel.
Civery.
Clinker.
Closer.
Clustered arch
Cob-wall.
Coffer-work.
Columbaria.
Commissure.
Concrete.
Coping.
Corbel
Corbel-table.
Cordon.
Counter-fort.
Countermure
Counter-vault.
Countess.
Course.
Coursed masonry.
Coursed-rubble masonry.
Coussinet.
Cover.
Coving.
Creasing
Crest-tile.
Cresting.
Cross-bond.
Cross-springer.
Crypt.
Curb.
Cushion.
Cut-splay.
Cut-stone.
Dead-flue.
Dead-wall.
Diatoni.
Discharging-arch.
Dog's-tooth.
Dook.
Door-stone.
Dove.
Dovetailing.
Draft.
Dressings.
Drip-stone.
Drum-curb.
Dry arch
Dwarf-wall.
Earth-table.
Embattled.
Embrasure.
Emplectum.
Extrados.
Face-guard.
Feather.
Fireplace
Fire-proof structure.
Flag-stone.
Flat-band.
Flint-wall.
Float-stone.
Footing.
Fraise.
Gable.
Gaged-rib.
Galets.
Garreting.
Gavel
Geostatic arch.
Grading.
Grouting.
Hacking.
Hack-barrow.
Handsaw.
Hanging-buttress.
Header.
Heading-course.
Heart-bond.
Herring-bone.
Hewn-stone.
Hod
Holing.
Hook-tool.
Houguette.
Hydraulic cement.
Hydraulic lime.
Hydrostatic arch.
Impost.
Incertum.
Incrustation.
Incrusted
Intrados.
Invert.
Inverted arch.
Isodomon.
Jack-arch.
Jamb.
Jasper.
Joggle.
Jointer.
Jointing-rule.
Kevel.
Keystone
Kinsh.
Knapping-hammer.
Knobbing.
Lagging.
Lapis lazuli.
Later.
Ledgement.
Ledger.
Level
Lewis.
Liernes.
Line-pin.
Liner.
Lockrand.
Lunette.
Lutheran.
Lychnoscope.
Mallet.
Mantel.
Marble Artificial
Marble-cement.
Marble-grinding machine.
Marbleizing slate.
Marble-polishing machine.
Marble relief-work.
Marbles. Playing
Marble-worker's files.
Marble-working.
Marcus.
Marmoratum.
Marteline chisel.
Marteline hammer.
Martin.
Masonry.
Matrix.
Moellon.
Monolith.
Mortar.
Mortar-tempering machine.
Mullion.
Nigged ashlar.
Nog.
Obelisk.
Off-set.
Opus.
Paros marble.
Parpoint-work.
Parting-tool.
Party-wall.
Perbend.
Pick-hammer.
Piel.
Pietra dura.
Pinning-in.
Pisé work.
Pitch.
Pitched work.
Plaster.
Plinth.
Plug and feather.
Plumb.
Point.
Pointer.
Pointing.
Porphyry.
Poyntel.
Pozzuolana.
Protean-stone
Pseudisodomon.
Pudding-stone.
Pugging.
Puncheon.
Put-log.
Quarrel.
Quarrying.
Quoin.
Raker.
Raking-piece.
Regrating.
Relieving-arch
Reredos.
Retaining-wall.
Reticulated wall.
Reticulatum.
Reveal.
Revetment.
Ridge-tile
Ripper.
Ripping-bed.
Rip-rap.
Rock-drill.
Rough-cut.
Round-nose chisel.
Rubbing-stone.
Rubble masonry.
Runner.
Rustication.
Rustic quoin.
Rustic work.
Saddle-back.
Sagitta.
Scabbling-hammer.
Scagliola.
Scantling.
Scapple.
Scarcement.
Scraper.
Screw-plate
Segmental arch.
Semicircular arch.
Serpentine.
Set-off.
Severy.
Skew
Skew-back.
Skiffling.
Slab.
Slate.
Slate-cutter.
Slate-making machine.
Slate-pencil.
Slate-trimming machine.
Slatt.
Slushed.
Soffit.
Spall.
Span.
Spandrel.
Spandrel-wall.
Spire.
Springing
Square.
Squinch.
Stabbing.
Steening.
Stereostatic arch
Stone. Artificial
Stone-axe
Stone-boat.
Stone-breaker.
Stone breaker's hammer.
Stone-bridge.
Stone-channeling machine
Stone-crusher.
Stone-cutting.
Stone-dressing machine.
Stone-drilling machine.
Stone-gatherer.
Stone-grinding machine.
Stone-hammer.
Stone-molding machine.
Stone-polishing machine.
Stone-preserving.
Stone-saw.
Stone-vessel.
Stoneware
Straggling
Straight-arch.
Stretcher
Stretching-course.
String-course.
Stucco.
Summer
Terrasse.
Tesselated pavement.
Testing-machine.
Throat.
Through-stone.
Tie-wall.
Tile
Tile-creasing.
Tile-machine.
Tin-saw.
Tooling.
Toothing.
Trapezoidal wall.
Trass.
Travertine
Underpinning
Undersetting.
Vault.
Vault-cover.
Vault-light.
Veneering-marble.
Vise.
Voussoir.
Water-table.
Wall.
Wing-wall.
Withe.
Wood-brick.
Worm.

Ma'son's-lev'el. A plummet-level.

Mas'si-cot. (*Glass.*) The manufacturer's name for the protoxide of lead used in making flint-glass.

Mas-sool'a-boat. (*Nautical.*) A boat of the Coromandel coast, adapted to be beached on the surf-beaten shore. The planks are sewed together with coir, over wads of coir which press upon the seams. They are 30 to 35 feet long, 10 to 11 feet beam, 7 to 8 feet deep, and are rowed by 12 men, oars double-banked, and a steersman with an oar at the stern.

Mast. (*Nautical.*) A long spar placed amidship, nearly perpendicularly upon the keelson, and serving to support the yards and gaffs to which the sails are bent.

Masts are known by a variety of terms which define their position or relation.

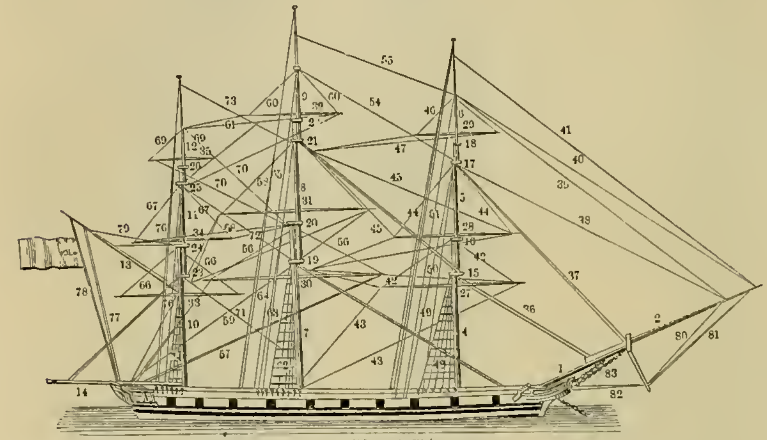
A mast consisting of one piece is a *pole-mast.*

Masts are also known as *single-tree* masts or *made* masts.

Masts for large vessels are composed of several pieces, about 1 foot square, with rounded segmental lengths on the outside, and the whole encircled at intervals by hoops. The middle tree is the spindle. The *fishes* are the side-trees.

With *two* masts: the larger is the *main*-mast, the smaller is the *fore*-mast or the *mizzen*-mast, according to its position relatively to the main-mast.

Fig. 3084.



Rigged Ship

This rule is thus stated by the authorities, but is not always adhered to in practice.

Brigs, by this rule, have *fore* and *main* masts.

The *ketch, brigantine*, and *schooner* have *main* and *mizzen* masts.

With three masts: they are called *fore, main, mizzen.*

With four masts: they are called *fore, main, main-mizzen, bonaventure-mizzen.*

The proportions of the different masts to each other are about as, —

Mizzen, 7; main, 10; fore, 9.

The portions of a mast consisting of several spars are termed, —

The *lower-mast, top-mast, top-gallant mast, royal-mast.*

The hight of a lower-mast has three subdivisions:

The *housing;* from the heel to the upper deck.

The *hounding;* from the deck to the *hounds.*

The *head;* from the hounds to the cap.

The *heel* of a mast is its lower end, and rests in the *step* on the *keelson.*

At the deck it is supported by *carlings* and *beams.*

Above the deck are cleats called *partners*, which form a rim around the deck-opening.

At the *hounds* the rigging is secured to the mast. The mast is stayed by *fore-stays, back-stays*, and *shrouds.*

The *head* is the portion to which the lower end of the topmast is secured.

The *cap* is the block at the head of a mast, which forms a yoke for the attachment of the upper mast thereto.

The *hounds* are cheeks supporting the *trestle-trees.*

The *trestle-trees* are fore and aft timbers to support the *top.*

The *cross-trees* are timbers lying athwartship and scored down upon the *trestle-trees.*

The *top* is a flat platform to spread the shrouds of the upper mast, and for other purposes.

On the sides of the *top* are *futtock-plates*, having holes through which pass the *futtock-shrouds*, whose lower ends are secured to the chain-necklaces on the mast below the hounds.

The *fid* is a transverse key passing through the heel of the topmast and resting on the *trestle-trees.*

Iron masts are made hollow, the plates of the shell being single-riveted at the longitudinal joints and double-riveted at the circular joints. Internal stiffening ribs and braces prevent flexure, collapse, or torsion.

Tripod masts, invented by Captain Coles, English Navy, have three diverging legs, and obviate the use of standing rigging.

A *trysail*-mast is a small mast abaft the mizzen to carry a gaff.

A *spencer*-mast is a similar spar, abaft the *fore* or the *main* mast.

A *jigger* is a small mast, erected on the stern of a *yawl*, a vessel whose rig in other respects is that of a *cutter.*

Fig. 3084 shows the various spars and the most important ropes of a full-rigged ship.

1, bowsprit.
2, jib-boom and flying-jib boom.
3, martingale-boom.
4, fore-mast.
5, fore-topmast.
6, fore topgallant and royal mast
7, main-mast
8, main-topmast.
9, main topgallant and royal mast.
10, mizzen-mast.
11, mizzen-topmast
12, mizzen topgallant and royal mast.
13, spanker-gaff.
14, spanker-boom.
15, fore-mast trestle-trees.
16, fore-mast cap
17, fore-topmast trestle-trees
18, fore-topmast cap.
19. main-mast trestle-trees
20, main-mast cap
21, main-topmast trestle-trees.
22, main-topmast cap.
23, mizzen-mast trestle-trees.
24. mizzen-mast cap.
25, mizzen-topmast trestle-trees.
26, mizzen-topmast cap.
27, fore-yard.
28, fore-topsail yard.
29, fore-topgallant yard.
30, main-yard.
31, main-topsail yard.
32, main-topgallant yard.
33, cross-jack yard.
34, mizzen-topsail yard.
35, mizzen-topgallant yard.
36, forestay.
37, fore-topmast stay.
38, jib-stay.
39, fore-topgallant stay.
40, flying-jib stay.
41, fore-royal stay.
42, fore-lifts.
43, fore-braces.
44, fore-topsail lifts.
45, fore-topsail braces.
46, fore-topgallant lifts
47, fore-topgallant braces.
48, fore-rigging.
49, fore-topmast backstays.
50, fore-topgallant backstays.
51, fore-royal backstays.
52, main-stay.
53, main-topmast stay.
54, main-topgallant stay.
55, main-royal stay.
56, main-lifts.
57, main-braces.
58, main-topsail lifts.
59. main-topsail braces.
60, main-topgallant lifts.
61, main-topgallant braces.
62, main-rigging.
63, main-topmast backstays.
64. main-topgallant backstays.
65. main-royal backstays.
66. cross-jack lifts.
67, mizzen-topsail lifts.
68, mizzen-topsail braces.
69, mizzen-topgallant lifts.
70, mizzen-topgallant braces.

71, mizzen-stay.
72, mizzen-topmast stay.
73, mizzen-royal stay.
74, mizzen-shrouds.
76, mizzen-topmast backstays.
76, mizzen-royal backstays.
77, spanker-vangs.
78, ensign-halliards.
79, spanker-peak halliards.
80, jib-boom martingale-stay.
81, flying jib-boom martingale-stay.
82, martingale back-ropes.
83, bobstays.

Guppy's mast, English patent, 1826, consisted, instead of a single pole or spar, of a pair of spars stepped into the ends of the beams and uniting at the crosstrees, forming an isosceles triangle. Being hinged at the deck, they were designed to be lowered fore and aft, depending for their stability in use upon the stays.

Shuldham's revolving mast (English patent) is capable of rotation, so as to present the sails in the required direction by rotation on its axis, instead of veering the yards.

Here, as in regard to many other subjects, the Greeks credit Dædalus with the first invention. How many centuries previously the rivers of China, the Ganges, and the Nile had been dotted with sailing craft, it is impossible to say. A part of the corn which Joseph collected was probably brought in sailing-vessels to the depot, over 400 years before the date of the Athenian mechanic.

Icarus, says Pliny, was the person who invented sails, and Dædalus the mast and yards.

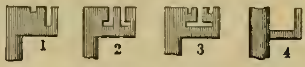
The ships of antiquity depended more upon rowers than sails, but were provided with masts and sails as accessories. Upon the Nile, the barges were propelled by sails generally, excepting that numerous class which partook of the character of rafts, were floated down the river, carrying produce, and were not returned up stream. One mast and one sail, the latter depending from a yard, is the general feature, though a plurality of masts was not uncommon, especially with large vessels, such as the galley built by Archimedes for Hiero of Syracuse. It had 3 decks, towers on the bulwarks, stables, libraries, baths, fish-ponds, a crew of 600 men, and a main-mast that came from England. This was about 240 B. C. (See SHIP.) Syracuse was captured by Marcellus 212, and Archimedes slain. The mast is presumed to have been brought by the Phœnician or Carthaginian navigators from England, as those maritime nations were yet in existence. Poor Tyre had been desolated by Alexander 100 years before, but the people dispersed around the Mediterranean were yet active, and Carthage had not fallen before her imperial rival, remorseless Rome.

In the time of Isaiah the masts were strengthened with shrouds from the deck or bulwarks. A few years later we read that the Tyrians obtained cedar masts from Lebanon, as no doubt they had been doing for 1,000 years before Ezekiel wrote. The planking of the vessels was "fir-trees of Senir" (Hermon), calked by men of Gebal; the oars of oak from Bashan; the rowers' benches of ivory from the "Isles of Chittim" (some western land on the African coast). The sails were fine linen of Egypt, the awnings of purple and blue fabric "from the Isles of Elishah." Josephus identifies the descendants of Elishah, the eldest son of Javan, with the Æolians. So Greece furnished the Tyrian dye. Lydia of Thyatira, a seller of purple, was converted A. D. 53, under the preaching of Paul of Tarsus. This was in or near the ancient Æolia, so that the local profession was yet preserved.

Mast-car'ling. (*Shipbuilding.*) Large timbers at the side of the mast-rooms that are left deep enough to receive the cross-chocks.

Mas'ter-key. A key which commands many locks of a certain set, the keys of which are not interchangeable among themselves. While neither one of a series of keys may suffice to open any lock besides the one for which it was constructed, a master-key is one which may operate any one of the set. In the annexed series, the key No. 4 is master of the locks for which the keys Nos. 1, 2, and 3 are specially constructed.

Fig. 3085.



(*No.* 4) *Master-Key.*

Mas'ter-tap. A *tap-screw.*

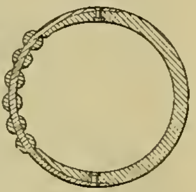
Mas'ter-wheel. The main wheel in a machine which acts as a driver of many parts. Such is the large cog-wheel in a horse-power which imparts motion to a circular system of pinions. See HORSE-POWER.

Mast-hole. (*Shipbuilding.*) A hole in the deck to receive a *mast.* It is of larger diameter than the mast by double the thickness of the wedges which hold the mast in position.

The framing of the mast-hole consists of *fore-and-aft partners*, *cross-partners*, and *corner-chocks.*

Mast-hoop. A circular band to which the luff of a fore-and-aft sail is bent, and which slips on a spar in raising and lowering. In the example, the hoop is composed partly of wood and partly of metal, the metallic portion being provided with friction rollers.

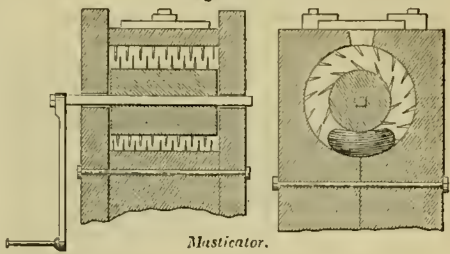
Fig. 3086



Mast-Hoop

Mas'ti-ca-tor. 1. A small machine to cut up meat for aged persons or those who have lost their teeth or the power of chewing. It is screwed to the table; the food is fed in at the top, and a crank to which a number of sharp knives are attached is turned in opposition to a number of stationary ones. This minces the food, and deposits it on the plate of the person. Food cut up in this manner retains all the nourishing qualities. The interior of this machine is lined with porcelain, and is easily kept clean. See MEAT-CHOPPER; MEAT-CUTTER; SAUSAGE-MACHINE.

Fig. 3087.



Masticator.

2. The machine which kneads the raw caoutchouc to render it homogeneous.

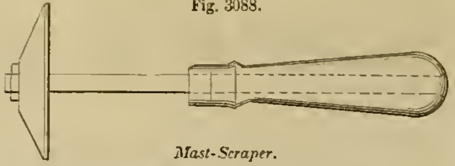
Mast'ing-shears. A hoisting device consisting of two spars and one or more guys, used to elevate masts on end to put them in position aboard vessels, or remove them from vessels. See SHEARS.

Mast-prop. A spar forming a lateral support for a mast when a ship is careened.

Mast-scrap'er. A tool for scraping masts; it is usually a triangular plate with an edge whose bevel is away from the handle. Its edge is sometimes partly concave, to more nearly fit the contour of the mast.

Mast-step. A socket at the foot of a mast.

Fig. 3088.



Mast-Scraper.

Mast-tack'le. (*Nautical.*) *a.* Purchases used in putting up or sending down masts.

b. Purchases attached to the mast for lifting or lowering boats, getting in freight or stock, bulky stores, machinery, blubber, etc.

Mast-trunk. (*Nautical.*) A box, in small vessels, in which stands the mast.

Mat. 1. (*Nautical.*) A wad of woven or thrummed junk. Used to secure standing rigging from the friction of yards and ropes.

2. (*Domestic.*) *a.* A rug of straw, rushes, husks, coir, junk, hemp; a tufted fabric of these materials or of wool; a skin with the hair or wool on; a set of slats, etc. Mats are for cleaning shoes at a door; keeping the feet from a cold floor, as in cars or halls, and elsewhere; covering up plants against frost, etc.

b. A small piece of oil-cloth, fabric, or worsted work, to place beneath a hot dish or wet pitcher, to preserve the polish of a table.

3. (*Photography.*) An ornamental plate or passepartout laid over a daguerreotype, etc., and forming an oval or other symmetrical border to the picture, as well as keeping the plate from abrasion by the glass.

4. (*Metallurgy.*) An alloy of metals in a crude form, in the process of reducing. *Matt, matte.*

Match. 1. A splint or strip of combustible material, usually wood, one end of which is dipped in a composition that ignites by friction.

The earliest and most primitive way of obtaining fire by artificial means seems to have been that still in use among the South-Sea-Islanders and other savage tribes, by rubbing two sticks of dry wood together. To this succeeded the flint, steel, and tinder-box, and to them various forms of friction-matches and chemical devices.

The word "matches" recalls to our memory the slips of pine with their ends pointed and dipped in brimstone. This was the old associate of the tinder-box, with its flint and steel, of which the rising generation knows nothing. A *match* now means a little square or round splint dipped in a composition which explodes by friction, and renders the flint, steel, and tinder unnecessary. There were several steps in the progress from one system to the other, as we shall see. For a description of a series of inventions which preceded *matches*, see LIGHTING-DEVICES.

About 1820, the first attempt may be said to have originated to dispossess the old flint and steel dynasty, though as long ago as 1677 the German chemist Krafft had indicated the uses of phosphorus for procuring light or fire. Boyle, at this period, describes it as "a factitious, self-shining substance," procurable in small quantities at great expenditure of time and labor. In 1680, Godfrey Hanckwitz, at his laboratory in Southampton Street, London, manufactured and sold large quantities of phosphorus for the purpose of striking light.

About 1825, the hydrogen-lamp was invented by Doběreiner, a German, and was long in favor. It consisted of a piece of spongy platinum, which was rendered incandescent by the passage of hydrogen. See HYDROGEN-LAMP.

About the same time we hear of a composition of phosphorus and sulphur placed in a vial, and used by dipping a match and then rubbing the composition on the cork to excite ignition.

Then followed the match dipped successively in sulphur and then in a mixture of sugar and chlorate of potash. These were lighted by dipping in sulphuric acid.

The "Promethean" matches were made of a roll of paper treated with sugar and chlorate of potash and a small cell containing sulphuric acid. This cell was broken with a pair of pliers, and the acid ignited the composition by contact therewith.

Next (about 1834) we find the "Lucifers," which were coated with a mixture of sulphide of antimony and chlorate of potash made into a paste with gum-water, and ignited by drawing between the surfaces a folded piece of sand-paper.

The "Congreve" next appeared, in which phosphorus was substituted for sulphide of antimony.

In March, 1842, Reuben Partridge patented a machine for making splints.

1845, Schrötter of Vienna discovered amorphous or allotropic phosphorus, which rendered the manufacture less unhealthy, and the matches less dangerous.

The process of manufacture is, according to Tomlinson, as follows: —

Thick pine planks are cut into blocks by a circular saw, and these are divided into splints by a series of lancets in a reciprocating frame, which score the face of the block to a certain depth. A scythe-shaped knife, cutting the whole width of the block, then swings round and severs the row of splints. This produces square matches.

Circular matches are made by pressing the block against a plate having circular perforations, the interspaces between which are beveled so as to form cutting edges.

As the splints fall from the cutting-machine they pass down a shoot into an apartment below, where they are tied up in bundles of half a gross, after which they are dried in a hot room.

Each end of the bundle is next dipped in a pot of melted sulphur, and another string is tied around it, so that when divided by the circular saw two complete bundles are formed. They are now dipped in the phosphorus composition, the ingredients of which vary somewhat among different manufacturers, but consist essentially of nearly equal proportions of phosphorus, glue or gum, and fine sand (whiting is preferable), with coloring matter added, the whole mixed with water. Heat is applied in incorporating the materials, and the vessel containing them is maintained at a temperature of 98° in a water-bath. The composition is spread on a steam-heated slab. The matches are prepared for dipping by inserting them singly in a perforated frame containing fifty matches, from which each end of the splint projects. A boy then takes each frame and presses the ends of the matches upon the composition on the slab. They are next dried and boxed, which latter operation is performed, at the rate of 3,000 boxes per day, by little girls. Since the above was written more expeditious methods have been adopted.

The modes of operation in the United States differ somewhat in different establishments. The whole work is, however, done by machinery.

By one mode the splints are cut by a small machine containing 12 circular cutters, and carried by an endless chain 200 feet long, the sides of which are grooved to hold them to the sulphur-bath, imperfect splints being dislodged on the passage by the upward blow of a small hammer.

A wheel, revolving in the bath of molten sulphur, gives their ends a coating as they pass, after which they are carried 40 or 50 feet farther, where a similar wheel touches their ends with phosphorus. They are carried by the chain about an equal distance onward, where the chain passes over a wheel, descending perpendicularly to the trays for receiving the matches, which, as they arrive, are pushed from the chain by a slider, and received in the trays.

Eight of these machines make 800 gross, 14,400 each, of matches daily. 600,000 feet of pine lumber, 250,000 feet of bass-wood for packing-cases, 300 barrels of brimstone, and 9,000 pounds of phosphorus are annually consumed.

Making the splints is in general a separate branch of the manufacture, as they can be made cheaper by machinery on a larger scale. See MATCH-SPLINT MACHINE.

A factory in New York State uses annually 720,000 feet of pine for matches, and 400,000 feet of bass-wood (linn) for cases; of sulphur 400 barrels, and phosphorus 9,000 pounds. The daily consumption of paper is 500 pounds, and of pasteboard for large boxes 8,000 pounds weekly. The daily consumption of paste is produced from 66 pounds of flour, and the one cent stamps used daily foot up the amount of $1,440.

Some matches are made without sulphur, thus avoiding the offensive smell of that mineral. A German composition for this purpose consists of phosphorus, 4 parts; water, 10; fine glue, 6; red ocher or red lead, 5; smalt, 2. The ingredients, in the order named, are incorporated with the liquefied glue to form a paste.

The ends of the splints are, in some cases, dipped in paraffine, to secure more ready ignition.

It has been proposed to employ sodium instead of phosphorus in the manufacture of matches. It ignites as easily, and is free from offensive odors.

A scientific journal strongly deprecates the idea, and cautions the public against the use, as sodium is so readily oxidized as to burn when wetted.

2. (*Ordnance and Mining.*) A *slow*-match consists of loosely twisted hempen cord dipped in a solution of saltpeter and lime-water. It burns at the rate of one yard in three hours.

A *quick-match* is cotton coated with a composition of mealed powder, gum, and water. When not confined it burns at the rate of one yard in thirteen seconds.

Another *quick-match* is made of cotton-wick boiled in saltpeter and water. Alcohol is added to the warm solution; mealed powder is added, and the wick left to steep for 24 hours. The match is then dried.

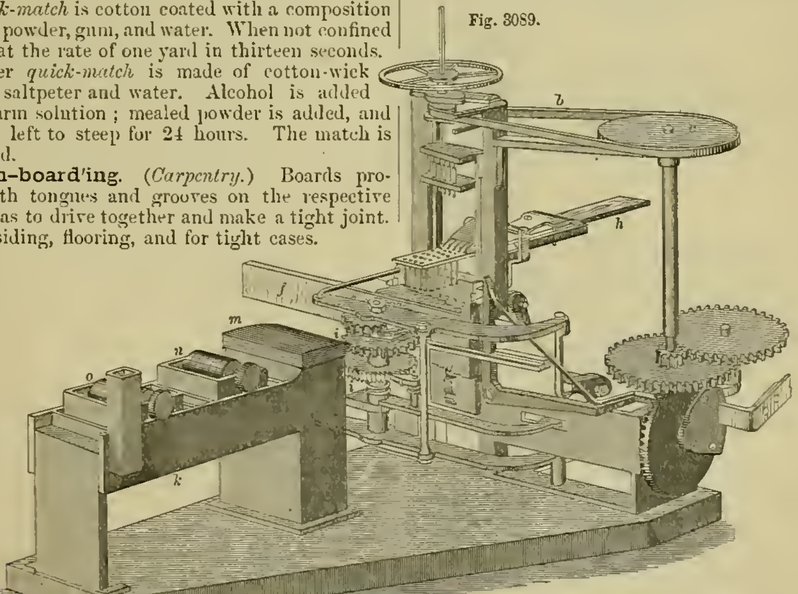
Match-board'ing. (*Carpentry.*) Boards provided with tongues and grooves on the respective edges, so as to drive together and make a tight joint. Used in siding, flooring, and for tight cases.

Match-box Ma-chine'. In Poirier's machine the boxes are made of pasteboard, which is cut into pieces each of suitable size to make the body or the top of a box. These pieces are rectangular in form, but are rounded at the angles. They are introduced one by one into the machine, and are instantly forced by a plunger into a box-shaped matrix or socket, where they receive at one movement the form desired. In this operation the corners, in which the material is in excess, are folded over on the sides, and an energetic pressure is exerted on the folds by means of four cams; in consequence of which these folds become compacted into one mass with the sides of the box. The capacity is 3,000 per hour.

Match-cloth. (*Fabric.*) A coarse woolen cloth.

Match-dip'ping Ma-chine'. Schmidt's match-dipping machine at the Paris Exposition was arranged for dipping 6,000 matches in four minutes. The splints, properly cut and prepared, are received upon a horizontal plate or table grooved to the size of the matches, and are made to fall into the grooves by the action of a broad brush which is suspended above the table, and which the operator moves by means of a pedal. In front of the table on which the matches thus arranged lie, is a frame placed vertically, which is designed to receive a number of layers of matches, one above another. This frame presents immediately before the row of matches a narrow receiving-plate or bed. By the action of a second pedal the workman causes a row of needles to advance, which push forward the matches on to this plate, and are retracted by a spring. The matches are pushed beyond the edge of the receiving-plate just so far as may suffice for dipping, and their ends are kept separate by thin partitions, which are a fixed part of the machine. The frame, which has a movement up and down in guides, is then depressed sufficiently to permit another receiving-plate to be laid on the last row of matches, at a proper level to receive an additional row; and this process goes on until sixty rows, each containing one hundred matches, have been piled up in the frame. The frame is then locked up by bringing down a traverse

Fig. 3089.



Match making Machine.

bar at the top, so as to compress the whole mass and secure it in place. The matches are thus confined as in a printer's chase. They are then evened at their end like type, and are ready for dipping. — *Dr. Barnard's Report Paris Exposition.*

Match-gear'ing. (*Gearing.*) Two cog-wheels of equal diameter geared together.

Match-hook. A double hook or pair of hooks in which one portion forms a *mousing* for the other.

Match'ing-ma-chine'. A wood-planing machine which tongues and grooves the respective edges of a board. See Molding-machine.

Match'ing-plane. See Match-plane.

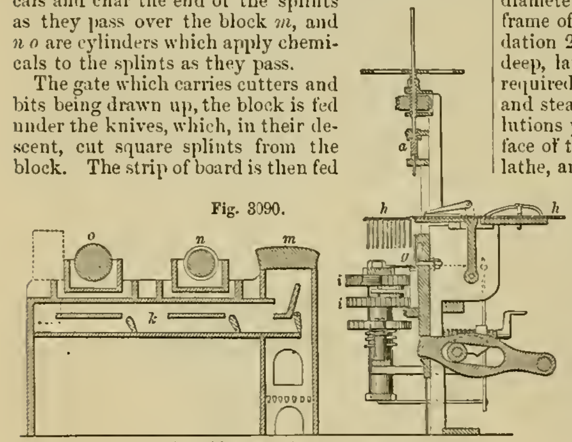
Match-lock. The form of gun-lock which preceded the wheel-lock and the flint-lock. It had a match, whence its name, which was presented to the priming. Still used in some parts of Asia. See Revolver.

Match-mak'ing Ma-chine'. Young's match-machine cuts the splints from a block or bolt of wood, sticks them singly in a strip of thin board, and passes them, points downward, over a trough or vat containing the chemicals, which are applied and the matches completed before the strip leaves the machine.

Fig. 3089 shows Young's machine. A gate carries a set of boring bits above and as many cutters *g* below. The bits are geared to run together at uniform speed, and are driven by belt *b* from pulley *c*. These bits are to bore holes in the strip *h*, into which all the matches are stuck as soon as cut from bolt *f*. *i i* are feed-wheels to bring the bolt of match timber to the cutters. *k* is a steam-chamber to heat chemicals and char the end of the splints as they pass over the block *m*, and *n o* are cylinders which apply chemicals to the splints as they pass.

The gate which carries cutters and bits being drawn up, the block is fed under the knives, which, in their descent, cut square splints from the block. The strip of board is then fed under the bits and over these newly cut splints. The bits bore a hole for each splint, then retreat, and by the farther descent of the gate the ends of the splints are forced into their respective holes in the slip *h*. The farther progress of the slip applies the chemicals, the slip advancing one row of matches to each descent of gate.

Fig. 3090.



Match-making Machine (Section).

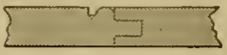
After the matches have been completed by the machine and dried a suitable time, they can be removed from the strips of wood and packed in boxes, or they may be sold adhering to their backing, in which condition they are known as *block matches.*

Fig. 3090 is a transverse section of the same machine.

Match-planes. A pair of planes making a tongue and groove respectively, the former to fit the latter. Used in making tight joints on meeting edges of boards.

Adjustable match-planes have moving fences to determine the distance of the tongue or the groove from the working edges of the respective boards. For varying widths of grooves and tongues different *irons* are used.

Fig. 3091.



Match-Joint.

Match-plate. (*Founding.*) A plate upon the opposite sides of which the halves of a pattern are placed correspondingly, to facilitate the operation of molding. The plate is placed between the parts of a flask, rammed up from both sides, and removed, allowing the parts to come together.

Match-safe. A box to contain matches for use. Usually hung up near a gas-bracket or elsewhere within ready reach.

Match-splint Ma-chine'. Matches of cylindrical form have been made by compressing the quadrangular slips or drawing the wood through holes in a draw-plate. The Austrian circular matches are cut from planks of clean grained wood, by means of hand-planes carrying a series of steel tubes, which produce long, thin splints of wood of circular section. These are afterward cut into lengths.

In Rimailho's machine the block of wood is the length of the match. The machine has a slide carrying a series of tubes made out of a solid piece of steel and kept sharp at their edges; a frame keeps the wood in contact with the tool. The slide is moved rapidly backward and forward by an eccentric, and cuts a row of matches at each stroke, each fresh row throwing out those previously made.

De Bowen's machine consists of a wheel 20 feet in diameter, and 6 feet across the face, supported on a frame of heavy timbers, and resting on a stone foundation 25 × 12 feet in length and width, and 5½ feet deep, laid in cement. This ponderous foundation is required in order to maintain the necessary accuracy and steadiness in the wheel, which makes 21 revolutions per minute. The blocks are clamped to the face of the wheel. A rest, similar to that of an iron lathe, and moved to the right or left in like manner, is placed in front of the breast of the wheel, and carries 16 annular steel cutters. The number of these may be doubled if necessary.

They are adjusted so as to face the blocks, and as the wheel revolves each cuts a splint out of the wood, which drops below. The cutters are advanced forward the exact thickness of a splint at each revolution of the large wheel, until they have cut through the thickness of the blocks, 6, 8, or 10 inches, when they are brought back to their original position by turning a wheel. The cutters are adjusted to cut the splints out of the projections left between the corrugations made by them in the blocks at the preceding revolution of the wheel. It is said that each machine, with 16 cutters, will cut 86,400 sticks per minute, 5,184,000 per hour, or 51,480,000 in a working day of 10 hours.

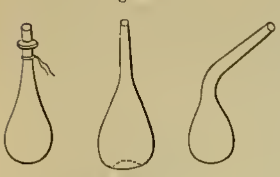
The sticks fall from the cutters in a shower into a trough below, through which passes a belt that carries them to a series of shakers having latticed bottoms, through which imperfect sticks and pieces of shavings drop. They are then deposited in cases with latticed bottoms and conveyed to the drying-rooms, where the boxes are placed in tiers, three or four deep, upon steam-pipes heated to a temperature of 120°, where they are allowed to remain a day and a night, effectually drying the wood. After drying they are arranged in parallel rows by another series of shakers and packed in boxes. They are then ready for shipment to the manufacturers, who perform the dipping process, that being a separate branch of the manufacture.

Match-tub. A tub about eighteen inches high, in which a slow-match is hung, fire downward.

Match-wheel. A cog-wheel adapted to mesh into or work with another.

Mat'rass. (*Pharmacy.*) A glass vessel with a long neck, a rounded body, and sometimes furnished with a tubulure. It is used for distilling and digesting.

Fig 3092.



Matrasses.

Ma'trix. 1. A mold which gives form to an object driven into it or hardening therein, as, —

a. The intaglio or indented device for a coin, either engraved or produced from a *hub* on which the design has been produced in relief. The *matrix* is the mold into which a soft steel *plug* is driven, and which is to be used in making the *die* from which the coin is struck.

The series is as follows: —

1. The engraved *hub* (cameo).
2. The *matrix* (intaglio).
3. The *punch* (cameo).
4. The *die* (intaglio).
5. The *coin* (cameo). See DIE.

b. A bottom die or *bed.*

c. The *mold* in a type-making machine which gives the form to the letter on the end of the type. The letter is originally engraved on the end of a piece of steel, which is subsequently hardened, and is called a *punch.* The *punch* is used to impress the *ma'rix.*

Fig. 3093.

Matrix.

d. The plaster mold (in intaglio) obtained from a form of type, and used to obtain an impression (cameo) in type-metal, known as a STEREOTYPE (which see).

e. A matrix in paper is obtained by dabbing down upon the surface of the type successive sheets of unsized, thin paper, with occasional layers of paste. The dabbing is done by a brush, and thus the paper is forced into every crevice of the type. The matrix is then dried and used similarly to a plaster mold. If intended for a *turtle,* it is bent into cylindrical form before casting the metal upon it. The process is much used in newspaper work.

f. A mold for casting. A shape in which anything is formed.

2. The *gangue* or stony substance in which metalliferous ores are formed, associated, or imbedded.

Matt. 1. (*Metallurgy.*) A mass of imperfectly reduced metal having impurities, mineral and metallic, as in the case of copper. See COPPER-FURNACE.

2. (*Gilding.*) The *dead* or unburnished surface of gold, when the gold-leaf is merely pressed upon the size and is not rubbed with the burnisher. The dead appearance of portions acts as a foil to the lustrous surface over which the burnisher has passed. See GILDING.

Mat'ted-glass. (*Glass.*) A mode of ornamenting glass for windows, in which the surface is covered with a very fusible powder, either opaque, white, or tinted. This being removed in portions, the glass is fired and the composition fixed, giving a bright pattern on a dull ground.

Substantially the same effect is produced by painting the pattern on the glass with an asphaltum varnish, and then etching the surface with hydrofluoric acid.

By a similar process the glass bottles of the chemist have their labels ineffaceably inscribed.

Mat'ter. (*Printing.*) Type composed. It is *live, standing,* or *dead,* according as it is ready for use, awaiting re-use, or ready for distribution.

Mat'ting. 1. Matting is made of hemp, coir (the fiber covering the cocoa-nut), jute; also of rushes, hair, grass, palm-leaves, etc. The India matting is made of a peculiar Oriental grass. Russia matting of *bast* or linden bark. Also of strips of black-walnut or other ornamental wood, with wires passing through them at right angles. The wooden strips are separated by elastic washers made from india-rubber tubing. The matting can be rolled up into a compact form for transportation, and is found to have superior advantages for hallways of tenement-houses, street-cars, reception-rooms of hotels, railway depots, etc.

2. The passepartout over a picture. A *mat.*

3. (*Gilding.*) Covering plates with varnish in gilding on water size.

4. A regular rough lusterless surface.

Mat'ting-loom. (*Weaving.*) One in which slats are introduced into the shed to form the woof.

Mat'ting-tool. (*Metal-working.*) A kind of chasing tool, employed in producing a regular rough surface on an object; usually in the lathe.

Mat'tock. An implement with an iron head, having blades at each end presented in different planes, and an eye in the middle into which the handle is inserted perpendicularly to the head. The cutting edges are presented like those of an axe and an adze respectively.

The mattock, pick, grubbing-hoe, or a tool substantially similar and used for digging and grubbing, has been in use in Egypt and Palestine for nearly 4,000 years, as we know, and probably much longer.

The Egyptian hoe of the time of the Pharaohs was a large wooden implement, and answered for mattock, spade, and hoe. It had a single head, like the *surculus simplex* of Palladius, in contradistinction to the *bicornis,* or two-bladed tool, which resembled our pick. See HOE.

"They had a file for the mattocks." — 1 Samuel, xiii. 21 (1093 B. C.). By reference to Isaiah vii. 25, it appears that the mattock was relied upon for grubbing out briers and thorns as at present, and the pronged hoes of the Greeks had a similar duty in addition to their ordinary use in preparing the ground for seed.

Mat'tress. A padded bed, or one stuffed and quilted or tied, so as to keep the stuffing to a general thickness. The filling is hair, moss, sponge, cotton, husk, straw, *excelsior* (shredded wood), etc.

An elastic bed-bottom of coiled or woven wire.

Maul. A large wooden hammer, adapted for driving wedges, and sometimes called a *beetle.* (See MALLET.) A knot-maul (*x*, Fig. 3032) is made of a tough piece of timber, generally a knot chopped out of the side of a log. It is usually the frustum of a cone, the handle being inserted into an auger-hole bored through the axis and fastened by a wedge at the end.

The ring-maul (*y*, Fig. 3032) is a piece of a tough stick, gum, dogwood, hickory, or oak, with a hole passing transversely through it for the handle, and rings upon the ends to prevent splitting.

The iron-maul (*z*, Fig. 3032) has recessed faces to receive disks of wood, which are the working faces of the maul, as it is not fit that the iron should touch the object to be driven. A good maul is a valuable tool; and this iron-head, if carefully used, will last a long time, the wooden faces being burned out when worn, and then renewed.

The light *maul* of the United States artillery service has a head of elm or hickory, 6 inches in diameter and 8 inches long; handle of ash, 1½ inches diameter, 24 inches long; an iron hoop on each end of the head 1 inch wide, ¼ inch thick. It is used for driving pickets. Weight, 10 pounds.

Maul-stick. (*Painting.*) A wooden rod on which an artist rests the right hand to steady it.

Maun'dril. (*Mining.*) A prying pick with two prongs.

Max'i-mum Ba-rom'e-ter. A barometer having an indicator so arranged as to follow the movement of the mercury up to the highest point which it may reach, and there remain stationary when the mercury recedes, thus showing the maximum hight of the column and consequent maximum of pressure during storms, etc.

Negretti and Zambras's contrivance for this purpose consists in jointing to the longer leg of a siphon barometer, at 8 inches from its top, a bent glass tube, which is carried up for 6 inches parallel to the main tube, joining it again at 2 inches from the top. The mercury flows freely in and out of this tube, maintaining the same level as that in the larger tube. It contains a small piece of steel, maintained in position by fine glass springs; as the mercury rises, the steel is pushed up, but remains stationary when the mercury descends. A similar contrivance in the shorter leg shows the minimum reading of the barometer.

Max'i-mum Ther-mom'e-ter. A thermometer arranged to register the highest point reached between observations, as Rutherford's. See THERMOMETER.

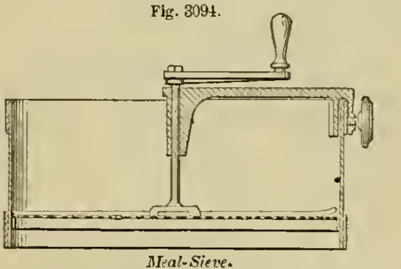
Meak. A hook with a long handle.

Mealed Pow'der. Gunpowder pulverized by treating with alcohol.

Meal'er. A wooden rubber for mealing powder.

Meal-sieve. (*Domestic.*) One for sifting cornmeal and flour, to remove portions of hulls from the former, lumps and weavil from the latter. The frame which rotates above the foraminous surface of the sieve is journaled in a frame attached by a clamp and set screw to the edge of the sieve.

Fig. 3094.



Meal-Sieve.

Meas'ure. 1. A quantity assumed as a unit. See UNIT.

The measures of antiquity — and the modern have much the same origin — are derived from the parts of the human body.

The *finger-breadth* (*digitus*).

The *thumb-breadth* (*pollex*).

The *palm*, or hand-breadth (*palmus*).

The *span*, or distance comprised between the tips of the thumb and little finger when extended.

The length of the *foot* (*pes*).

The distance from the elbow to the tip of the middle finger (*cubit*).

A *step* = 30 inches (*gradus*).

A double-step or *pace* = 5 feet (*passus*).

The reach of the extended arms = 6 feet (*orgyia*).

The inch was not a unit of measure, but is the twelfth of a foot. The Greek measures were decimal, the Roman duodecimal.

The intinerary measure of distance was the *stadium*, the length of the foot-race course. The Olympic stadium was 600 feet.

The Roman measure of area was the *jugerum* = ⅘ of an acre English. Its name and quantity signify that it was a day's work for a *yoke* of oxen in plowing.

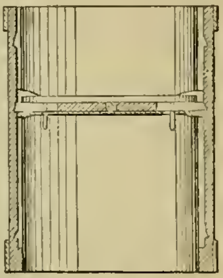
The *mille passuum*, or 1,000 paces, was the common name of the Roman mile.

A common Roman measure for land was the 10-foot pole, *pertica* or *decempeda*.

The unit of measure differs among different nations. See UNIT; METRIC SYSTEM.

Measures of merchandise and artificers' work are according to custom and trade: the yard and its fractions for woven goods; the fathom for rope; the bushel, peck, and gallon for grain and roots; the gallon and its subdivisions for liquids.

Fig. 3095.



Adjustable Measure.

Fig. 3095 is a measure with a bottom adjustable for different quantities. Spring catches on the bottom are operated by projections beneath, and enter notches in the sides of the cylinder at the proper points.

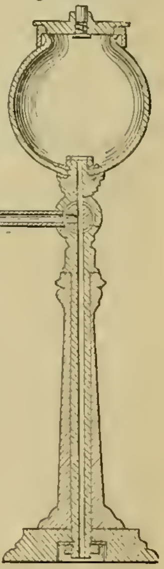
The gallon, quart, and pint are used for small measures of capacity. For weight we have, foolishly enough, several kinds of pounds of varying weight, the avoirdupois weighing 7,000 grains and divided into 16 ounces, and the ounce into 16 drams; the Troy pound of 5,760 grains divided into 12 ounces, the ounce into 20 pennyweights, and the pennyweight into 24 grains; the apothecaries' weight of 5,760 grains, divided into 12 ounces, the ounce into 8 drams, the dram into 3 scruples, and the scruple into 20 grains. The grain is the constant. See books on weights and measures, Haswell's "Handbook," and the specific index under METERS.

Among measuring devices are those known as *rules*, *sticks*, *tapes*, *lines*, etc. See also lists under GAGES, CALCULATING AND MEASURING INSTRUMENTS, DRAFTING AND MATHEMATICAL INSTRUMENTS.

Besides these may be simply mentioned *measuring faucets*, *funnels*, *pumps*, *board*, *cloth*, *lumber*, *surveyor's*, *tailor's*, *tire measures*, etc. See also succeeding articles, which describe measuring attachments for tanks, stills, casks, faucets, funnels, tires, etc.

2. (*Joinery.*) *Single measure* is square on both sides; *double measure* molded on

Fig 3096.



Measuring-Apparatus.

both sides; *measure and a half*, molded on one side, square on the other.

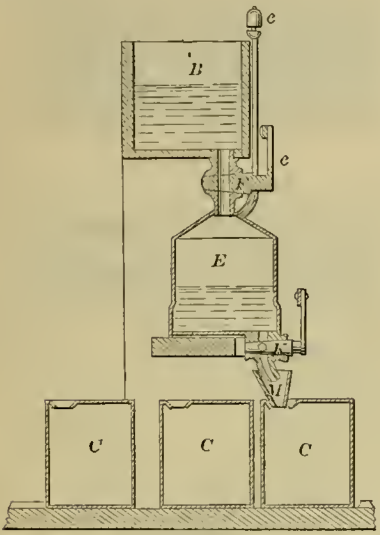
3. (*Mining.*) A stratum or bed of coal.

4. (*Printing.*) *a.* The space in a composing-stick between the end and the slide. The length of a line.

b. The width of a column or of a page of type.

Meas'ur-ing-ap'pa-ra'tus. A device for measuring liquid in transitu. In Fig. 3096 the liquid flows into the measuring-globe, and by the rotation of the faucet is shut off from the induction-pipe and drawn off by the eduction-faucet. The globe is of known capacity, and the successive fillings and emptyings are counted.

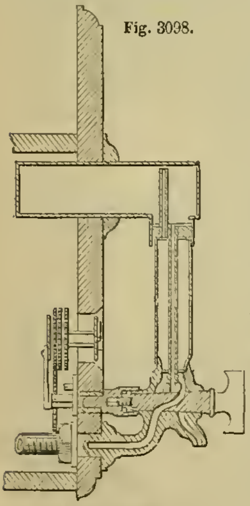
Fig. 3097.



Can-Filler.

Fig. 3097 is a device for filling cans of given capacity. A number of cans, *C C C*, stand in a row, and over each is a chamber *E* which has a measured capacity. The plug-levers *c* of the fill-cocks of the series of measures *E* are connected together so that one movement opens or closes them simultaneously. The discharge-cocks *K* are similarly connected. Whistles connected with the tops of the measures indicate by the passage of air the flow of liquid into the measures. Pivoted funnels *M* gravitate to the mouths of the cans on their presentation.

Fig. 3098.



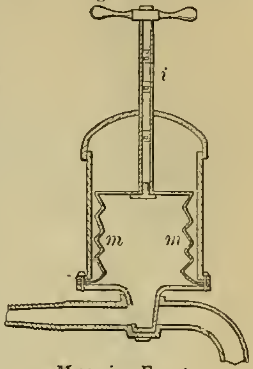
Registering Measuring-Apparatus.

In Fig. 3098 the two-way cock allows the liquor to flow alternately into and from the receiver and connects with a register. The receiver communicates with an air-chamber above it, the compression of the air balancing the weight of liquor and assisting to empty the receiver. A pipe communicates from the air-chamber to the supply-pipe to keep up the equilibrium by discharging any liquor which had entered the air-chamber when the pressure of liquor was at its maximum.

Meas'ur-ing-chain. The SURVEYOR'S-CHAIN (which see).

Meas'ur-ing-fau'cet. A faucet which measures the amount of passing liquid. There are several types. In Fig. 3099, the chamber being in a position to form communication between the vessel to be drawn from and the interior of the flexible tube, the disk is raised so as to draw liquid into said tube, — the discharge end of the faucet being, in the mean time, closed. The chamber is then turned so as to reverse the direction of the tube's communication with the faucet, and, the disk being then depressed, the measured liquid is ejected from the tube through the outer end of the faucet. For drawing off a less quantity than the capacity of the flexible chamber *m m*, the stem *i* is graduated.

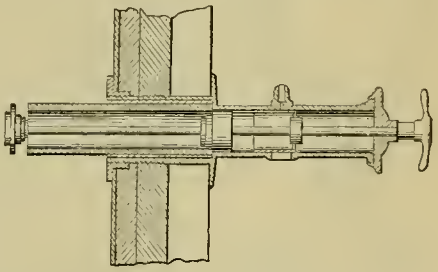
Fig. 3099.



Measuring-Faucet.

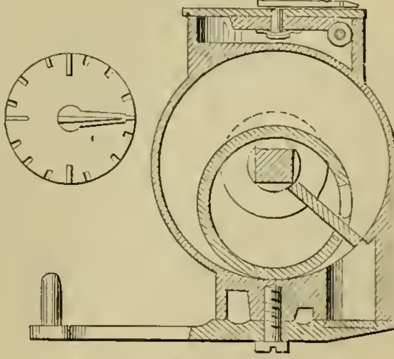
Another variety has a piston working in a glass cylinder of known capacity. The liquid included between the valve and piston is drawn forward to the discharge opening, which is unstopped by the motion of the inner sleeve.

Fig. 3100.



Piston-Faucet.

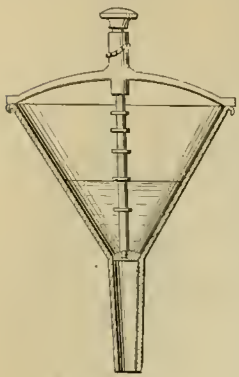
Fig. 3101.



Baker's Measuring-Faucet.

Baker's measuring faucet is on the principle of the rotary pump. An eccentric in the chamber is revolved by a crank, and the sliding piston ejects at each revolution the known contents of the cylinder. A register on top keeps tally of the revolutions.

Fig. 3102.



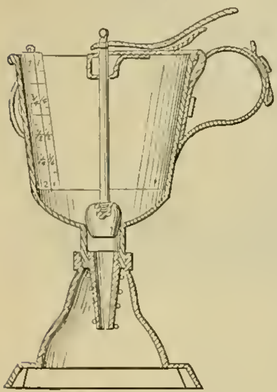
Measuring-Funnel.

In another variety of this type, two cylinders work together, in the manner of Root's blower, projections on one entering cavities in the other, and each being packed against its own portion of the twin cylinder inclosing the two.

Meas′ur-ing-fun′nel. One having graduations to indicate quantity at different degrees of fullness.

Fig. 3102 has a valve-stem, on which, at calculated distances, are small disks indicating the quantity of liquid in the funnel at different levels. To lift or close the valve, the stem is turned by its handle, when a projection from it ascends or descends an inclined slot in the collar ascending from the bar.

Fig. 3103.



Measuring-Funnel.

In Fig. 3103, the scale is marked on a bent strip which clips the side of the vessel. The stem of the valve is guided in a projecting bridge-piece, and the measure stands upon a detachable base.

Meas′ur-ing-ma-chine′. An instrument for ascertaining length, or "end measurement," with great exactness.

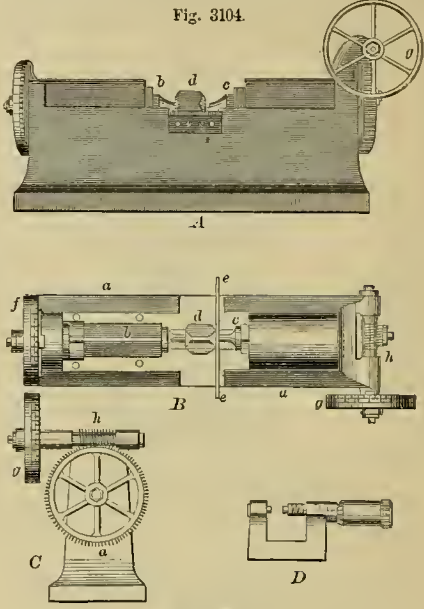
Whitworth's measuring-machine, which can be graduated to the one-millionth part of an inch, is shown in Fig. 3104, at *A B C*.

The solid bed of the machine *a* is carried up at the ends so as to form two head-stocks. A V-shaped groove runs from one of the head-stocks to the other, and in this groove the square bars *b* and *c* are laid, as is also the standard of the bar *d*, of which the length is to be tested. The sides of the groove and of the bars are worked up to as true a plane as possible, and are kept at right angles to each other. The ends of the bars are also made square with their sides and brought to true planes, the ends being turned down to present circular instead of square faces.

Through each head-stock runs an accurately pitched micrometer-screw, by which *b* and *c* are driven along the groove. The screw on the side of *b* has exactly 20 threads to the inch, and is turned by the wheel *f*, the circumference of which is divided into 250 parts. Consequently, by turning the wheel forward one division, the bar is moved one five-thousandth of an inch.

The other screw has a similar thread, is driven by a worm-wheel of 200 teeth, into which gears a tangent screw *h*, having fixed upon its stem the graduated wheel *g*. The circumference of this wheel being also divided into 250 parts, a movement of one division corresponds to a traverse of $\frac{1}{20} \times \frac{1}{200} \times \frac{1}{250}$ = one millionth of an inch on the part of the bar *c*. Fixed pointers enable the exact movement of wheels *f* or *g* to be read off, so that this extremely minute difference in the length of any bars may be detected, provided the micrometer screws exert an equal pressure in every case.

Fig. 3104.

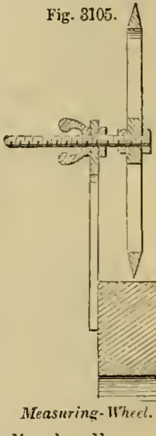


Measuring-Machine.

This equality of pressure is secured by a very simple and beautiful arrangement. Between one extremity of the bar under comparison and the sliding-bar a small steel piece, with true parallel sides, is introduced. This piece is called the *feeler*, and its ends *c e* rest upon two supports on the sides of the bed. When little or no pressure is exerted on the bar *d*, the feeler falls back of its own weight if one of its ends be raised. A very slight pressure prevents this falling back, and the friction between this piece and the ends of the bars becomes a very delicate measure of the pressure to which it is subjected.

D, Fig. 3104, is a pocket-instrument, made to measure to one thousandth of an inch. The screw has 50 threads to an inch, the head having 20 divisions on the circumference. Consequently, a turn of the head through one division advances the screw $\frac{1}{50} \times \frac{1}{20} = \frac{1}{1000}$ of an inch.

Fig. 3105.



Measuring-Wheel.

Meas′ur-ing-pump. One in which the piston operates in a chamber of known capacity, a train of wheels and dial registering the pulsations of the piston.

Meas′ur-ing-tape. A tape divided into inches and fractions, and coiled around an axis in a box; retracted by a spring or winding handle.

Paine's American steel-tape measure is made of a steel ribbon, divided into yards, feet, links, or some other unit of measurement. The metallic ribbon has many advantages over that made of linen, in respect of its not being affected by moisture, or liable to extension of length by tension. Measuring-tapes are frequently accompanied by registering devices, the axis of the tape being connected to a set of gearing and pointers in the manner described under ARITHMOMETER (which see). See Paine's patents of 1860.

Tape-measures are specifically made for surveying, lumber measuring, cloth measuring, etc.

Meas'ur-ing-wheel. 1. One for measuring the circumference of a carriage-wheel, in order to find the length of tire required. *A circumferentor.* The small wheel has a known circumferential measurement, and is divided into inches and fractions. The result is told in numbers of revolutions and fraction of a revolution expressed in inches. In the illustration the wheel has a guide which traverses against the side of the rim and assists in maintaining the measuring-wheel in place. *A circumferentor; a tire-measurer.*

2. An ODOMETER (which see).

Meat-bis'cuit. A portable, concentrated preparation of meat, pounded, dried, mixed with meal, and baked. It was originally introduced by Mr. Gail Borden.

For making meat-biscuits, good beef is selected and boiled by steam until all the nutritive qualities are extracted. The liquor is strained, allowed to settle, and then evaporated by heat to the consistence of thick treacle; the fat is skimmed off as it rises. While the liquor is yet hot, flour is added to it, and both are kneaded up into a stiff dough, which may then be rolled, pressed, made into biscuits, and baked. The biscuits are either kept whole or are ground to powder, and are preserved in air-tight cases. For making into soup, the powdered biscuit is mixed with hot water and boiled, with the addition of salt and other condiments.

The process of Carr and Lucop consists in pulverizing plain biscuit, mixing this powder with the extract of meat, and subjecting the compound to a heavy pressure or stamping it in molds.

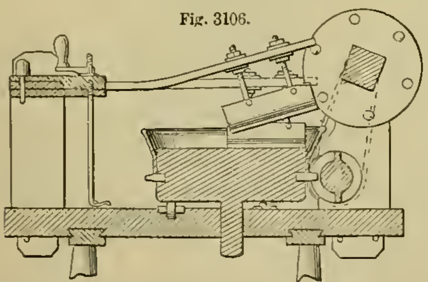
The same method is employed in making biscuit with preserved fruits or any material liable to be injured by the heat of the oven.

Cheese-biscuit are made by inclosing the powdered cheese between two layers of powdered biscuit, and pressing the whole in a mold.

Meat-chop'per. A machine for mincing meat for sausage or for stewing. Among the many varieties may be cited the kind having vertical knives on flexible or weighted stocks. In Fig. 3106, the block rotates by the engagement of its sprockets with the worm on the shaft. The cleavers are attached to spring arms, and the force of the blow is regulated by a nut on the pivoted block, in which their shanks are clamped.

Fig. 3107 has a revolving block, but the knives, instead of snapping, are simply reciprocated in guides by means of pitmans and gearing. The guides are removable to allow the cutter-heads to be inverted, to clean or sharpen the knives, and to remove the chopped meat. The block is vertically adjustable, and receives a rotary motion by means of an endless screw and worm-wheel. See also MEAT-CUTTER; SAUSAGE-MACHINE.

Fig. 3106.



Meat-Chopper.

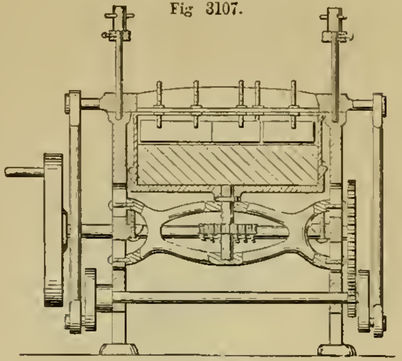
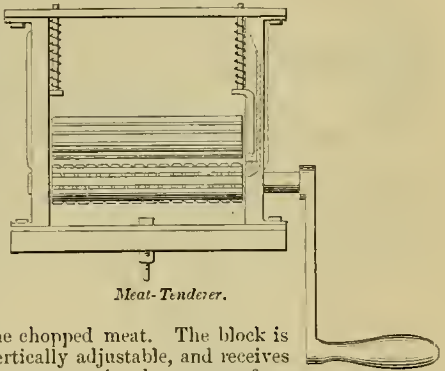


Fig 3107.

Sausage-Machine.

Fig. 3108.

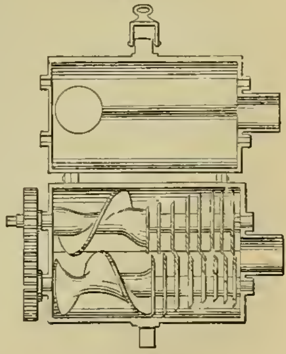


Meat-Tenderer.

Meat-crush'er. A pair of rollers for tendering steak. In the example, one roller has circumferential and the other longitudinal corrugations.

Meat-cut'ter. A machine for mincing flesh. *A sausage-machine.* In Fig. 3109, the two sections of the shell have smooth surfaces and are hinged together. The cutters are interchangeable, and are placed in spiral relation upon the shaft, and with intervening washers, which regulate their distance apart. The worm on the shaft forces the meat between the knives, which make a shear-cut against each other, and so to the exit.

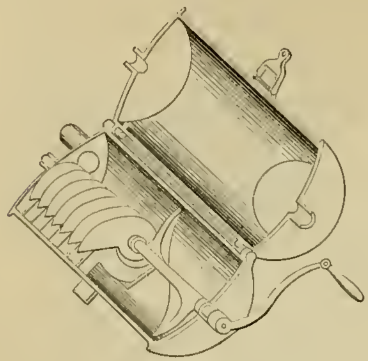
Fig. 3109.



Sausage-Machine.

In Fig. 3110 there is but a single system of moving cutters, which pass between knives attached to the shell, while the meat is forced forward by the screw, as in the former case.

Fig. 3110.

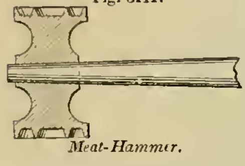


Meat-Cutter.

Meat-ham′mer. A maul with a notched or ridged face, to pound meat and render it more tender, as in the example, where the hammer-face has angular projections.

Meat-hook. One in a larder or on a butcher's stall, to hang joints of meat.

Fig. 3111.

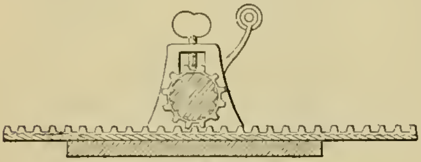


Meat-Hammer.

Meat-knife. One the haft of whose blade passes through the handle, which consists of two pieces known as *scales* and secured by rivets.

Meat-man′gler. A device for tendering steak.

Fig. 3112.



Meat-Mangler.

The roller has a roughened surface counterpart to that of the bed to which it communicates motion.

Meat, Pres′er-va′tion of. Mechanical or chemical appliances to prevent decay of animal food have been in use from the earliest ages. Freezing, salting, and drying meat for future use are older than history.

Freezing is perhaps the simplest and quickest mode of preservation, and answers well in cold climates. Attempts have been made to freeze meat by artificial means in countries where live stock is plenty, as in Australia and Texas, and transport it in a frozen state to market. Several hundred tons of beef were packed in a refrigerating ship in Australia, but the attempt to transport it to England failed because of the exhaustion of the supply of ice.

Dried meat is usually prepared by cutting in thin strips and hanging in the sun. The American Indians pound their meat in wooden mortars until it forms a paste, which is mixed with fat and dried in blocks. It is then called *pemmican*, is quite nutritious, and is used in large quantities by Arctic voyagers.

Artificially dried meat is usually more or less smoked in preservation. The pyroligneous acid and creosote contained in peat or wood smoke coagulates albumen, with which it comes in contact. So-called *smoked-meat* generally owes its preservation to the salt with which it is saturated, the creosote only penetrating a short distance.

Meat is salted either in a pickle or brine, or dry-salted, which latter way is more expensive, but retains more of the nutritive qualities of the meat.

A mode of salting by wholesale is by an injection of brine and saltpeter into the heart of the animal immediately after it is killed. The brine penetrates the whole vascular system, expelling the blood, and flows from the right ventricle in a clear stream.

The first attempt to preserve meat by canning in air-tight vessels was made by M. Appert, at Paris, 1810. His process consisted in partly cooking the meat, placing it in a glass vessel in a bath of chloride of calcium, and then hermetically sealing it.

The modern process of putting up "preserved meats" is substantially as follows: —

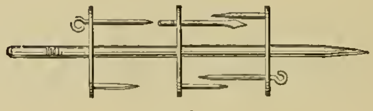
The meat is placed in the can, which is then filled up with soup. A cover pierced with a small hole is then soldered on. The can is placed in a bath of a solution of chloride of calcium, which boils at about 320° Fah. When the generated steam has expelled the air, a drop of solder closes the hole. When the can cools, the pressure of the air resulting from the condensation of steam bends in the heads, which become concave. The cans are then placed in a proof-chamber, and exposed to a tropical heat of say 120° Fah., as high as they will be apt to encounter. Taint in the meat, or imperfect closure, manifests itself by the bulging out of the heads.

Meat-saw. A saw with a thin blade strained in an iron frame and used by butchers.

Meat-screen. A metallic screen placed behind roasting meat to reflect back the heat of the fire.

Meat-spit. One for holding a roasting joint while turning in front of the fire. In the example, the spit has sliding skewer plates which have fixed and removable skewers. The spit is oblong in section, to prevent the skewer plates from turning thereon.

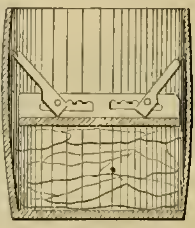
Fig. 3113.



Spit.

Meat-tub. One for holding pickled meat. The example has a follower to keep the pieces below the surface of the brine. The cover lies upon the meat in the barrel, and is kept down by the engagement of the points of the pivoted arms with the inside of the barrel.

Fig. 3114.

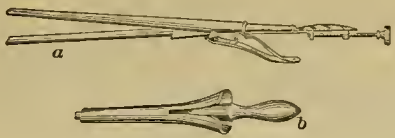


Meat-Tub.

Me-a′tus-knife. A small knife with a triangular concealed blade in a long thin shaft; used in operations in the meatus auditorius, such as obliterating strictures, opening pustules, scarifying, removing polypi, etc.

a, meatus-knife. *b*, meatus-cope.

Fig. 3115.



Meatus-Knife and Meatuscope.

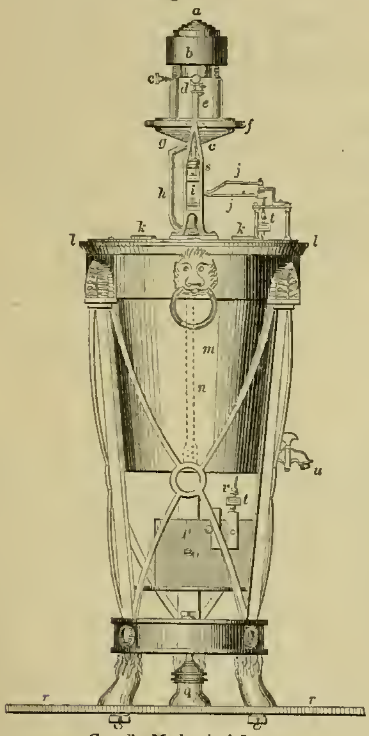
Me-a'tus-cope. A urethra speculum.

Me-chan'i-cal Broom. A sweeping-machine, usually propelled by horses, and having revolving brooms actuated by the supporting wheels, and delivering the dust and mud into the box of the wagon. See STREET-SWEEPING MACHINE.

Me-chan'i-cal Lamp. Another name for Carcel's clock-work lamp, in which the oil is pumped from a lower reservoir to the wick-tube by means of clock-work, so as to furnish a supply exceeding that consumed by the wick, the surplus flowing back outside of the burner. The object is to afford equal and ample supply of oil to the flame.

A spiral spring and piston in the reservoir have been used as a substitute for the clock-work pump, which is objectionable on account of its expensiveness for domestic uses, but is valuable in important situations, such as lighthouses.

Fig. 3116.



Carcel's Mechanical Lamp

James Watt, in a letter to Argand, August 8, 1787, gave sketches of proposed lamps with oil-pumps worked by clock-work. See "Engineer," Vol. I. p. 37.

Fig. 3116 represents a mechanical lamp adapted for dioptric lights of the first order.

a, wick-holder.
b, glass-holder.
c, screw to rack for raising wick.
d, rack for raising wick.
e, pipe supplying oil to wick.
f, collar supporting burners.
g, drip-cup.
h, return-pipe for overflowing oil.
i, valve-box.
j, crank-rods for working leathern valves
k, hinge of lid.
l, lid of cistern.
m, oil-cistern.
n, suction-pipe
o, winding-arbor for clock-work.
p, box for clock-work
q, screw for adjusting level of burner
r, service-table.
s, coupling-screw for oil-tube.
t, universal joints for connecting-rod.
u, cock for emptying cistern.
v, connecting-rod for cranks.

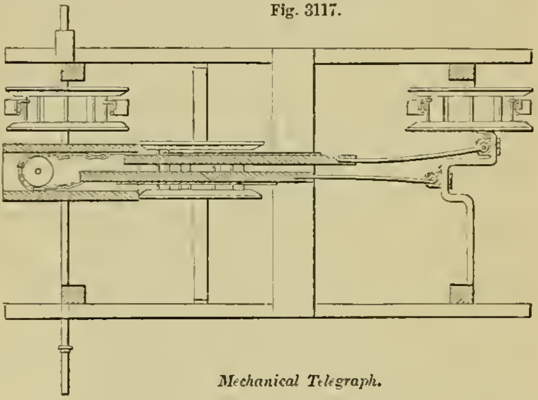
Me-chan'i-cal Leech. See LEECH, ARTIFICIAL.

Me-chan'i-cal Pi'geon. A flying object forming a substitute for a pigeon in shooting-matches. See PIGEON.

Me-chan'i-cal Tel'e-graph. Another name for the automatic telegraph, in which a message represented by a series or succession of dots is passed beneath a key or stylus, so as to make and break the circuit by simply mechanically passing through.

In another apparatus of local use perhaps, but not susceptible of application to distant points, the apparatus has bell-cranks which stand at angles of 120° with each other; the crank of the shaft at one station is connected by rods with that of the other. Endless chains with lettered links pass around the wheels, correspondence being maintained between the two; one being actuated by an operator to bring given letters in series to a fixed point, the corresponding letters are brought by synchronous action to analogous position on the other to be viewed by the observer at that point.

Fig. 3117.



Mechanical Telegraph.

Me-chan'o-graph. One of a set of multiplied copies of an original, executed by means of a machine.

Mèche. (*Surgical.*) A bunch or pledget of charpie, cotton, or raw silk, for keeping open an ulcer or wound. Applied by an instrument known as a *porte-mèche.*

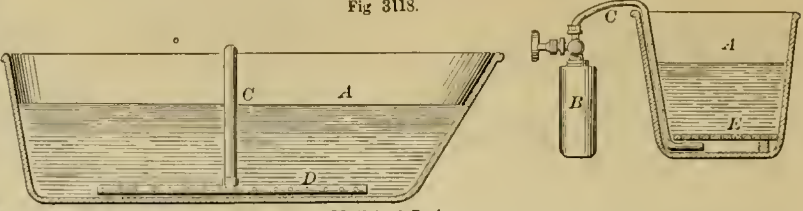
Mech'lin-lace. (*Fabric.*) A light Belgian lace with an hexagonal mesh; made of three flax threads, twisted and plaited to a perpendicular line, the pattern being worked in the net, and the plait-thread surrounding the flowers.

Me-com'e-ter. (*Surgical.*) A graduated instrument used at the Hospice de Maternité in Paris, to measure new-born infants.

Med'al. An ancient or a memorial coin.

Me-dal'lic En-grav'ing. In this beautiful art the direction and distance of the lines are so modified as to give the appearance of a figure or object in relief. It is executed by machinery. The machines of M. Collas and Mr. Bate, as well as those of Asa

Fig 3118.



Medicinal Bath.

Spencer, Mr. Froude, and Mr. Saxon, are all improvements upon an apparatus described in a French work, the "Manuel de Tourneur," about 1814. This machine will give a good general idea of the construction of these machines, and its operation is as follows: —

The medal and the copper on which the medal is to be engraved are fixed on two sliding plates at right angles to each other, and so connected that when the plate on which the metal is fixed is raised vertically by a screw, the side holding the copper plate is advanced by an equal quantity in the horizontal direction. The medal is fixed on the vertical slide, with its face toward the copper plate and a little above it. A bar, terminating at one end in a tracing-point and at the other in a short arm at right angles with the bar, and holding a diamond-point, is placed horizontally above the copper, so that the tracing-point shall touch the medal to which the bar is perpendicular, and the diamond-point shall touch the copper plate to which the arm is perpendicular. Under this arrangement, the bar being supposed to move parallel to itself, and consequently to the copper, if the tracing-point pass over a flat part of the medal, the diamond-point will draw a straight line of equal length upon the copper; but if the tracing-point pass over any projecting part of the medal, the deviation from the straight line by the diamond-point will be exactly equal to the elevation of the corresponding point of the medal above the rest of the surface. Thus, by the transit of this tracing-point over any line upon the medal, the diamond will draw upon the copper a section of the medal through the line. A screw is attached to the apparatus, so that if the medal be raised a very small quantity by the screw, the copper plate will be advanced by the same quantity, and thus a new line of section may be drawn. By continuing this process, the series of sectional lines upon the copper produces the representation of the medal on a plane, the outline and the form of the figure arising from the sinuosities of the lines and from their greater or less proximity.

Me-dal′lion. 1. A large medal.

2. A carved, molded, cast, or stamped circular ornamental work.

Med′al-ma-chine′. A machine for making copies of medals and raised or sunk works on a scale larger or smaller than the original. It comprises adjustable frames on the pantograph principle for carrying tracers which pass over the face of the original, and mandrels in which the various cutters for producing the copy are inserted. It operates upon the CARVING-MACHINE (which see).

Med′i-cat-or. (*Surgical.*) A spoon, syringe, or insufflator, for directing a medicament into or upon a deeply seated part.

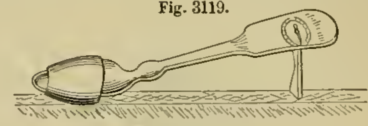
Me-dic′i-nal Cup. One for the administration of medicine to persons prostrated by sickness or injury. Some such cups have graduations to indicate quantity; or a tubular handle through which the liquid may be conducted to the mouth without spilling; or the lip of the cup has a little hood which constitutes an aperture through which the liquid is poured. Another cup resembles a pipette, discharging at the lower opening when the finger is temporarily withdrawn from the orifice in the upper end.

A medicinal cup of a former age was of antimony, rendering emetic a dose of wine allowed to stand therein.

Me-dic′i-nal Bath. In the apparatus, Fig. 3118, the medicinal vapors are forced, by their own pressure or otherwise, from the reservoir *B* through the pipe *C*, and, entering the bath-tub *A* beneath the perforated false bottom *E*, through the longitudinal perforated pipe *D*, pass upward in bubbles.

Med′i-cine-spoon. A spoon for the administration of medicines. As in the example, it may consist of a common teaspoon, provided with an adjustable lid which covers the bowl, leaving a small aperture at the tip, whereby the contents escape when the spoon is introduced into the mouth. The spoon is filled at the aperture near the handle.

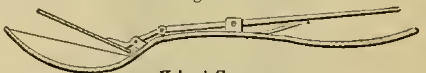
Fig. 3119.



Medicinal Spoon.

In another form the cover is connected to a compound lever, which is influenced by a spring to close it. The cover is depressed by the lever. A portion at the point of the spoon is left uncovered to allow the exit of the medicine.

Fig. 3120.



Valved Spoon.

Me′di-um. A size of drawing and writing paper between demy and royal, measuring 22¼ × 17¼ inches, and weighing 20 to 34 pounds to the ream.

Of printing-paper, 19 × 24 inches.

Med′ley. (*Fabric.*) Cloth woven from wool dyed of various colors and spun. Technically, blue and black are excluded. First made in 1614.

Meer′schaum. Meerschaum (foam of the sea), a superior species of white clay, chiefly consisting of silicate of magnesia, and dug mostly in the peninsula of Natoli, Asia Minor. It is sent to market in irregular blocks of different sizes, the latter fixing the price, which is much higher in proportion for large lumps than for small ones. The Turkish government owns the mine and stipulates the quotations according to the demand, which generally exceeds the supply.

In manufacturing pipes, the lumps are cut into shape with a knife, after having been lightly wetted; the bowls are then carefully rubbed to obtain a clear, smooth surface, and afterward boiled either in pure wax, or wax, oil, and fats, the latter effecting a yellow hue, and facilitating the coloring.

Meet'ing-post. (*Hydraulic Engineering.*) That stile of a canal-lock gate which meets the corresponding stile of the other gate at the midwidth of the bay. See LOCK-GATE.

Me-gal-eth'o-scope. An improved form of stereoscope invented by Ponti, in which the photograph is considerably magnified and an increased appearance of sphericity obtained.

It is so arranged that the object may be viewed by direct or reflected sunlight, or by artificial light. — Prac. Mech. Jour., 3d series, Vol. III. p. 111.

Me-gam'e-ter. 1. An instrument for determining the longitude by observation of the stars.

2. A micrometer.

Meg'a-scope. (*Optics.*) 1. A solar microscope in which the objects are opaque and illuminated in front by reflecting mirrors.

2. An optical instrument for exhibiting an object on a large scale.

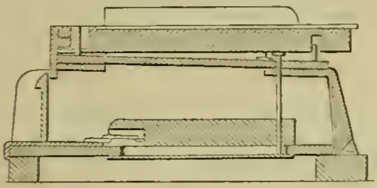
Me-gass'. Refuse sugar-cane from which the juice has been expressed. See BAGASSE.

Meir. (Eng. *local.*) Thirty-two yards of ground in a vein of ore.

Me-lan'o-type. (*Photography.*) Sometimes written *melainotype.* A process which takes its name from the *black* ground of varnished sheet-iron supporting the collodion which receives the picture. Also called FERROTYPE (which see).

Me-lo'de-on. (*Music.*) A wind-instrument with a row of reeds and operated by keys. The instrument has a bellows which formerly blew air through the reeds; but Carhart in 1846 patented the feature of drawing air through the reeds by suction bellows: he also invented machines to make, rivet, and plane the reeds; also the *tube board* to hold the reeds, a machine to rivet the reeds to the blocks, and one for cutting the cells in the reed-board. Pressure on the key drives down the pin and the valve, allowing passage to the air. The principle is the same as the accordeon. *Flutina, parlor-organ, harmonium, seraphine,* are all names of instruments of this kind.

Fig. 3121.



Melodeon.

Mel'o-type. (*Photography.*) A process in photography in which a dark chamber is not used, and the pictures are developed at a subsequent convenient time.

Melt'ing-fur'nace. A foundry cupola, or a glassmaker's furnace.

Melt'ing-point. That point of the thermometer at which a substance becomes fused. See FUSING-POINT; THERMOMETER. See also p. 1422.

Mel'ton. (*Fabric.*) A kind of broadcloth for coating.

Me-nis'cus. A lens convex on one side and concave on the other. See LENS.

The concave side has a curve of greater radius than the convex side, and the lens is thicker in the middle than elsewhere.

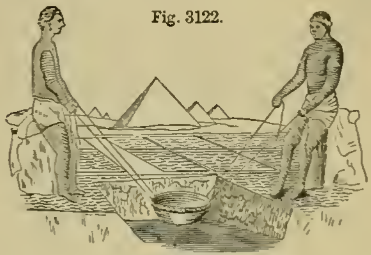
In this respect the meniscus differs from the *concavo-convex lens,* whose convex face has a curve of greater radius.

Men's Har'ness. An arrangement by which men are attached to a gun-carriage which is to be moved but a short distance or where animal power cannot be employed. It consists of a rope 18 feet long and 4 inches in circumference, having a thimble at one end and a thimble and hook at the other. Ten leather loops are fixed in pairs to the rope, 5 on each side. These are of sufficient size to allow a man to pass his body through them, the strain of the draft coming on his chest.

Men'stru-um. A solvent, such as water, alcohol, ether, acids, oils, etc.

Men'tal. A basket made water-tight, and having four ropes attached, by which two men dip water from a stream or cistern and discharge it into a trench for irrigation.

Fig. 3122.



Mental.

Mer-ca'tor-chart. A mode of projection invented by Gerald Mercator, in which the meridians and parallels are straight and parallel lines. The meridians are equidistant, but the distance between the parallels increases from the equator towards either pole. See CHART; MAP.

Mer'chant-i'ron. Bar-iron.

Mer'chant-rolls. Finishing rolls of a rolling-mill.

Mer'chant-train. A train of rolls with grooves of varying sizes and shapes, which reduce the reheated *puddle-bars* to bar-iron of merchantable form.

Mer-cu'ri-al Bath. Used in the pneumatic trough in collecting such gases as are largely absorbed by water.

Mer-cu'ri-al Gage. The pressure-gage in which the steam acts upon a body of mercury and raises a column in a glass tube.

Mer-cu'ri-al Horn-ore. Horn quicksilver.

Mer-cu'ri-al Lev'el. A form of level in which mercury is used.

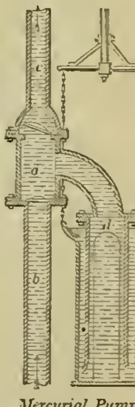
Mer-cu'ri-al Pen'du-lum. A compensation pendulum invented by Graham of London, 1700.

A jar of mercury is used for the *bob* or weight. As the pendulum expands the mercury rises, and by the rise of its center of gravity compensates for the other inequality. See PENDULUM.

Mer-cu'ri-al Pump. A pump invented by Haskins in 1720, in which a column of mercury acts as plunger and piston packing.

Fig. 3123 shows a pump of this form. *a* is the chamber of the pump, with a valve at each end opening upwardly. *b* is the suction-pipe, and *c* the outlet. A bent tube connects chamber *a* with cylinder *d*, open at bottom and surrounded by a large cylinder or cup

Fig. 3123.



Mercurial Pump.

c filled with mercury, or with a wooden core to save a portion of the mercury, as in the illustration.

If now the cup *c* be lowered, the tendency will be to produce a vacuum in chamber *a*, which will be immediately filled with water from the inlet pipe. By raising cup *e* the water will be expelled through *c*.

Mer-cu′ri-al Ther-mom′e-ter. A thermometer tube filled with mercury, in contradistinction to a spirit, air, or metallic thermometer.

Mer′cu-ry. Equivalent, 100 ; symbol, *Hg.*; specific gravity, 13.59 ; fusing-point, – 39° Fah. Fluid at ordinary temperatures.

Occurs principally as a sulphide (*cinnabar*). It is a brilliant, silver-white, heavy metal. Distills at 662° Fah.

It is used in medicine associated with chalk (*blue pill*) and lard (*mercurial ointment*).

The chloride is corrosive sublimate, used in the Kyan wood-preserving process ; and the sub-chloride is calomel.

The metal is used in philosophical instruments, — barometers, thermometers, etc.

An alloy of mercury with another metal is called an Amalgam (which see).

Mercury is used to extract gold or silver from the earthy and baser metallic constituents of these ores ; amalgamating with the gold and silver when brought into contact therewith. See Amalgamator ; Silver-mill, etc.

An amalgam of tin, 4, mercury, 1, is used to *silver* looking-glasses.

Many metals amalgamate with mercury, and others do not.

Added to certain fusible alloys it reduces their point of fusion below the heat of boiling water. See Alloy, p. 62.

The ore of mercury — chiefly cinnabar, the sulphide of mercury — is broken, sifted, and crushed. It is then heated in a furnace with lime, iron, or some other agent which combines with the sulphur.

The mercury is vaporized, passes off, and is condensed into a metallic form. It is purified by filtration and stored in iron bottles.

Quicksilver has been mined from time immemorial in Spain at Almaden in the province of La Mancha. "Dioscorides separated mercury from cinnabar." (Humboldt.) Pliny states that 700,000 pounds (of cinnabar?) were received yearly from that source, and that the Greeks received it from thence 800 years previously to the date at which he wrote (A. D. 70). (See Amalgam.) It is now mined extensively at Idria, in the Schiefergebirge, and is found in Hungary, many parts of Germany, in China, Japan, Mexico, Honduras, Columbia, Peru, and California.

The modes of obtaining mercury by the decomposition and distillation of cinnabar have been very imperfect and wasteful; and even at this day, with all the advantages of skill and capital, the actual product is but a small proportion of the amount obtained by a careful analysis. It is understood that in Europe the ores are heated upon open arches and the vapors condensed within brick chambers.

For detailed description of the process and apparatus, we must refer the reader to Ure's Dictionary and chemical treatises, as the subject is not so clearly within the scope of this work that it can be treated at any length.

The extensive quicksilver mine of New Almaden is twelve miles from San José in California, and has had the benefit of energy, skill, and capital in its development. A good description of the place and the works was written in 1857, and given in Harper's "Magazine," June, 1863. Changes may have since taken place. The mode of mining and breaking into pieces suitable for the furnace has nothing peculiar to offer, but the condensing-furnaces are worthy of notice. They are sixteen in number, arranged side by side, and extend a distance of several hundred feet beneath a spacious roof. They stand 8 feet apart, are 40 feet in length, 10 in hight, and 8 in breadth. The ore is cleaned, broken, and dumped into the receiving-chamber, which is next to the furnace, and holds 7 tons of ore. The cover being luted on, the sublimated vapors pass by a circuitous route through 12 chambers successively, the connecting apertures being alternately at the tops and bottoms of the division walls. The mercury condensed in each chamber passes through small holes in the side to a covered trough on the outside, which conducts it to a reservoir, whence it is dipped into iron flasks which receive a charge of 75 pounds, and are then closed by a screw cap. While passing from the last of the twelve to the stack, the vapor is brought into contact with a pan of water, which still farther condenses escaping fumes.

Mer′cu-ry-fur′nace. A furnace in which cinnabar is treated for the production of mercury.

The localities yielding the sulphide of mercury are not numerous. The Almaden mines of Spain were known to the Greeks 700 B. C., and were celebrated in the time of Pliny. The mines of Idria, the Palatinate, and of New Almaden in California, are extensive and rich. The ore is also found in Peru, China, Hungary, Sweden, Japan, and Chili.

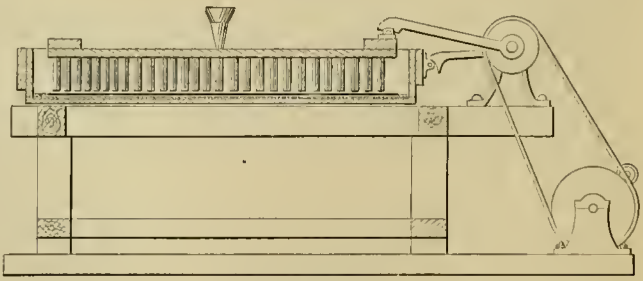
In the furnace the ore is subjected to distillation in retorts which lead to condensing-chambers, or the blocks of ore are roasted in a furnace, the whole volatile results of the furnace passing with the metalliferous fumes to a series of condensing-chambers. See Condenser. See previous article.

The latter is the plan adopted at Idria in Austria, the former in Bavaria and California. Dr. Ure's retort-furnace, erected at Landsberg in Bavaria, resembles the apparatus for the distillation of coal-gas.

In Spain, the old Buytrone or Aludel furnace is still adhered to. See Aludel.

Mer′cu-ry-gath′er-er. (*Metallurgy.*) A stirring apparatus in which *floured* quicksilver, which has been rendered what is technically known as *sick*, is gathered together. See Amalgam.

Fig. 3124.



Quicksilver-Gatherer.

Mercury which is *floured* is in a sort of powdery condition, the particles being coated with sulphur from the pyrites or from other cause ; and the object of the mechanical agitation and rubbing, in the mercury-gatherer, is to cause the globules of mercury to coalesce and resume the fluid condition.

Me-rid'i-an. A great circle supposed to pass through both poles, and the zenith and nadir of a given place.

Me-rid'i-an-cir'cle. 1. A transit instrument with a graduated circle securely fastened at right angles to the horizontal axis and turning with it.

The meridian circle in the National Observatory of Washington was made by Ertel and Son, of Munich. Its object-glass has an aperture of 4½ inches, with a focal distance of 58 inches. This instrument is provided with a circle 30 inches in diameter, divided into arcs of 3′, and reads by four micrometers to single seconds.

2. The altitude circle of a globe.

Me-ri'no. (*Fabric.*) A fine, French, woolen goods, so named as being made of the wool of the merino sheep. It is a lady's dress goods, all wool, and twilled on both sides.

The Merino variety of sheep is a native of Spain, which country was celebrated for its wool in the time of Pliny.

The greater number of the sheep of Spain belong to the *mesta*, or merino corporation, which has about 5,000,000 sheep in flocks of 10,000 each. Each flock has an officer, 50 shepherds, and 50 dogs.

In summer, the sheep feed upon the elevated lands of Biscay, Navarre, and Arragon, and toward winter are driven southward to the fertile plains of New Castile, Andalusia, and Estramadura. The lambs come in January, and shearing commences the 1st of May, being carried on in houses where the flocks of sheep are folded on their northern march. 125 men shear 1,000 ewes per day, 50 weathers per man being considered a day's work. The ewes yield from 4 to 5 pounds of wool, the weathers from 7 to 8. The wool of each sheep is sorted into four varieties.

The carcass is but little esteemed.

The institution of the *mesta* dates from the time of the plague in 1350, when whole provinces were nearly depopulated and vast estates became ownerless. The proprietors of neighboring estates combined to throw the unoccupied tracts into a common pasture on which they herded sheep according to an agreed ratio.

Free passage is allowed to the flocks through the cultivated territories, and great hardship results. The power of this tyrannical corporation was somewhat reduced by the French, during their temporary occupancy of the country, 1808 – 12; a better legacy than any left by the succeeding English occupation, which was all in the interest of aristocracy and monopoly.

The merinos are now kept in immense numbers in Australia and Van Dieman's Land.

Turdetania, the country of the Guadalquiver, was famous for the quality of its wool in the time of Strabo, about the Christian era. A buck of fine quality was worth a talent (? Attic), equal to 1,180 dollars.

They were introduced into England in 1788.

Mer'kin. A mop for cleaning cannon.

Mer'lon. (*Fortification.*) The solid part of an embattled parapet, between two embrasures.

Mesh. 1. (*Gearing.*) Or *mash.* The engagement of the teeth of wheels with each other or with an adjacent object, as the rack, in a rack and pinion movement.

2. (*Netting.*) The loop made over a stick and engaging the loop in its vicinity.

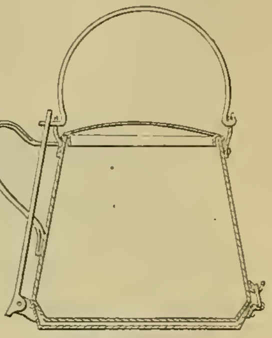
Mesh-stick. (*Netting.*) A flat slat with rounded ends, used to form the mesh of nets, the loops being made over it and knotted on its edge.

Mes'sen-ger. (*Nautical.*) A rope passing from the capstan to the cable to which it is fastened by nippers. The winding of the messenger on the capstan hauls in the cable and the nippers are successively taken off that part of the cable that is approaching the capstan, and put upon that part which has just come inboard, through the *hawse*-hole.

Mess-kit. That portion of camp equipage consisting of cooking-utensils.

In the example, a frying-pan or griddle is conveniently attached to the bottom of the coffee-pot, by passing the handle of the pan up through a hole made in the handle of the coffee-pot, and then catching it by passing the end of the bail through a hole in its upper end, for convenience of transportation.

Fig. 3125.



Mess-Kit.

Met'a-car'pal Saw. (*Surgical Instruments.*) A narrow-bladed saw, about six inches long, used for dividing the bones of the fingers or middle hand or of the foot in amputation. In former times they were made with small bows: they are now straight, stiff-bladed, ground thinner on the back, to make them follow the cut easily; or thin-bladed with a stiffening *back*, which, after having cut to the depth of the blade, can be raised, when the blade will follow in the cut. See p. 92.

Met'al. 1. An elementary mineral substance possessing certain attributes, particularly the luster called metallic, by which it is distinguished from other inorganic productions. With few exceptions, metals possess considerable specific gravity, hardness, and cohesion, and require a high degree of heat to liquefy them. One, mercury, is liquid at ordinary temperatures, and a very few, as sodium and potassium, are lighter than water, which they decompose with such energy as to produce combustion.

The properties and qualities of metals by which distinctive descriptions are drawn are, —

Specific gravity, chemical equivalents, fusibility, hardness, brittleness, malleability, ductility, tenacity, elasticity, opacity of surface, sonorousness, color, lustrousness, odor, taste, dilatation by heat, specific heat, conductivity of heat, and also of electricity, magnetic or diamagnetic character.

The metals constitute about five sixths of the elementary bodies known to exist. They are distinguished by a peculiar luster, by their opacity, their power of conducting heat and electricity, and generally by a specific gravity considerably exceeding that of water.

Metals have been divided into five classes, principally depending upon their affinity for oxygen and the nature of the compounds formed by the union.

2. (*Civil Engineering.*) *a.* Broken stone for roads, according to the McAdam principle.

McAdam laid at most 10 inches of *metal* on a surface prepared by leveling and sloping.

Telford laid as a bottoming a compact layer 7 inches thick of pieces from 4 to 7 inches in dimension. Over this he spread the *metal*, which was made of a size to go through a ring 2½ inches in diameter.

METAL.	Symbol.	Equivalent (old system).	Atomic Weight (new system).	Specific Gravity.	Fusing - Point, — Degrees Fah.	Specific Heat.	Linear Expansion in being raised from 32° to 212° Fah.	Magnetic or Dia-magnetic.	Order: Mag. or Diamag.	Order of Malleability.	Order of Ductility.	Tenacity, — Wire one tenth Inch Diameter sustains Pounds.	Conductivity,* Silver being 100. For Heat.	Conductivity,* Silver being 100. For Electricity.	Discoverer.	Date.	Derivation of Name.
Aluminium, cast .. Aluminium, rolled.	Al.	13.7	27.49	2.56 2.67	1,562	.2143				7	10		66		Wöhler......	1827	Lat., *Alumina* (alum).
Antimony...........	Sb.	122	122	6.71	797	0508	$\frac{1}{923}$	Diamg.	2				21	5	Valentine...	1450	Arabic, *Al-ithmidun*.
Arsenic.............	As	75	75	5.8		.0814		Diamg	12					5	Schroeder...		Gr. *Arsenikon* (potent).
Barium..............	Ba.	68.5	136.84		887										Davy........	1808	Gr. *Baros* (heavy).
Bismuth............	Bi.	212	210.34	9.823	500	.0308	$\frac{1}{719}$	Diamg.	1				6	1	Agricola.....	1529	Ger. *Wisemat*.
Cadmium............	Cd.	56	112.12	8.655	617	.0567		Diamg.	5	11	7		58	24	Stromeyer ..	1818	Gr. *Cadmia* (calamine).
Calcium.............	Ca.	20	40.21	1.578											Davy	1808	Lat. *Calx* (lime).
Chromium...........	Cr.	26 7	52.5	6.81	3,992			Mag.	5						Vauquelin ..	1797	Gr. *Chroma* (color).
Cobalt..............	Co.	29.5	58.8	8.95	3,272	.1069		Mag.	3	13	8			17	Brandt	1733	Ger. *Kobold* (a goblin).
Copper..............	Cu.	31 7	63.49	8.95	1,742	.0950	$\frac{1}{582}$	Diamg	10	3	5	600	84	99			Lat. *Cyprium* (Cyprus).
Gold	Au	98	196 66	19.34	2.282	.0324	$\frac{1}{661}$	Diamg.	11	1	1	200	98	78			Hebrew.
Iridium.............	Ir.	99	197.1	21.15	3,932	.0326		Diamg.	15						Tennant. ...	1804	Lat. *Iris* (the rainbow).
Iron.................	Fe.	28	56.08	7.844	2,912	.1138	$\frac{1}{812}$	Mag.	1	6	4	570 - 720	44	17			
Lead.................	Pb.	103.5	206.91	11.36	617	.0314	$\frac{1}{351}$	Diamg.	8	10	13	18	29	8			
Lithium	Li.	6.9	7.02	0 593	374	.9408					16			19	Arfwedson...	1817	Gr. *Lithos* (a stone)
Magnesium..........	Mg.	12.2	24.6	1.743	1,382						15				Davy	1807	Magnesia in Asia Minor.
Manganese..........	Mn.	27.6	55.7	8.013	3,452	.01217		Mag.	4						Gahn.......	1740	Magnesia in Asia Minor.
Mercury	Hg.	100	200	13.596	— 40	0318		Diamg.	7					2			The deity and planet.
Molybdenum........	Mo.	46	96	8.62	3,632	0722									Hjelm	1782	Gr. *Molybdos* (lead).
Nickel	Ni.	29 6	58.8	8.82	2,912	.1086		Mag.	2	12	9			13	Cronstedt...	1751	Ger. *Kupfernickel*.
Osmium..............	Os.	99.6	198.8	21 4	3.992	.0306		Mag.	10						Tennant	1804	Gr. *Osmi* (odor).
Palladium...........	Pd.	53.3	106.47	11.8	3,632	.0593	$\frac{1}{1000}$	Mag.	8	5	6	280		18	Wollaston ..	1803	The goddess and asteroid Pallas.
Platinum............	Pt.	98.7	197.1	21.5	3,992	.0324	$\frac{1}{1131}$	Mag.	9	4	3	560	38	18			Sp. dim. of *Plata* (silver).
Potassium	K.	39.2	39.13	0.865	131	.1695									Davy	1807	Eng. *Potash*.
Rhodium	Ro.	52.2	104.3	12.1	4,352	.0580		Diamg.	14						Wollaston ..	1804	Gr. *Rhodon* (a rose).
Silver	Ag.	108	107.93	10.53	1,832	.0570	$\frac{1}{524}$	Diamg.	9	2	2	400	100	100			
Sodium..............	Na	23	23.04	0.972	194	.2934		Diamg	6				36		Davy	1807	Lat. *Salsola* (soda).
Strontium	Sr.	44	87.25	2.54										7	Davy	1808	Strontian in Scotland.
Tellurium...........	Te.	64	128.3	6.25	752										Müller......	1782	Gr. *Tellus* (the earth).
Tin..................	Sn.	59	118	7.294	428	.0562	$\frac{1}{516}$	Diamg	4	8	12	48	42	12			
Tungsten	W.	94	184	17.6	4,352	.0334		Diamg.	16						De Luyart...	1786	Sw. *Tungsten* (a heavy mineral)
Uranium.............	U.	60	120	18.4	3,632			Diamg.	13						Klaproth ...	1789	The deity and planet Uranus.
Zinc.................	Zn.	32.5	65.04	7.146	707	.0955	$\frac{1}{340}$	Diamg.	3	9	11	75	64	29	Paracelsus...	1541	

This list does not include a number of rare metals which are not known out of the laboratory, and have no importance as yet in the arts.
The data, with the exception of the equivalents (old system), fusing-points, and tensile strength are derived, with few exceptions, from Miller's Chemistry.
The conductivity for heat is that given by Calvert and Johnson. The results obtained by Wiedemann and Franz differ widely from these.
For electric conductivity, Mathiesson's results, which differ from those of Becquerel, are employed.
The fusing-points are those given by Professor P. H. Van der Weyde.

* Heat-conducting power of marble............	2.34
Heat-conducting power of porcelain	1.22
Heat-conducting power of brick earth........	1.13

b. Broken stone around and beneath the wooden ties of a railway.

3. (*Glass.*) The technical name for the molten glass in order for blowing or casting.

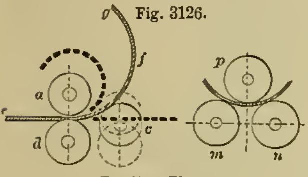
4. The effective power of the guns of a vessel expressed in the sum of the weights of the solid shot.

5. (*Founding.*) The workman's term for cast-iron.

Met′al-bend′ing Ma-chine′. Sheet-metal, such as tin-plate or boiler-iron, is bent into the cylindrical form by passing between rollers.

For the smaller descriptions of work the machine consists of two cylindrical rollers, *a* and *d*, geared to run together, and a third roller *c* which is capable of vertical adjustment. The metal is moved by the carrying rollers *a* and *d*, and, on striking the surface of the roller *c*, is bent up so as to pass over the same. As this bending occurs in an equal degree at every point of the sheet of metal, the result is that it assumes a circular sweep, the radius of which depends upon the position of *c*. In the central position, the sheet would assume the shape *e f g*, and, when *c* is more raised, say to the upper position, the plate would follow the dotted circle, the radius of which is much less. When the bending-cylinder *c* is thrown out of level, the sheet is thrown into a conical form.

Fig. 3126.



Bending Plates.

In the machine for bending plates the rollers *m n* are not necessarily in contact, and the regulation for different curvatures is by vertical adjustment of the upper roller *p*. The bending of sheet-metal for stove-pipes, chimneys, tin-ware, plow-mold boards, etc., is similar in principle.

Machinery is also used for bending skelps for tubes and gun-barrels; and for twisting strips into coils for gun-barrels.

Some articles are preferably bent into form by a stamping action.

Tubes are bent while filled with solder or resin, which allows them to assume a curve without puckering or disturbing the true circular section. By this mode the curved tubes of wind-instruments are made.

Met′al-fur′ni-ture. (*Printing.*) The metallic portion of the pieces used in filling up blanks, etc., in chases.

It includes reglet, side sticks, head and foot sticks, *quotation furniture* (hollow pieces of metal used to fill up blank spaces), and hollow quadrats. It is convenient to have reglet, etc. ready cut into lengths, varying from 18 to 120 or 130 ems. See Furniture.

Met′al-gage. One for determining the thickness of sheet-metal. A sheet-metal gage.

Met′al-ine. A compound for journal-boxes of metal, metallic oxide, organic matter, reduced to powder and compounded with wax, gum, or fatty matters. See Journal-box.

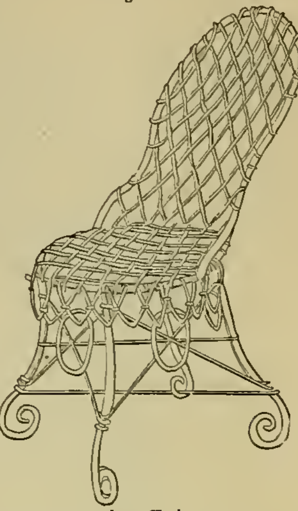
Me-tal′lic Ba-rom′e-ter. One as contradistinguished from an instrument in which a fluid is employed. Also known as a *ho′o-te-ric* barometer. Vidi invented the diaphragm form. (See Aneroid.) Bourdon invented the bent-tube form; a flattened, curved, exhausted tube, one end of which is fixed and the other geared to an index-pointer which traverses a graduated arc. Changes of pressure of the atmosphere affect the curvature of the tube, and so move the finger. See Bourdon Barometer.

Me-tal′lic Car′tridge. One in which the charge is contained in a metallic capsule, in contradistinction to the paper cartridge. See Cartridge.

Me-tal′lic Chair. A chair of iron slats or wires interwoven, or of cast portions secured by rivets or screw-bolts.

Used for parks, gardens, and auditoriums.

Fig. 3127.



Iron Chair.

Me-tal′lic Dust. Grains of metal for giving a metallic luster to wall-paper, shell-work, lacquered ware, and for other purposes. It was first made by John Hautsch of Nuremberg (1595–1670). It is prepared by sifting the filings of different metals, washing them in a strong lye, and then placing them on a metallic plate over a strong fire, where they are continually stirred till their color is altered. Those of tin acquire by this process shades of gold color, with a metallic luster; copper, shades of flame color; those of iron or steel become blue or violet; those of tin or bismuth appear of a bluish-white color. The dust is then put through a flatting-mill, having polished steel rollers.

Me-tal′lic Pack′ing. Piston-packing consisting of a ring or several rings of iron or other metal, sometimes cast so as to possess elasticity in themselves, or sometimes cut into segments and pressed against the interior of the cylinder by springs, so as to form a steam-tight contact. See Piston-packing.

Me-tal′lic Pa′per. Paper for memorandum-books, adapted to take an indelible mark from a leaden or pewter pencil. The paper is surfaced with a solution of lime, whiting, and size.

Me-tal′lic-tis′sue Loom. A loom for weaving with metallic threads, as in making gold and silver lace, braid, etc., entirely of metal, without any mixture of silk or other threads.

The wire is wound on hollow metallic bobbins, which are heated by the introduction of red-hot pieces of metal, and then allowed to cool, thus annealing the wire. The warp-threads (or wires) are then placed in the loom in the usual way. The weft must be somewhat finer than the warp, and a shuttle somewhat heavier than in silk weaving is used.

These looms are also used in making tissues in which the warp is of silk or thread and the weft of gold or silver wire or silk thread covered with a flattened silver wire which has been gilt.

Me-tal′lo-chrome. A coloring of metals by means of galvanism. It is an invention of Nobili, and consists in depositing thin films of a metal on metallic bodies by means of a galvanic battery, so as to form a number of rings. As the deposited rings — called, after the inventor, Nobili's rings — are not everywhere of the same thickness, they produce elevations and depressions, which, though not visible to the naked eye, nevertheless cause a refraction of the rays of light, thus giving rise to the formation of the same colors that are seen in thin films of varnish, fissures in the ice, on window-glass that has been partially decomposed by atmospheric action, in soap-bubbles, pearls, and which also show themselves very beautifully in heating bismuth and other fusible metals.

"A saturated solution of acetate of lead is prepared and placed in a horizontal trough. Three or four battery cells are required. A steel plate is laid in the solution with its polished face upward, and is connected with the copper of the electro-battery. If a wire be connected with the zinc end of the battery and held over the steel plate in the solution, a series of circles in brilliant colors arises at the spot immediately beneath the wire, and expands and spreads like the circles when a stone is thrown into a pond. Silver-blonde is the first color; then fawn-color, followed by different shades of violet, indigo, and blue, lake, bluish-lake, green, and orange, greenish-violet, and passing through reddish-yellow to rose-lake, which is the last color in the series.

According to the shape of the metal into which the current enters, — be it a point, a slip, a cross, a concave or a convex disk, — so is the form of the colored figure varied. If, in addition to this, a pattern in card or gutta-percha is cut out and interposed between the two surfaces, the action is intercepted by the portions not removed, and the design is produced on the steel plate in colors that may be greatly varied, according to the duration of the experiment. The different colors are due to the different thicknesses of the films of peroxide of lead." — C. V. WALKER.

Met′al-log′ra-phy. 1. A process invented by Abate, in 1851. It consists in printing from wooden blocks upon metallic surfaces, so as to produce imitations of the grain of the wood. A veneer of wood is wetted with a solution of hydrochloric or sulphuric acid, and is then impressed upon the metal so as to cause the deposition of a colored metallic oxide.

Or the impression is taken on muslin, which is then in a condition to transfer it to the metal under pressure.

2. A substitute for lithography in which metallic plates are substituted for the lithographic stone. Kocher and Houssiaux of Paris use a surface of tin-foil backed by an alloy of lead and antimony, and strained around a roller which thus becomes the pressure and printing roller. The Exhibition of 1862 in Paris showed several varieties of this art, which, in one of its branches, is closely allied to the calico-printing by copper rollers of raised design.

Met′al-lur′gy. The art of separating metals from their ores or from impurities: *smelting*, *reducing*, *refining*, *alloying*, *parting*, *plating*, etc. See under the following heads: —

Æthiop's mineral.
Affinage.
Aich's metal.
Albata
Alloy (varieties, see ALLOY).
Altar.
Altincar.
Aluminium.
Aluminium-bronze.
Amalgam.
Amalgamating zinc-plates.
Amalgamator.
Amalgam-varnish.
Ammonium.
Annealing.
Annealing-oven.
Annealing-pot.
Anti-friction metal.
Antimony.
Argentan.
Argentine.
Argentometer.
Arsenic.
Assay-balance.
Assay-furnace.
Assaying.
Aurum musivum.
Autogeneous soldering.
Babbitt-metal.
Ball-vein.
Barium.
Bath-metal.
Bean-shot.
Bear.
Bell.
Bessemer-process.
Biddery.
Billon.
Bing.
Bismuth.
Black-flux.
Black-plate.
Black-tin.
Blanched copper.
Blanching.
Blazing-off.
Blister-steel.
Block-furnace.
Bloom.
Bloom-steel.
Blow-pipe.
Blue-metal.
Bluing.
Book.
Boshes.
Bottoms.
Box-metal.
Brake-sieve.
Brass.
Brass-foil.
Brassing.
Brass-powder.
Brazing.
Bronzing.
Browning.
Bucking.
Bucking-iron.
Buddle.
Bull-dog.
Burdon.
Burning.
Burning-house.
Button.
Cabbling.
Cadmium.
Calamine.
Calcination.
Calciner.
Calcium.
Calebasserie.
Cannon-metal.
Capellina.
Capsule.
Caracoli.
Case-hardening.
Casting.
Cast-steel.
Caxon.
Cazo.
Cement.
Cementation.
Cerium.
Chafery.
Charge.
Chat-roller.
Chats.
Chill.
Chill-hardening.
Chimming
Chlorine process for extracting gold.
Chromium.
Cinder.
Cliché.
Clincher.
Clinker.
Clinquant.
Coating metals with metals.
Cobalt
Cobbing.
Cock-metal.
Cold-blast.
Cold-hammering
Col-rake.
Columbium.
Concentrator. Ore
Condenser.
Convertor.
Copper.
Copper-furnace.
Cradle.
Crevet.
Crucible.
Crucible-tongs.
Crusher. Ore and stone
Crystallized tin-plate.
Cupellation.
Cupello.
Cupola.
Cuttings.
Damascus iron
Damascus twist.
Damask.
Damaskeening.
Damask-steel.
Dam-plate.
Dead.
De-silvering.
De-sulphurizing ore.
Dilluing.
Dipping.
Dolly.
Double d'or.
Dradge.
Dross.
Dry-gilding.
Dutch gold.
Electro plating.
Electrum.
Eliquation.
Estufa process of extracting silver.
Fagot.
Fandon.
Fauld.
Fettling.
Files Tempering
Fining-pot.
Fixing.
Float.
Floran.
Florence leaf.
Flosh.
Floss.
Floss-hole.
Flux.
Foil.
Foyer.
Framing.
Frosted metal.
Fulguration.
Furnace.
Fusible alloy.
Galvanizing-iron.
Ganister.
German-chest.
German silver.
German-steel.
Gilding.
Glass-silvering
Gold.
Gold and silver by lead bath. Extraction of
Gold-beater's skin.
Gold-chlorinating.
Gold. Electro process for extracting
Gold-leaf.
Gold-shell.
Gold-size.
Gold-varnish.
Gold-washer.
Granulated steel.
Griddle.
Gun-metal.
Hammer-hardening.
Hardening.
Hearth.
Hearth-ends.
Horn.
Hot blast.
Hotching-tub.
Hushing.
Hutch
Hydro-metallurgy.
Ilmenium.
Ingot.
Iridium
Iridosmine.
Iron.
Iron-chamber.
Iron with copper. Coating
Jagging-board.
Jigger.
Jigging machine.
Keeve.
Knockings.
Labyrinth.
Lacquer
Ladle.
Lamero.
Latten.
Launder.
Lead.
Lead-bath for extracting gold and silver.
Lead from silver. Separating
Leaf-metal.
Lightening.
Limp.

Lined gold.
Liquation.
Litharge.
Lithium.
Lobbing.
Long-tom.
Loobs.
Lool.
Loup.
Lustering.
Magistral.
Magnesium.
Malleable iron.
Malleable cast-iron.
Manganese.
Manheim-gold.
Matrix.
Matt.
Mercury.
Mercury-gatherer.
Metallic dust.
Metallochrome.
Metallography.
Metallurgy.
Metals
Metals with metals. Coating
Meteor-steel.
Mill.
Minargent.
Mock-gold.
Mock-platinum.
Mock-silver.
Moire-metallique.
Molybdenum.
Mosaic gold.
Muntz's metal.
Natural steel.
Nickel
Nickel-plating.
Niobium.
Ore-calcining.
Ore-concentrator.
Ore-crusher.
Ore-grinding.
Oreide.
Ore-mill.
Ore-separator.
Ore-stamp.
Or-molu.
Oroide.
Orsedew.
Osleon-iron.
Osmium.
Oxidizing-ore.
Pack
Packfong.
Palladium.
Pan.
Parting.
Patio-process.
Pattinson's pots.
Pelopium.
Percussion-sieve.
Percussion table.
Petong.
Pewter.
Pig.
Piling.
Pina.
Pinchbeck.
Plating.
Platinum.
Plomb-brut.
Plush-copper.
Pocket.
Poling.
Potassium.
Pot-metal.
Prill.
Prillion.
Prince Rupert's metal.
Puddled-steel.
Puddling.
Puddling-furnace.
Pug-tub.
Quartation.
Quartz-crusher.
Quartz-liquefier.
Quartz-mill.
Queen's metal.
Quenching.
Quicksilver.
Rabble.
Rack.
Ragging.
Refinery.

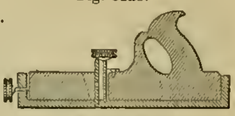
Refining-hearth.
Regenerating-furnace.
Regenerator.
Regulus.
Repoussé-work.
Retort.
Rhodium.
Roasting.
Roasting-furnace.
Rocker.
Roll
Rondle.
Ruff-wheel.
Ruthenium.
Sand-washer.
Scissel.
Scoria.
Screening-machine.
Semilor.
Separator.
Shaking.
Shear-steel.
Sheathing-metal.
Sheet-iron.
Sheet-metal.
Shoe.
Shot-metal.
Silicium.
Silver.
Silver from lead. Separating
Silvering.
Silver-mill.
Silver-plating.
Silver-powder.
Sizing-apparatus.
Skelp.
Slag.
Slakin.
Sleeping-table.
Slimes.
Slime-pit.
Sludge.
Smeddum
Smelter's fume.
Smelting.
Sodium.
Solder.
Spalling.
Speculum-metal.
Spelter.
Sponge.
Stamp
Stamp-head.
Steel.
Steely iron.
Sterro-metal.
Strake.
Strip.
Strontium.
Sublimation.
Sullage
Sweeping-table.
Sweep-washings.
Taggers.
Tain.
Tasting-hole.
Temper.
Tempering.
Test.
Tilted steel.
Tin.
Tin-foil.
Tinning-iron.
Tin-plate.
Tin-scraps. Utilizing
Tinsel.
Titanium.
Tombac.
Torta.
Tossing.
Touch-needle.
Touchstone.
Tula-metal.
Tungsten.
Tutania.
Tutenag.
Tying.
Tymp-plate.
Type-metal.
Uranium.
Vanadium
Vanning
Vat
Vermeil.
Walled area.
Washer. Gold

Washing-table.
Water-bosh.
Welding.
White-copper.
White-lead.
White-tombac.
Wire-tempering.

Wolfram.
Wootz.
Yellow metal.
Zinc.
Zinc-white.
Zirconium.

Met′al-plane. A form of plane for facing soft metal plates by taking a fine shaving therefrom. Planing-machines of various kinds plane the backs of stereotypes and electrotypes. The angle of the plane with the sole is adapted to the hardness of the metal being worked.

Fig. 3128.



Metal-Plane.

Met′al-saw. A fine-toothed, hard, steel saw stretched in a frame and used for sawing metal. A *hack-saw*.

Met′al-work′ing Tools and Ma-chines′, etc. See under the following heads: —

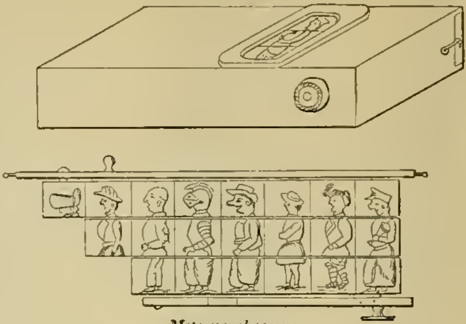
Agate.
Ancony.
Angle-gage.
Arbor
Auger-twister.
Babbiting-jig.
Backing-up.
Ball.
Balling-tool.
Bar-cutter.
Barrel-setter.
Bar-shear
Beaded wire.
Beam.
Bear.
Bell
Bench-drill.
Bench-shears.
Bending-machine.
Bending metal plates.
Billeting-roll.
Binder-frame.
Bolster.
Bolt cutter.
Bolt-heading machine.
Bolt-machine.
Bolt-screwing machine.
Bolt-threader.
Boring-bar.
Boring-block.
Boring-machine.
Boring-mill.
Boring-table.
Boring-tool.
Boss.
Box-beam.
Boxes. Machines for making metal
Brace.
Breaking-down rollers.
Broach.
Broad.
Buckled plate
Burning.
Burnisher.
Burr-cutter.
Bush.
Bush-extractor.
Calipers.
Carbon tool-points
Card-grinding machine.
Center chisel.
Center-gage.
Centering-machine.
Centering-tool.
Center-lathe.
Center-punch.
Chamfering-tool.
Chaser.
Chasing-mallet.
Chasing-stake.
Chasing-tools.
Cherry.
Chipping-piece.
Chuck.
Clamming-machine.
Coining.
Colander.
Corner-punch.

Corrugated iron.
Corrugating-machine.
Counter-punch.
Countersink
Cramp-drill.
Cranked tool.
Cut-nail machine.
Cutter.
Cutter-bar.
Cutter-grinding machine.
Cutter-head.
Cutting-out machine.
Cylinder.
Cylinder-boring machine.
Die.
Die-stock.
Dinged work.
Dog. Lathe
Dolly.
Drag-bench.
Drawing-bench.
Drawing-machine.
Drawing-punch.
Draw-plate.
Drift.
Drill.
Drilling-machine.
Drive
Driver.
Drop-press.
Expanding-mandrel.
Expanding-reamer.
Eyelet-machine.
Eyelet-punch.
Fagot
Feather
File
File-carrier.
File-cutting machine.
File-stripper.
Filigree.
Filing-block.
Filing-machine.
Finishing-rolls.
Fish-hooks. Machine for making
Flanging-machine.
Flatting-mill.
Flogging-chisel.
Fluting-cylinder.
Fly-punching press.
Folding-machine.
Forging-apparatus.
Forging-metals.
Gage.
Gear-cutter.
Hammer (varieties, see HAMMER).
Hanger.
Hanging-tool.
Heading-tool.
Hoe-blank machine.
Hook-tool.
Horseshoe-machine.
Horseshoe-nail machine.
Housing.
Hub
Hydraulic punch.
Jam-nut.

Jim-crow.
Journal.
Journal-bearing.
Key-seats. Machine for cutting
Knurling.
Laminating-machine.
Lap.
Larget.
Lathe.
Lead-pipe.
Lead-shaving.
Leveling-block.
Lever-punch.
Lubricator.
Machine-tool
Mandrel.
Marking-machine.
Metal-bending machine.
Metal-drawing machine.
Mill.
Milling.
Milling-machine.
Milling-tool.
Mold
Mold-blocking machine.
Molding
Mowing-machine grinder.
Muck-roll.
Mullar.
Nail-head tool.
Nail-machine
Nail-plate clamp.
Nail-plate feeder.
Nail-plate shears.
Needle.
Needle-making machine.
Nippers.
Nurling.
Nut.
Nut-bar.
Nut-lock.
Nut-making machine.
Nut-planer.
Nut-tapping machine.
Oil-can.
Oiler.
Palier-glissant.
Pass.
Pig-iron breaker.
Pillow-block.
Pin.
Pin-machine.
Pipe-cutter
Pipe-driver.
Pipe-threading machine.
Pipe-wrench.
Planchet.
Planer.
Planer-center.
Planing-machine.
Planishing-rollers.
Plant
Plate-bending machine.
Plate-iron girder
Plate-shears.
Pressing metals.
Puddling-roll.
Punch.
Punch and shears.
Punching-bear.
Punching-machine.
Rail-bender.
Rail-punch.
Rail-straightening machine.
Ratchet-brace.
Reamer.
Reeding.
Rifling.
Rivet.
Rivet hearth.
Riveting-machine.
Riveting-tools.
Rivet-machine.
Rolling-metals.
Rolling-mill.
Routing-tool.
Rove.
Scissel.
Scobs.
Screw.
Screw-cap.
Screw-cutter.
Screw-cutting lathe.
Screw-cutting machine
Screw-making machine.
Screw-molding.
Screw-plate.
Screw-threading machine.
Screw-wrench.
Set.
Set-up.
Shafting.
Shaft-straightener.
Shaping-machine.
Shearing and punching machine.
Sheet-iron.
Sheet-metal bender.
Sheet-metal cutter and folder.
Sheet-metal die.
Sheet-metal folder.
Sheet-metal forming machine.
Sheet-metal polisher
Sheet-metal scourer.
Sheet-metal straightener.
Shim.
Shingler.
Shingling-hammer.
Shot-making.
Shrunk-on.
Skelp.
Skelp-bender.
Sledge.
Slide-rest.
Slitting-machine.
Slotting-machine.
Snap.
Soldering.
Soldering-iron
Spherical-shot machine.
Spike-machine.
Spinning-metal.
Spring-coiling machine.
Spring-polisher.
Spring-tester.
Squeezer.
Stamping-metals.
Staple-making machine
Staving-metals.
Stencil-cutter.
Straightening-metals.
Swage.
Swage-block.
Swaging-machine.
Swaging-metals.
Swarf
Swing-tool.
Tap.
Tap-plate.
Teeming-punch.
Templet.
Thumb-nut.
Tin-lining pipe.
Tire-upsetting machine.
T-iron.
Tool-holder.
Triblet.
Tube.
Tube-cutter.
Tube-making
Tube-sheet cutter.
Turning-lathe.
Turning-mill.
Turning-tool.
Upsetting-machine.
Upsetting-press.
Vise
Washer.
Washer-cutter.
Web.
Welding-machine.
Welding-metals.
Wheel-cutting machine.
Wheel-molding machine.
Wheel-press.
Wheel-quartering machine.
Wire-cloth crimper.
Wire-cloth loom.
Wire-cloth painter.
Wire-covering
Wire-covering machine.
Wire-drawing.
Wire-gage.
Wire-pointer.
Wire-rope.
Wire-straightener.
Wire-tempering.
Wire-twister.
Wordle.
Wrench.

Met'a-mor'pho-scope. A toy having an opening at which the pictures on several belts are presented, the respective belts having head, body, and leg portions of figures. The belts are of different lengths, so as to mismatch the sections as they are revolved.

Fig. 3129.



Metamorphoscope.

Me'te-or'o-log'i-cal In'stru-ments. See under METER for list; including BAROMETER, THERMOMETER, HYGROMETER, RAIN-METER, etc.

Me'te-or-om'e-ter. (*Telegraphy.*) An apparatus for receiving, at a local station, transmitting to a central station, by telegraph-wires, and there recording, the direction and velocity of the wind, condition of the barometer and thermometer, amount of rainfall, etc.

Stephen Chester of Elizabeth, New Jersey, patented in 1862 a telegraphic meteorometer which records at frequent intervals by a single wire, from as many instruments as may be desired, and at any distance; the purpose being to collect reports for the signal service. A clock-work mechanism at the sending station throws the wire alternately into connection with a registering anemometer, vane, barometer, thermometer, etc., at such intervals of time as may be decided upon.

The anemometer is of the windmill kind, and its shaft carries a tooth which breaks an electric circuit at each revolution. The rapidity of electric-pulsations, therefore, indicates the velocity of the wind. The motion of the vane opens and closes various circuits as it traverses the circle, and so records itself.

Thermometric and barometric registration is obtained by making the mercury column a part of an electric circuit. As the columns rise and fall they make connection with a greater or less number of wires, which transmit their report to the line-wire as their turn comes. Other connections are obvious. The operations are to be conducted from the receiving station, where are also the recording instruments which register the indications of the various sending instruments, as they are consecutively and automatically connected by switch with the telegraphic wire.

Me'te-or'o-scope. An instrument used for taking angles, and making measurements of the heavenly bodies.

Me'te-or-steel. An alloyed steel which has a wavy appearance, resembling the Damascus steel.

An alloy of zinc, 80; nickel, 16; silver, 4 = 100, is placed in a black-lead crucible, covered with charcoal, and melted. It is rendered friable by pouring it into cold water, is reduced to powder, called *meteor-powder*, and is added to steel in a crucible in the following proportions: —

Blister steel, 28 pounds; meteor-powder, 10 ounces; chromate of iron, 8 ounces; charcoal, 1 ounce; quicklime, 2 ounces; porcelain-clay, 3 ounces.

These materials are melted in the usual manner, cast into an ingot, drawn into bars, and treated as cast-steel.

The wavy appearance may be farther brought out by washing the surface with dilute nitric acid; acid 1 part, water 19 parts.

Me'ter. (Fr. *Mètre.*) 1. The French unit of measurement of length, equal to 39.3708 inches, or 3.2809 feet. The $\frac{1}{10000000}$ part of the quadrant of the earth measured on a meridian. See METRIC SYSTEM.

One of the original set of iron meters, made in France, is now at the Coast Survey Museum in Washington, where are also the brass standard yard of England and many other standard measures and weights, home and foreign.

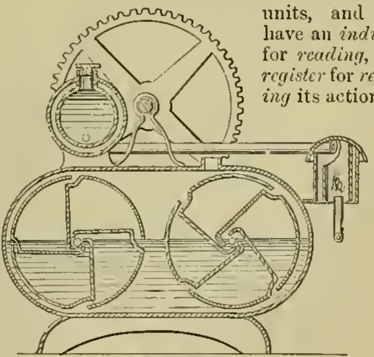
The new international meter-measure was cast, in the presence of the commission at Paris, in the laboratory of M. Sainte-Claire Deville. It consists of an alloy of platinum and iridium. Nine kilogrammes of platinum and one kilogramme of iridium were melted by means of the oxyhydrogen gas blowpipe. This process took three quarters of an hour; the molten mass was then let off into a mold made, like the crucible, from a block of limestone, whose inner surface was burnt to lime in consequence of the heat. The metal did not lose its luster in cooling, and was afterward shaped, tested, and graduated.

2. A measuring instrument. See under the following heads: —

Acetimeter.
Acetometer.
Acidimeter.
Acoumeter.
Actinometer.
Aerometer.
Air-meter.
Airometer.
Air-thermometer.
Alcoholmeter.
Aleurometer.
Alkalimeter.
Altarimeter.
Altometer.
Anemometer.
Angle-meter.
Angulometer.
Anthracometer.
Antimeter.
Apomecometer.
Areometer.
Argentometer.
Arithmometer.
Astrometer.
Atmidometer.
Atmometer.
Autometer.
Balance-electrometer.
Barkometer.
Barometer.
Barometrical aeriometer.
Bathometer.
Bdelometer.
Blanchimeter.
Blast-meter.
Calorimeter.
Capillarimeter.
Carbonometer.
Cardiometer.
Cathetometer.
Chartometer
Chlorometer.
Chromiometer.
Clinometer.
Colorimeter.
Conchometer.
Conchylometer.
Craniometer.
Cupel-pyrometer.
Current-meter.
Cyanometer.
Dasymeter.
Declinometer.
Decolorimeter.
Deflectometer.
Dendrometer.
Densimeter.
Diagometer.
Diaphonometer.
Diastimeter.
Drop-meter.
Drosometer.
Dry-meter.
Ductilimeter.
Durometer.
Dyactinometer.
Dynameter.
Dynamometer.
Echometer
Elaiometer.
Elaterometer.
Electrical meter.
Electrometer.
Endosmometer.
Entomometer.
Eriometer.
Esthesiometer.
Eudiometer.
Evaporameter.
Fluid-meter.
Focimeter.
Galactometer.
Galvanometer.
Gas-meter.
Gasometer.
Gas-thermometer.
Goniometer.
Grain-meter.
Graphometer.
Gravimeter.
Halometer.
Harmonometer.
Heliometer.
Hemadrometer.
Hemadynamometer.
Holometer.
Holosteric barometer.
Horometer.
Hydro-barometer.
Hydrometer.
Hygrometer.
Hypsometer.
Inclinometer.
Indigometer.
Inductometer.
Klinometer.
Lactometer.
Limestone-meter.
Liquid-meter.
Litrameter.
Long-range barometer.
Lucimeter.
Macrometer.
Magnetometer.
Manometer.
Marine barometer.
Maximum barometer.
Mecometer.
Megameter.
Meteorometer.
Metrochrome.
Metrograph
Metrometer.
Metronome.
Metroscope.
Micrometer.
Micronometer.
Minimum barometer.
Mountain-barometer.
Murometer.
Myo-dynamometer.
Nauropometer.
Nephelodometer.
Nephelorometer.
Nephelscope.
Nilometer.
Nitrometer.
Odometer.
Œnometer.
Oleometer.
Ombrometer.
Operameter.
Ophthalmometer.
Opthalmodiastimeter.
Opsiometer.
Optometer.
Ozonometer.
Panta-chronometer.
Pantamometer.
Pantometer.
Pediment-barometer.
Pedometer.
Peirameter.
Pelvimeter.
Photograph-meter.
Photometer.
Piezometer.
Pirameter.
Planimeter.
Planometer.
Platometer.
Pleximeter.
Pluviameter.
Pneumatometer
Polaristrobometer.
Polymeter.
Prism-spherometer.
Procheameter
Psychrometer.
Pthongometer.
Pulmometer.
Pulp-meter.
Pyrheliometer.
Pyrometer.
Radiometer.
Rheometer.
Rhysimeter.
Rotary meter.
Saccharometer.
Salinometer.
Seismometer.
Self-registering barometer.
Sonometer.
Sphereometer.
Sphygmometer.
Spirit-meter.
Spiritometer.
Spirometer.
Stadimeter.
Steam-power meter.
Stereometer.
Stethometer.
Stylometer.
Submarine thermometer.
Sympiesometer.
Tachometer.
Telemeter.
Thallasometer.
Theodolite-magnetometer.
Thermo-barometer.
Thermometer.
Tithonometer.
Tonometer.
Tradiometer.
Trechometer.
Tribometer.
Tympanometer.
Udometer.
Urinometer.
Velocimeter.
Viatometer.
Voltameter.
Water-meter.
Wet-meter.
Wheel-barometer.
Zygmosimeter.
Zymometer.

The terms *meter*, *register*, *counter*, *indicator*, are somewhat irregularly used, but are not exact synonyms. An *indicator* makes audible or visible notice of results or condition. A *register* records. A *meter* measures distance, capacity, power, etc., giving results usually in volumes or other units, and may have an *indicator* for *reading*, or a *register* for *recording* its action.

Fig. 3130.



Meter-Wheel.

Me'ter-wheel. One used in connection with gas and liquid meters and air-carbureting machines.

In the former, it is driven by the flow of gas whose volume it measures; and in the latter case it is usually employed to induce a flow of air through the hydrocarbon liquid, and performs the function of a blower. It has usually several chambers, and when measuring gas, is submerged above its axis in water, in the chamber wherein it rotates. The chambers in the wheel are of known capacity, and the revolutions are registered upon dials. In the gas-meter, the gas passes in at the hollow trunnion, and passes from the central pipe to each chamber in turn. As the gas fills the chamber it rises, and, when filled, its lip rises above the surface of the water and discharges its gas into the upper part of the containing-case. As the chambers of the drum pass over, they again fill with water. See GAS-METER.

Mete-stick. (*Nautical.*) A measure used in storing cargo, in order to preserve proper levels.

Met'o-pe. (*Architecture.*) The space between the triglyphs in the frieze of the Doric order.

Me-tren'chy-tes. (*Surgical.*) A syringe for injecting medicated liquids into the uterus.

Met'ric Sys'tem. The system adopted by the French convention in 1795, in which all measures of length, area, capacity, and weight are based upon the length of a quadrant of the meridian measured between the equator and the pole.

The origin of the system is due to the government of Louis XV., who named a commission to investigate the best means of reforming the great diversity of weights and measures then used in the different cities and provinces of France. These investigations were continued under his successor, and in 1790 Talleyrand distributed among the members of the National Assembly a proposal for the establishment of a single and universal standard of measurement.

A committee from the Academy of Sciences, Borda, Lagrange, Laplace, and Condorcet, all men of the highest scientific eminence, were appointed under a decree of the Assembly to report upon the selection of a natural standard. They proposed, in their report, that one ten-millionth part of a quarter circumference of the globe at the meridian of Paris should be taken as the unit of lineal measure.

This is undoubtedly a more definite standard than that of the English and American systems, which are based upon the length of a pendulum beating seconds in the latitudes of London and New York respectively. It may be remarked that the English and American determinations of the foot and yard from these sources differ slightly, though not enough to affect any practical result. The values of the meter are, in English inches, 39.37079; in American inches, 39.368. The values of the metric measures in the following tables are compared with those of the English yard.

Van Swinden was one of the commissioners for settling the basis of the system, and gives a lengthy description, from which we derive the following: —

"The standard is founded upon the basis of the quadrant of the earth, being the part of the terrestrial meridian contained between the equator and the north pole. The 10,000,000th part of this quadrantal arc was adopted to be the linear measuring unit, which they called "mètre," applying it equally to superficial and solid measures, taking for the unit of the former the square of the decuple, and for that of the latter the cube of the tenth part of the meter. They chose also for the measuring unit of weight, the quantity of distilled water equal in bulk to the same cube at a certain temperature. They also decided that the multiples and sub-multiples of each kind of measure, whether of weight, capacity, surface, or length, shall be always taken in the decimal or decuple proportion, as the most simple, natural, and easy for calculation, according to the system of numeration which all Europe has used for many centuries.

"The Institute (National Institute of France) ordered a new and actual measure of the whole arc of the meridian extending the whole length of France, from Dunkirk on the north to Barcelona in Spain, and passing Paris, an extent of almost 10°. The measurement of this arc employed Mechain and Delambre for several years. They employed rods of platinum of 12 feet in length for measuring the bases; and whole circles, accurately made, for taking the angles to 10ths of seconds, by repeating the measures in different parts of the circumference, and taking the mediums of the whole. The precision with which the angles were observed is such that, out of 90 triangles which connect the extremities of the meridional arc, there are 36 in which the sum of the 3 angles differs from its proper quantity by less than 1 second; that is, in which the error of the three angles taken together is less than 1 second; there are 27 triangles in which this error is less than 2 seconds; in 18 others it does not amount to 3 seconds; 4 are under 4 seconds; and the remaining 3 are under 5 seconds.

"Every care was taken to support and dispose the platinum rods properly in measuring the bases. The extremities of the rods were never brought into contact; an interval being left, which was measured by a tongue of platinum, sliding from the end of one of the rules and carrying a vernier and microscope. The corrections or allowances for differences of temperature, for obliquities of the line actually measured, and for the elevation above the level of the sea, were also attended to and allowed for. One rod was kept unemployed for a module or standard at 10° Reaumur or 54° Fah."

In deducing the length of the quadrant of the meridian, the arc measured by Bouguer and La Condamine in Peru, in 1736, was taken as an element. More recent and extended measurements at different points of the earth's surface indicate that the data upon which the metric determinations were founded were inadequate for ascertaining the exact variations in curvature of this irregular ellipsoid at different latitudes, and that consequently the meter is not exactly what it should be, but 10,000,000 meters fall short, according to Sir J. F. W. Herschel, by 4,008 feet of measuring a meridional quadrant. This error, amounting to but $\frac{1}{208}$ of an inch to the meter, is disregarded.

As before observed, the meter is the basis of all measurements. From it are derived the following units: —

Of area; the *are*, — 1 square decameter.
Of capacity; the *liter*, — 1 cubic decimeter.
Of weight; the *gram*, — 1 cubic decimeter of water.

The names of the graduations below the unit are formed from the Latin, and above the unit are formed from the Greek, as follows, the unit being 1: —

Myria	10,000
Kilo	1,000
Hecto	100
Deka	10
	1
Deci	0.1
Centi	0.01
Milli	0.001

In each of the four classes, — length, area, capacity, and weight, — these prefixes indicate the character of the measure. Greek for multiples, Latin for fractions.

Measures of Length.

Millimètre (.001 mètre),	0.03937 inches.	
Centimètre (.01 mètre),	0.39371 "	
Décimètre (.1 mètre),	3.93708 "	
Mètre (unit),	39.3708 "	or 3.2809 feet.
Dékamètre (10 mètres),	32.809 feet,	or 10.9363 yards.
Hectomètre (100 mètres),	328.09 "	109.3633 "
Kilomètre (1,000 mètres),	1,093.63 yards,	or 0.62138 miles.
Myriamètre (10,000 mètres),	10,936.33 "	6.21382 "

Table.

10 millimeters make	1 centimeter.
10 centimeters make	1 decimeter.
10 decimeters make	1 meter.
10 meters make	1 decameter.
10 decameters make	1 hectometer.
10 hectometers make	1 kilometer.
10 kilometers make	1 myriameter.

Measures of Area.

The unit of area is a square whose side is 10 meters. It is called an ARE, and is equal to 100 square meters.

Centiare (.01 are or square mètre),	1 1960 sq. yards=1,550 square inches.
Are (sq décamètre and unit),	119 6033 sq. yards or 0.0247 acres=3.9536 p.
Decare (10 ares),	1,196.033 sq. yards or 0 247 acres=39.536 p.
Hectare (100 ares)	11,960.33 sq. yards or 2 471 acres=2 a. 1 r. 35.376 p.

Table.

100 centiares make	1 are.
10 ares make	1 decare.
10 decares make	1 hectare.

Measures of Capacity.

The unit for the measure of volumes is a cube whose edge is $\frac{1}{10}$ of the meter; that is, a cube whose edge is 3.937 inches. It is called a LITER, and is $\frac{1}{1000}$ part of a cubic meter.

Metric Denominations.				English Equivalents.		United States Liquid Measure.
Milliliter	0.001	of a liter	1 cubic centimeter	0.00704 gills	0.061027 cubic inches	0.27 fluid drams.
Centiliter	0.01	of a liter	10 cubic centimeters	0.0704 gills	0.610271 cubic inches	0.338 fluid oz.
Deciliter	0.1	of a liter	.1 cubic decimeter	0.704 gills	6.102705 cubic inches	0.845 gill.
Liter	1	liter	1 cubic decimeter	1.761 pts.	61.027052 cubic inches	1.0567 quart.
Decaliter	10	liters	10 cubic decimeters	2.201 galls.	610.270515 cubic inches	2.6417 galls.
Hectoliter	100	liters	.1 cubic meter	2.751 bus.	6,102.705152 cubic inches	26 417 galls.
Kiloliter or stere	1,000	liters	1 cubic meter	27.512 bus.	61,027.051519 cubic inches	264 17 galls.

Table.

10 milliliters make	1 centiliter.
10 centiliters make	1 deciliter.
10 deciliters make	1 liter.
10 liters make	1 decaliter.
10 decaliters make	1 hectoliter.
10 hectoliters make	1 kiloliter or stere.

Weights.

The unit of weight is equal to $\frac{1}{1000000}$ part of the weight of a cubic meter of pure rain-water weighed in a vacuum. It is called a GRAM, and is equal to 15.432 grains Troy = .0352746 ounces avoirdupois, nearly.

METRIC DENOMINATIONS AND VALUES.			Equivalents in denominations in use.
Names.	Number of Grams.	Weight of what quantity of water at maximum density.	Avoir'pois.
Milligram	0.001	1 cubic millimeter	0.0154 gr.
Centigram	0.01	10 cub. millimeters	0.1543 gr.
Decigram	0.1	1 cub. centimeter	1 5432 gr.
Gram	1	1 cub. centimeter	15.432 gr.
Dekagram	10	10 cub centimeters	0.3527 oz.
Hectogram	100	1 deciliter	3.5274 oz.
Kilogram or kilo	1,000	1 liter	2.2046 lbs.
Myriagram	10,000	10 liters	22.046 lbs.
Quintal	100,000	1 hectoliter	220.46 lbs.
Millier or ton	1,000,000	1 cubic meter	2,204.6 lbs.

Table.

10 milligrams make	1 centigram.
10 centigrams make	1 decigram.
10 decigrams make	1 gram.
10 GRAMS make	1 decagram.
10 decagrams make	1 kilogram.
10 kilograms make	1 myriagram
10 myriagrams make	1 quintal.
10 quintals make	1 millier or ton.

On the adoption of the metric system, the French also reformed their currency, abolishing the *livre* and *sous*, and adopting the *franc*, which it was decreed should weigh five grams, and be composed of 9 parts pure silver and 1 part alloy. It is divided into 100 centimes. This piece constitutes the basis of the French coinage.

The United States, however, led the way in a decimal currency.

The metric system, though adopted in 1795, was not fully carried into effect until 1840. It is now employed throughout a large part of Continental Europe, and seems in a fair way to be generally adopted at some not very distant day in the United States, where it may now be legally employed at the option of the parties interested.

Met′ro-chrome. A color-measurer. Invented by Field and described in his "Chromatograph." It consists of three hollow wedges of glass, of exactly the same angle and capacity, and accurately graduated on the edge to the same number of equal degrees. These wedges are so arranged between two screens that any portion of their tapering sides may be presented at will to an aperture through which a direct view may be had, or a ray of light thrown. The wedges are filled respectively with a yellow, a red, and a blue transparent liquid, each color being exactly the same in depth or intensity. It is obvious that, descending from the apex to the base of these wedges, the amount of color or the number of its atoms presented to the eye increases in proportion to the divergence of its sides.

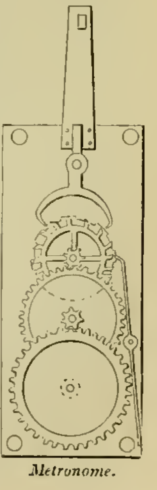
Met′ro-graph. An apparatus to be attached to a locomotive, indicating on a time-paper the speed with the number and duration of the various stoppages.

Me-trom′e-ter. (*Surgical.*) An instrument for measuring the size of the womb. A *hysterometer.*

Met′ro-nome. An instrument for beating and dividing the time in music. A musical time-keeper. Patented in England by John Mälzel, December 5, 1815.

It has a small pendulum which, being set in motion by clock-work, beats audibly a certain number of

Fig. 3131.



Metronome.

times in a minute; and this number may be altered by moving a sliding weight so as to give it the speed required.

In Fig. 3131, the verge-wheel is attached to a wheel having equal raised surfaces and depressions around its periphery, and these act on one end of a pivoted lever, whose other end is connected by a fine thread to an indicator attached to a spiral spring.

Met'ro-scope. (*Surgical.*) An instrument invented by M. Nauche, for listening to the sounds of the heart of the fetus in utero gestation. The extremity was suggested by the stethoscope of Laënnec, and is introduced through the vagina and applied against the neck of the uterus. It is used when the sounds and movements are imperceptible through the parieties of the abdomen.

Met'ro-tome. (*Surgical.*) An instrument like a bistoury caché, which is introduced into the cavity of the uterus, where the knife is unsheathed and cuts on withdrawing. Its purpose is to divide the neck of the uterus. See Thomas's "Diseases of Women." A *hysterotome.*

Mez-za-nine'. A low window occurring in attics and entresols.

Sometimes applied to an *entresol.*

A *mezzanine story* is a half-story; one lower than the stories above and below it.

Mez'zo-ri-li-e'vo. The moderate prominence of a sculptured figure from the plane surface to which it is attached. It is also known as *demi* or *half-relief*, and is a grade between *alto-rilievo* or *high-relief*, and *basso-rilievo* or *low-relief.* See RILIEVO.

Mez'zo-tint-en-grav'ing. The inventor of this art is believed to have been Colonel Ludwig von Siegen, a lieutenant-colonel in the service of the Landgrave of Hesse Cassel. Portraits executed by him exist, having the date of 1643. Prince Rupert gave so much attention to it, and was so instrumental in bringing it into favor, that he has been credited with the invention. Sir Christopher Wren has also been cited as the inventor, but his claims are antedated by Prince Rupert.

"Mr. Evelyn showed me the whole secret of mezzo-tinto, and the manner of it, which is very pretty, and good things done with it." — PEPYS's *Diary*, November 1, 1665.

The process consists in passing over a plate of steel or copper with an instrument called a *cradle*, by which a burr is raised over every portion of the plate, which, if filled with ink by the printer, would make a black impression. On the surface thus prepared, the lights and middle tints are burnished or scraped away; the burr being more or less perfectly removed, according to the gradation of light required. The plate is untouched in the parts intended for the darkest tint. The instruments used are the cradle or rocker, scraper, burnisher, roulettes. It is usual to etch-in the outlines of the design to form a guide in the operations of scraping and burnishing. A more extensive use of the etching process gives character and force to the work. The tools, cited above, are described under their respective heads.

Mi'ca. A mineral which cleaves into thin transparent plates. Known to miners as *glimmer.* It is the *lapis specularis* of Pliny, used in ancient times for window-panes.

The uses of mica in the mechanic arts are numerous. Among them may be cited, —

Windows for stoves and lanterns.

Chimneys for lamps.

Ground, as a lubricator and as a packing.

As a substitute for glass in spectacles, in protecting the eyes in various mechanical operations.

As a substitute for glass in silvered reflectors, in places where it will be exposed to heat, as in headlights, etc. (Marshall's patent.)

Mixed with varnish as a coating for wall-paper (Beck's patent), and in bronzing statuettes and other plastic articles.

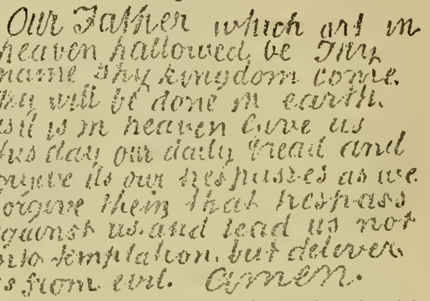
As a covering for roofs (Ditto's patent).

Mi'cro-cous'tic. (*Surgical.*) An aural instrument for collecting sounds for the partially deaf. An auricle or speaking-trumpet.

Mi'cro-graph. An instrument invented by Mr. Webb of London, for executing extremely minute writing and engraving; its general principle is that of the pantograph.

Fig. 3132 is a *fac-simile* of a photograph enlarged, from a specimen written by Mr. Webb on glass for the United States Army Medical Museum. The glass slip also contains the following inscription in a larger writing: —

Fig. 3132.



Our Father which art in
heaven hallowed be Thy
name thy kingdom come.
Thy will be done in earth
as it is in heaven Give us
this day our daily bread and
forgive us our trespasses as we
forgive them that trespass
against us. and lead us not
into temptation. but deliver
us from evil. Amen.

The Lord's Prayer (from a Micro-photograph of the original Writing on Glass, occupying the $\frac{1}{129654}$ of a Square Inch).

"Webb's Test. The Lord's Prayer. 227 letters in the $\frac{1}{294} \times \frac{1}{441}$ of an inch, or the $\frac{1}{129654}$ of a square inch, and at the rate of 29,431,458 letters to an inch, which is more than 8 Bibles, the Bible containing 3,566,480 letters."

The area within which the Prayer was written was micrometrically verified by Dr. J. J. Woodward, United States Army, who found that it and the above inscription were contained within a space $\frac{1}{16}$ of an inch square.

Mr. Webb claims that writing of this kind affords a test of microscopic power superior to that afforded by NOBERT'S PLATES (which see), the finest of which he endeavors to prove have no real existence, but result from an optical delusion produced by the polarization of light. Dr. Woodward, however, says that the optical appearance of such of Nobert's bands as have never been resolved into separate lines by the highest powers yet attained are so similar to the others that it is unreasonable to doubt that they are ruled as stated by Nobert. He attributes the success of Nobert to the minuteness of the points employed by him, which appear to far exceed those of other artists, and are the result of a secret which he has hitherto kept to himself.

According to a statement made in 1862 by Mr. Farrants, president of the Microscopical Society, Mr. Peters has succeeded in writing the Lord's Prayer, so as to be distinctly legible, with sufficient magnifying power, within the space of $\frac{1}{360000}$ of a square inch. The instrument employed was invented by him, and is termed the MICROPANTOGRAPH (which see).

Mi-crom'e-ter. An instrument used with a telescope or microscope to measure small distances, or the apparent diameters of objects which subtend very small angles. — WEBSTER.

Micrometers are variously constructed. The field of the telescope may be provided with a graduated scale, or a metallic ring, or a diaphragm having parallel and intersecting spider-lines or fine wires.

The micrometer with a *graduated scale* is used for measuring distances by direct comparison.

The application of the micrometer to the telescope is credited by Whewell to Huyghens, Malvasia, and Azout. It was a great advance in the attempt to do by accuracy of measurement what had previously been attempted, and in part accomplished, by enlarging the instrument so as to enable the measurements of smaller arcs.

The first micrometer on record is that of Gascoigne of England, constructed about 1640, and used by him in measuring the diameters of the moon and some of the planets.

The inventor perished in the civil war, 1644. The instrument had nicely ground parallel edges of brass plate, and parallel hairs were substituted by the renowned Dr. Hooke.

Huyghens, about 1652, measured the diameter of a planet by inserting in the tube of the telescope, at the focus of the object-glass and eye-glass, a slip of metal which covered exactly the image of the planet, and then deduced the diameter by the breadth of the slip compared with the breadth of the field.

Malvasia, shortly after, employed a network of fine silver wire, making a *reticulated* or *filar micrometer.* The wires were stretched across a diaphragm in his telescope, crossing each other at right angles and dividing the field of view into squares of equal size.

Azout, a French astronomer, published an account of the micrometer in 1667.

Picard, another French savant, who died in 1684, was instrumental in the practical application of the micrometer to instruments. He early adapted the telescope to the measurement of angles, and determined with reasonable correctness the length of a degree, which he measured by means of an ODOMETER (which see).

Roemer, in 1678, suggested the *divided object-glass micrometer,* which was more perfectly adapted by Bouguer, seventy years afterwards.

Boscovich, in 1740, invented the *circular micrometer,* which was used by Lecaille in 1742, and Olbers, 1798, and improved by Frauenhofer.

Ramsden, about 1780, suggested the use of *cobwebs* as a fine filament substitute for wire. It has been credited to Troughton.

A substitute for the spider-line micrometer, over which it possesses many advantages, is formed of a thin plate of glass on which equidistant parallel lines are ruled by means of a diamond-point. Spider-lines are liable to become displaced or to become relaxed in consequence of the hygrometric conditions of the atmosphere, while the glass plate is permanent and unalterable.

Rochon invented the *double-refraction* or *prism micrometer.*

A filament of silk, a fiber of spun-glass, of melted sealing-wax, of asbestos, or a minute crystal of mezzolite, were successively suggested and employed. Wollaston adopted a platinum wire, drawn to extreme tenuity by inclosing it in a plug of silver, afterward removed by acid; this is illuminated by a ray of light which passes from a lamp along the horizontal axis, and is reflected by a small speculum upon the wire.

The wires of the Oxford heliometer (England) are illuminated by a voltaic current, which renders them red-hot.

Porro illuminates the wires by a thin vein of light perpendicular to the axis of the telescope, so as to make the wires silvery white in a dark field.

Brewster proposed to obtain micrometer lines by placing in the field of view the reflected images of a fixed or movable system of wires or of lucid disks attached to the side of the eye-piece.

The photographic micrometer is thus described by Sir David: —

"If a system of opaque or transparent lines be impressed upon the collodion photographically when reduced to the minutest size, from a system of large and sharply defined lines, we shall have the most perfect micrometrical scale that can be conceived; the portion of collodion that contains no nitrate of silver being as transparent as if the dark places were solid wires or metallic plates placed in the focus of the eye-glass."

See Pearson's "Practical Astronomy," Vol. II.; Brewster's "Philosophical Instruments."

Cavallo's micrometer is a small, semi-transparent scale of mother-of-pearl, about $\frac{1}{20}$ of an inch broad and divided by finely ruled lines. It is situated within the tube, at the focus of the eye-lens of the telescope, with its divided edge in convenient proximity to the image.

See under the following heads: —

Annular micrometer.
Circular micrometer.
Cobweb micrometer.
Dioptric micrometer.
Divided object-glass micrometer.
Double-image micrometer.
Double-refraction micrometer
Eye-piece micrometer.
Filar micrometer
Heliometer
Linear micrometer.
Megameter.
Micrometer-balance.
Micrometer-microscope.
Micrometer-screw.
Mother-of-pearl micrometer.
Photographic micrometer.
Position-micrometer.
Prism-micrometer.
Reticulated micrometer.
Ring-micrometer.
Scale-micrometer.
Stage-micrometer.
Wire-micrometer.

Mi-crom'e-ter-bal'ance. Kenshaw's micrometer-balance, invented about 1842, consists of a beam or steelyard supported on a knife-edged fulcrum. Near one end of the beam a few threads are cut, on which is a wheel graduated to degrees, each of which corresponds to half a grain in weight. The coin is placed on the other end of the beam, and if of correct weight an index-bar points to zero on the wheel; but if it be light, the wheel is turned round, altering the leverage of the beam until it is in equilibrio. The degree to which the index-bar points shows how many half-grains the coin is short of its proper weight. The device may be adjusted to weigh half-sovereigns.

Mi-crom'e-ter-mi'cro-scope. The *micrometer-microscope* is used for reading and subdividing the divisions of large astronomical and geodetical instruments. (WEBSTER.) Around the mural circle of the Washington Observatory are placed six micrometer-microscopes, with an acute cross of wires at their foci for reading angles less than 5′. Five revolutions of the micrometer are designed to measure 5′ upon the circle. The micrometer heads being divided into sixty equal parts, each division represents 1″ of arc.

Mi-crom'e-ter-screw. A screw attached to optical and mathematical instruments as a means for exact measurement of very small angles.

The great space through which the lever of the screw passes, in comparison with the longitudinal motion due to the pitch, affords the means for a positive motion which is imperceptible on the object moved, though appreciable in its results.

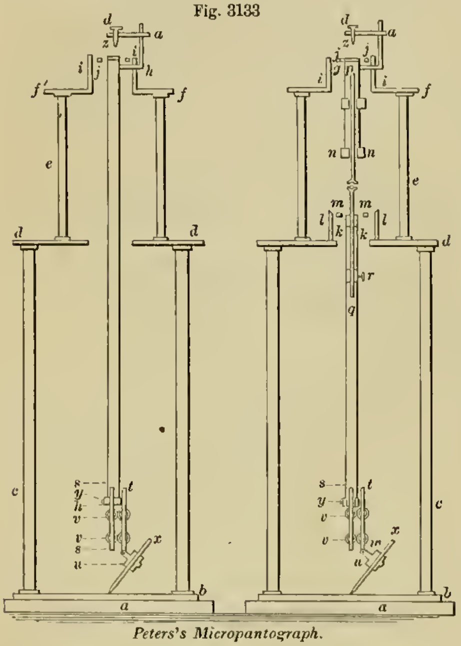
The head of the micrometer-screw being divided into sixty equal parts, and representing 1′ of arc, a revolution would be equal to 1°.

If the thread of a micrometer-screw in an instrument has 50 threads to an inch, and carries a pointer which traverses a graduated circle divided into 20 equal parts, the revolution of the micrometer-screw for a distance equal to one of the divisions will move the object to which the screw is attached $\frac{1}{1000}$ of an inch; that is, $20 \times 50 = 1,000$. See MEASURING-INSTRUMENT.

Mi'cro-nom'e-ter. A species of watch intended for measuring short intervals of time, as the flight of a projectile, etc., has been thus called. After being wound up in the ordinary way it is set in motion by pressing a spring with the finger, upon withdrawing which it is instantaneously stopped.

Mi'cro-pan'to-graph. An instrument invented in 1852 by Mr. Peters, an English banker and microscopist, for minute writing. It consists of an upright stand having four columns *c c* supporting a brass plate *d d*, on which are placed four smaller columns *e e*. On top of these is a second plate *f f* and ring *i i*, in which is journaled an interior ring *j j*; in this is pivoted a lever *q* having its arms in the proportion of 125 to 1. To the shorter arm of the lever is attached an arm *h* carrying the writing-point and sliding-arm *d a*. The lower end of the tubular lever *q* is caused to move in any required direction by means of the rods *s t*, which are connected by two pair of rings *v*, each pair joined together in one plane and each moving on horizontal pivots. The first enters the lower end of the lever *q*, and the second may be moved vertically, and has at its lower end a joint *u* connecting it with the arm *w* which carries the tracing-point; this being moved over the outlines of the letters of a piece of writing or other object, the tracer *d* at the top of the machine produces a reduced copy on a plate of glass fixed beneath it. In the example, this would be reduced to $\frac{1}{125}$ the linear dimensions of the original, or $\frac{1}{15625}$ of its area. This apparatus was improved by the inventor (see right-hand figure), who added an intermediate lever *p* consisting of two parts united by a universal joint; its ends slide in bearings *n n*, *k k* at the ends of the separated parts of the lever *g*, so that the relative lengths of the two parts, which in fact constitute the arms of a compound lever, may be varied within certain limits, so as to vary the proportion between the original and the reduction. The amount of diminution which the instrument is capable of producing may, by thus adjusting the relative length of the levers, be raised between 108 and 6,250 times, lineal measurement.

Fig. 3133



Peters's Micropantograph.

The writing or engraving point *d* is pressed against the glass plate on which the reduction is made or raised therefrom by springs, a connecting-rod, and a lever operated by the left hand, while the right is occupied with the tracer *x*. See MICROGRAPH; Fig. 3132.

It was stated in 1862 by Mr. Farrants, that the Lord's Prayer, containing 223 letters (*amen* being omitted), had been written on glass with this instrument within the space of $\frac{1}{356000}$ of a square inch; at which rate the whole Bible might be inscribed within the $\frac{1}{22}$ part of a square inch.

Mi'cro-phone. An instrument for increasing the intensity of low sounds by communicating their vibrations to a more sonorous body which emits a more audible sound.

Mi'cro-scope. An optical instrument by which objects too small to be viewed by the naked eye may be seen and examined.

A *single* or simple microscope is one by which the object is seen directly; it may consist of a single lens or of more than one.

In a *compound* microscope two or more lenses are so arranged that the image formed by one is magnified by the others, and viewed as if it were the object itself.

In a *solar* microscope a reflector and condenser are employed to direct the sun's rays on the object.

In a *lucernal* microscope the rays of a lamp are similarly directed.

The magnifying power of glass balls was known in early times to the Chinese, Japanese, Assyrians, and Egyptians, and more lately among the Greeks and Romans. The use of lenses for microscopes long preceded their application to telescopes. Sir David Brewster exhibited one in 1852 which was made of rock crystal, and was found among the ruins of Nineveh.

The refractive power of glass was known to Ptolemy, who gives a table of the deviation luminous rays experience when passing through glass under different angles of incidence. Descartes discovered the law that the amount of this refraction is proportional to the sine of the angle of incidence, and from that time date all great discoveries in optics.

Glass balls, called burning spheres, were sold in Athens before the Christian era. Their magnifying power was mentioned by the Roman philosopher Seneca, and by Porta of Naples in his "Magia Naturalis," published in 1590.

Alhazen, A. D. 1100, was the first to correct the popular error as to the nature of vision, showing that the rays came from the object and did not issue from the eye, as had been previously supposed. He determined that the retina is the seat of vision, and that impressions made on it by light are conveyed from it along the optic nerve to the brain; he explained that the formation of the visual images on corresponding portions of the two retinas is the cause of our seeing single when we use both eyes; he showed that a ray of light entering the atmosphere obliquely is deflected and follows a curvilinear path, owing to the increasing density of the air as the rays travel towards the earth, and deduced from the data that the limit of the hight of the atmosphere is about 58½ miles.

Huyghens states that Drebell had a microscope in 1621, and that he was the reputed inventor of it; the invention is also claimed by Fontana, a Neapolitan, in 1618. Burrell asserts that the Jansens, father and son, made the first microscope and presented it to Prince Maurice and Archduke Albert of Austria. The invention was, however, clearly anticipated by Roger Bacon. Spectacles were in use A. D. 1200. The double microscope was invented by Farncelli in 1624.

Dr. Hooke (1635 – 1702) made microscopes of a sphere of glass, from $\frac{1}{20}$ to $\frac{1}{30}$ of an inch in diameter. Having made and polished his lens, he placed it against a small hole in a thin piece of metal and fixed it with wax.

Leuwenhoeck's microscopes, 26 in number, which he presented to the Royal Society, have each a double-convex lens. Their powers were from 40 to 160.

"Comes Mr. Reeve, with a microscope and a scotoscope. For the first I did give him £5 10 *s.*, a great price, but a most curious bawble it is." — Pepys's *Diary*, 1664.

Stephen Gray's "poor-man's microscope," 1696, was merely a drop of water suspended at the end of a wire or pin. A piece of perforated cardboard or sheet-metal affords a better means of holding the drop of water, whose rounded surfaces give it the properties of a lens.

By fusing in the flame of a spirit-lamp a small piece of glass contained within a ring of platinum-wire, a lens may be formed. A piece of the wire should project, so as to form a handle.

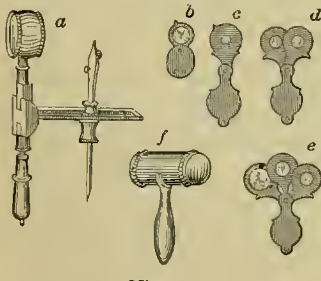
Plate-glass is the material commonly used for microscopic lenses. Flint-glass, on account of its great dispersive power, is unsuited for the purpose. Rock-crystal is an excellent material. The diamond and other precious stones have been employed, but the advantage of their high refractive power is found to be counterbalanced by their color, reflective power, double refraction, and heterogeneous structure. The crystalline lenses from the eyes of small fishes give a very perfect image of minute objects.

The lineal magnifying power of a single lens is equal to the distance of distinct vision divided by the focal length of the lens. The object is brought a little within the focal distance of the lens and appears erect.

Fig. 3134, *a* is a jointed microscope for flowers, insects, etc., and is made to fold up and be carried in the pocket. The holder is movable in the slide for focal adjustment and has forceps between which the object is held.

Simple microscopes, to fold in cases, *b c d e*, are made with one or several lenses, which have a diameter of from ¾ inch to 1¾ inches. They are variously mounted.

Fig. 3134.



Microscopes.

The Stanhope lens *f* was invented by Earl Stanhope, and is a cylinder of glass with two convex ends. It is 1½ inches in length and ¼ inch in diameter, and is mounted in a metallic tube. The ends have a relative convexity of 6 to 1, and the instrument has considerable power.

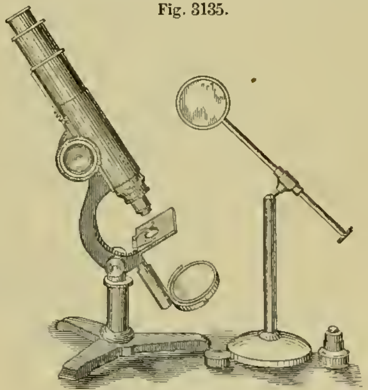
The "Craig" microscope comprises a single lens mounted on a stand, a glass for holding objects below it, and a mirror for reflecting light on the under side of the object and lens. The magnifying power is greater than that of the cheapest compound microscopes, and the instrument simple and convenient to use.

The compound microscope usually has three lenses, — the object-glass, the field-glass, which intercepts the extreme rays passing through the object-glass and thus enlarges the field of view, and the eye-glass. It shows objects in an inverted position. See also Objective.

The United States army microscope, made by Zentmayer, is thus described: It has a brass body, 16 inches high, on brass stand, with joint to incline it to any angle, double-milled head-rack and pinion for coarse adjustment, micrometer-screw for fine adjustment, and movable glass stage; under the stage a tube is fitted for carrying the accessory illuminating apparatus, concave and plane mirrors, arranged for direct or oblique illumination, two eye-pieces, one achromatic object-glass $\frac{8}{10}$ of an inch focus, of 24 degrees angular aperture, one achromatic object-glass $\frac{1}{5}$ of an inch focus, of 80 degrees angular aperture (not adjustable for glass cover), giving power of 50, 100, 250, and 450 diameters: camera lucida, stage micrometer ruled $\frac{1}{100}$ and $\frac{1}{1000}$ of an inch, and a condensing lens two inches diameter on separate stand.

Fig. 3135 represents a microscope especially designed for dentists' use. It has a rack and pinion for approximate, and a milled headed screw for accurate, adjustment of the focus, and is provided with two objectives having magnifying powers of 125 and 230 diameters respectively. It has also two mirrors, a plane and a concave, a revolvable and removable diaphragm, and a condensing lens on a separate stand.

Fig. 3135.



Compound Microscope.

Daylight or strong artificial light suffices for the observation of an object under a lens or microscope of moderate power, but with high powers more light is required, especially as the object is shaded by the lens. The condenser, a convex lens placed at the side of the object which is in its focus, is then employed. The light may be also concentrated on the object by a reflector.

Lieberkuhn, 1740, devised a hollow concave reflector with a hole in the center, in which was placed a small lens, the foci of the lens and mirror nearly coinciding. This throws abundance of light on an object placed in the focus, but as it comes equally from all sides no shadows are formed and the object is difficult to define. The device is, however, well adapted for the detection of small particles of metal, etc., in ores.

The Abbé Huc exhibited his microscope to the Regent of Thibet at Lha-Ssa.

"An exceedingly robust specimen of the *pediculus* was kindly furnished by a noble Lama, the secretary to the Regent, from his own preserves. When seized by the nippers, the Lama objected that the experiment would cause the death of a living creature. 'Be silent,' said the Regent. '*Tsong-Kaba!*' cried he, when invited to apply his eye to the glass; 'the creature is as big as a rat.' After looking at it a few moments, he hid his face with his hands, saying it was too horrible to look at. Every one approached the microscope in his turn, and every one started from it with cries of horror. The Lama plead for his little parasite. We removed the pincers and let it fall into the hand of its proprietor. Alas! the poor victim was motionless. The Regent said to his secretary, laughing, 'I think your animal is indisposed. Give it some medicine.'" — *Abbé Huc's Travels in Tartary and Thibet*, 1844-46.

The solar microscope consists essentially of two lenses and a mirror. The mirror reflects the sun's rays upon the first lens, by which they are concentrated on an object placed in its focus, and is still farther magnified by a second lens, which throws the image on a screen at some distance behind it. The exterior lens is placed in a hole through the shutter of a darkened room, and the mirror is adjustable so that it may receive the sun's rays under a proper angle to be reflected to the lenses. The object is here supposed to be transparent; if it is opaque, it must be so illuminated that the rays reflected by it shall pass directly to the interior lens.

The theory of the solar microscope is said to have been invented by Dr. Hooke, and was described by Professor Balthasaurs in Erlange in 1710; but its practical execution is due to Dr. Lieberkuhn in Berlin, who made the first successful apparatus in 1740. It is founded on the same principle as the *camera obscura*, only in place of causing the lens or lenses to form inside of the apparatus a small image of large exterior objects, as is the case with the *camera obscura*, on the contrary, in the solar microscope, the lens or lenses form outside of the apparatus a large image of small objects placed inside the apparatus.

When the objects are opaque and illuminated in front by reflecting mirrors, the apparatus has been called a *megascope*.

The apparatus of the hydro-oxygen and the electric microscope is identical with that of the solar microscope, only that for the solar rays, which are not always at command, the so-called Drummond, lime, hydro-oxygen, or electric light is substituted. The magnesium light has also been used in this way. Either of the above is inferior to the solar microscope in the same ratio that our best artificial lights are inferior to the solar light.

A modification of the above has been adapted for producing enlarged photographs of small objects. The enlarged photograph on glass is then placed in the magic-lantern or stereopticon, and re-enlarged for the benefit of the audience. Or the enlarged view may be taken upon the prepared surface of a wooden block, ready for the skill of the engraver. A beautiful set of engravings, thus produced, were given in Harpers' Magazine some years back.

The mode of obtaining enlarged prints from negatives of ordinary size is explained under SOLAR CAMERA. We are much indebted to Mr. Shive of Philadelphia for the improvements in this apparatus.

The variety of objects which afford interesting subjects for examination by the microscope is infinite. For such, the reader is referred to works treating the subject specially. It is also useful for detecting adulterations in food, drugs, and fabrics, and in many branches of scientific and medical investigation its aid is indispensable. Another use to which it may be applied was disclosed during the late Franco-Prussian war. Copies of newspapers, reduced many-fold in size by photography, were fastened in large numbers to carrier-pigeons and introduced into besieged cities. These were easily read by the microscope.

Microscopic writing has of late years attracted some attention. It is done by means of an instrument composed of a series of connected levers. The operator writes or traces with the longest lever of the system, while the shortest, which carries a marking instrument, faithfully copies whatever may be written. It was calculated that with Peters's machine, at the London Exhibition of 1862, the whole Bible might be copied 22 times in the space of one square inch. It has been proposed to apply this invention to practical use by making private marks, visible only under the microscope, to bills and other papers of value, as a protection against fraudulent imitations; being so minute, a counterfeiter would fail to perceive them, while they would be easily recognized by the proper parties. See MICROGRAPH; MICROPANTOGRAPH.

The prices, as well as the construction, of microscopes vary greatly; those having a magnifying power of less than 200 may be made comparatively simple and at a relatively cheap rate, but when the magnifying power exceeds 300 the whole apparatus becomes more complex, and must be more carefully made in order to handle, focus, and illuminate the objects properly, center the lens correctly, etc. In these the stand alone costs nearly $100, the eye-glasses $5 to $10 each, and the object-glass on Selligue's system from $10 to $75 each, according to power.

Besides eye-pieces and objectives of different powers, there are a number of necessary or useful appendages, as, condensing lens, prismatic illuminator, dark well, parabolic reflector, lieberkuhn, polarizing prism, micrometer, camera for delineating objects, etc., which tend to augment the price, so that a complete compound microscope costs from $300 to $1,000. The binocular microscope is, of course, still more expensive, the price in some instances reaching $15,000. A good instrument, however, amply sufficing for the wants of ordinary amateur observers, may be obtained for $100.

See "Carpenter on the Microscope"; Hogg's "History of the Microscope," etc.

The investigations of Leuwenhoeck, Schwammerdam, and the earlier microscopic inquirers, were conducted by means of single lenses, the compound microscope being esteemed comparatively untrustworthy, its true theory being imperfectly understood.

In 1829, Mr. J. J. Lister published the results of his investigations into the laws governing the aberrations of lenses, and gave practical directions for correcting them by combinations of lenses so arranged that the aberrations should balance each; from this period date the great and rapid improvements which have since been made in the compound microscope.

Among recent important improvements in the microscope is the illuminator of Professor Hamilton L. Smith, for opaque objects, in which the light is received upon a mirror behind the object-glass, through which it is reflected upon the object. Also his mechanical finger, by which objects invisible to the naked eye are picked up on the point of a hair, separated according to kind, and arranged conveniently for observation.

After the discovery of the theory of binocular vision by Wheatstone in 1838, and especially after the construction of the lenticular stereoscope by Sir David Brewster in 1852, the idea naturally occurred of applying this principle to microscopes. This was first effected by Professor J. L. Riddell of the University of Louisiana. He employed a pair of small rectangular prisms immediately behind the object-glass; these received the incident rays and reflected them through a second pair of similar prisms to the eye of the observer. This arrangement had the disadvantage of reversing the stereoscopic effect, projections appearing as depressions, and *vice versa*.

The first arrangement for producing a correct stereoscopic effect was invented by Mr. Nachet, and consisted of an equilateral prism which divided the pencil of rays into two equal parts, reflecting them to two similar prisms, right and left hand, which reflected them to the eye of the observer.

The Wenham binocular (Fig. 687, p. 285), in which the compound pencil is divided by means of a trapezoidal prism, has, however, on account of its greater simplicity of construction, been more generally employed.

Mr. Nachet has since introduced a simpler form of binocular microscope, which may be applied to an ordinary instrument without altering its construction or impairing its usefulness as a monocular. This is effected by making an opening in the side of the tube, into which is introduced a rectangular prism which reflects half the pencil of rays horizontally; this is received on another prism, which directs it to the eye of the observer. Arrangements are made for varying the distance between the tubes to accommodate them to the varying distances between the eyes of different persons.

The disadvantage common to binocular microscopes on this plan is that they perform well only with comparatively low magnifying powers. This led to the suggestion a few years ago by Mr. Wenham of a method of dividing the pencil by means of a transparent plane reflector, which, adjusted at a proper angle, might reflect one half the light of each pencil, allowing the other half to pass through. This plan involves the loss of the stereoscopic effect, but secures to the observer the satisfaction of using both eyes in viewing an object. It has, however, proved somewhat difficult to carry out this idea satisfactorily in practice. See PRISM.

Messrs. Powell and Lealand of London have patented an arrangement, consisting of a quadrangular prism which receives the rays, part of which pass through, while the remainder are reflected to a triangular prism which transmits them to the eye. This has the disadvantage of causing the object to appear unequally illuminated in the two tubes.

Mr. R. B. Tolles has constructed an instrument designed to remedy the defects of the original binocular microscope, at the same time permitting the ordinary single-tubed instrument to be used as a binocular. The double eye-piece has prisms similar to those employed in Nachet's earliest form, placed at a distance from the objective about equal to that of ordinary eye-pieces. In this form it is necessary that the axes of the pencils of rays should cross each other a second time, and for this purpose an erecting eye-piece is employed.

Professor H. L. Smith has proposed a form of binocular, consisting of a thin plane reflector, inclined at an angle of 80° to the axis of the telescope; a ray of light from the object, striking the surface of the mirror, is in part transmitted without change of direction, and in part reflected to a triangular prism having one of its angles truncated, where it undergoes a second reflection to correct the reversal produced by the first, and is transmitted along the axis of the secondary tube. By this arrangement, the intensities of the light of the directly viewed and reflected images appear sensibly equal.

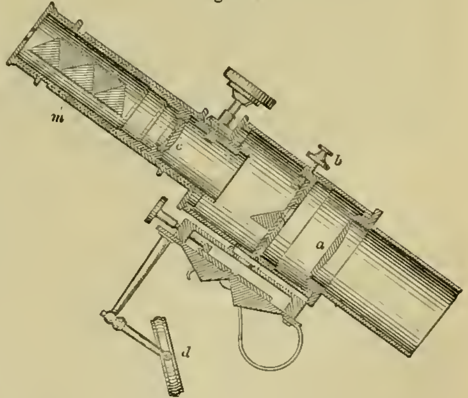
It is obvious that, after the division of the beam of light from the object, it is merely a matter of detail to give each of the divisions a direction proper to be viewed by two or more observers. This affords great advantages, not only in anatomical and other investigations, but, where the instrument is used merely for curiosity, it enables several persons to observe at the same time, thus greatly economizing time.

In the triple microscope for three observers, the beam of light is divided into three equal parts by a combination of suitable prisms, each part being directed into its proper tube. Provision is made for the general adjustment of the lenses, and also for the adjustment of the eye-piece of each tube to the eye of the particular observer.

The construction of the *stand* is a matter of considerable importance, as upon its arrangement largely depends the degree of illumination and the distinctness with which the objects can be viewed. A good arrangement of this kind, constructed by Tolles, comprises a movable stage having two tables, one facing upward and the other downward, firmly connected together and controlled by milled heads. When the object is placed on the lower table, it is secured by spring clips. In this case, the central part of the upper table is removed, and the objective descends through the opening. Any degree of obliquity of illumination, even up to 90°, is thus available for viewing the object. The stage is also capable of rotation on its optical center throughout the entire circle.

Mi′cro-spec′tro-scope. A spectroscope placed in connection with a microscope, in order that the absorption lines may be the more accurately measured. The eye-piece contains prisms so placed as to enable the reflected ray to pass in a direct line to the eye. *a* is the first lens of the eye-piece; *b* the screw for adjusting the slit which reduces the beam to a line of light; *c* is the second lens, where the rays

Fig. 3136.



Higgins's Microspectroscope.

are rendered parallel, after which they pass through three crown-glass prisms *m*, placed in one direction, and two flint-glass prisms, placed in the other direction, so that the spectrum is seen by looking straight at the source of light, the instrument being a direct-vision spectroscope.

The instrument is notably employed in viewing the absorption bands of blood in toxicological research. By means of the mirror *d*, a ray of light, shown by the dotted line, may be sent through a slit at one side of the instrument, which, being reflected upward, passes through the prisms along with the other light which came from the object under the microscope, and by this means the two spectra may be compared, one object being a liquid supposed to be blood, and the other one known to be blood, and so on.

Mi′cro-tome. A knife for making thin sections for microscopic examination. A pair of parallel knives in a single haft. See PARALLEL KNIFE.

Mid′dle-cut File. A file whose teeth have a grade of coarseness between the *rough* and *bastard*. See FILE.

Mid′dle-post. (*Carpentry.*) A king-post in a TRUSS (which see).

Mid′dle-press′ure En′gine. (*Steam-engine.*) An English term applied by some to a low-pressure or condensing engine, adapted for working at a pressure of steam comparatively high for its class, say 25 pounds or upward to the square inch.

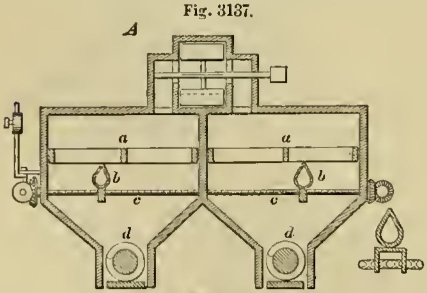
Mid′dle-shot Wheel. (*Hydraulic Engine.*) A *breast-wheel* which receives the water at about its middle hight.

Mid′dling. That portion of a gun-stock between the grasp and the *tail-pipe* or ramrod-thimble.

Mid′dlings-pu′ri-fi′er. (*Milling.*) An apparatus for cleansing the intermediate product of ground wheat termed *middlings*, and separating it from bran on the one hand and fine flour on the other. This was originally effected exclusively by passing the flour delivered from the millstones successively through a series of cylindrical bolts covered with cloth of different degrees of fineness, which were set in rapid rotation and brought in contact with a series of longitudinal rods termed beaters, the bolts separating in succession the finer and coarser qualities of flour and the middlings, the bran being retained within the last cylinder. See FLOUR-BOLT; BRAN-DUSTER.

This was succeeded by the dressing-machine, in which a like cylinder, rotating on an inclined axis, is covered with wire-gauze of several degrees of fineness, the coarsest being placed at the lower end; the flour is thus graded during its passage from the upper to the lower part of the cylinder, the middlings passing through the comparatively coarse meshes of the lower cloth while the bran passes out at the end as tailings. The interior of the cylinder is provided with a revolving reel set with brushes, which force the meal through the meshes of the cloth. When clogged, the cylinder is cleaned by an interior brush operated by the machinery.

Fig. 3137.



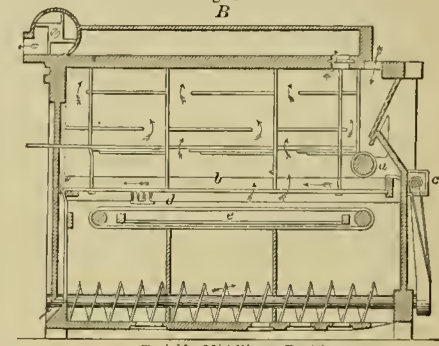
Lacroix's Middlings-Purifier

As at present constructed, machines of this kind may be divided into five classes, an example of each of which is given.

A (Fig. 3137) is one in which air, forced through perforated pipes, is used for cooling the flour and clearing the meshes of the cloth. The middlings are fed through hoppers over the screens *a a*, and are purified by a current of air passing through the tubes *b b*, which are arranged on the screw-threaded shaft *c c*, alternately rotated in opposite directions, causing the tubes to traverse from side to side of the screens; the lighter matters are drawn upward and carried off by a fan, while the middlings, passing through the screen, are removed by the screw-conveyors *d d*.

Fig. 3138, *B*, is a purifier in which brushes are employed for clearing the meshes of the cloth. The meal or middlings is fed by rollers *a* to the bolt *b*, its amount being regulated by a slide; a shaking motion is imparted to the bolt by an eccentric *c* on a shaft, and a continuous upward current of air is passed through the machine; fine particles adhering to the bolting-cloth are removed by brushes *d* attached to endless belts *c*.

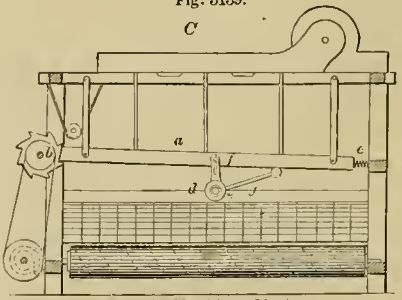
Fig. 3138.



Smith's Middlings-Purifier.

Fig. 3139, *C*, shows a machine with reciprocating shakers, with knockers for clearing the meshes of the cloth. In this machine the suspended shaker *a* is pressed against the ratchet-wheel *b* by a spring *c*, the rotation of the wheel causing a vibration of the shaker; *d* is a rock-shaft, pivoted at *e*, loosely connected with the shaker by a slot and pin at *f*, and

Fig. 3139.

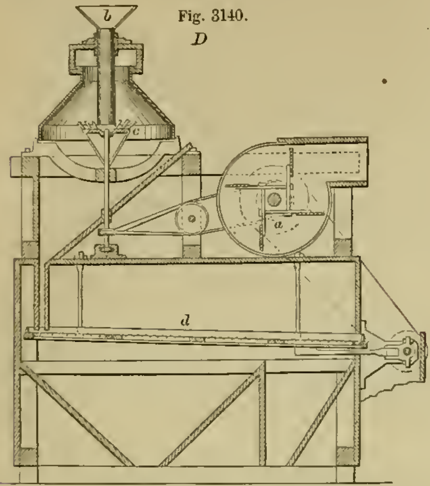


Mowry's Middlings-Machine.

provided with an arm *g* carrying a hammer, which strikes the bottom of the shaker at each reciprocation.

Fig. 3140, *D*, shows whippers or beaters in connection with an air-blast for operating on the middlings before bolting. A fan *a* produces an air-blast which is carried upward through an inclined trunk; middlings from the hopper *b* are caught by a revolving cone or disk *c*, provided with upwardly projecting pins, disengaging particles of dirt which adhere to the coarser particles of the meal; these are carried off by the blast, while the valuable portions slide down an incline to the sieves *d*, which are vibrated in the usual manner by a cam-shaft; the coarser and harder portions of the meal fall through the sieves, while foreign matters are finally shaken out at their ends and delivered into a spout.

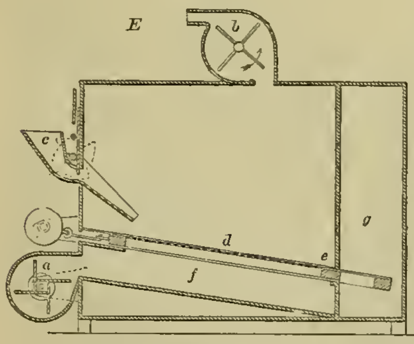
Fig. 3140.



Huntley and Holcomb's Middlings-Machine.

E (Fig. 3141) uses both suction and an air-blast. In this machine a blower *a* and exhaust-fan *b* are employed; the stuff from the hopper *c* is fed intermittingly to the screen *d* by means of a cut-off plate, while the screen has a longitudinal motion, and is divided into two parts by a partition *e*, one part being immediately over the air-tight chamber *f*, while the other projects within the air-tight chamber *g*; the first part is provided with cloth of such fineness that none of the middlings can pass, but the other allows the granulated portions to pass to a spout, by which they are conveyed to a receiver; the tailings fall over the lower end of the screen into another receiver.

Fig 3141.



Wilson's Middlings-Purifier.

The fine particles of dust and dirt are driven upward by the blower *a* and carried away by the exhaust-fan *b*. See "Digest of Middlings-Purifiers," DeW. C. Allen, Washington, 1873.

Mid-feath'er. (*Steam.*) A water-bridge in a steam-boiler furnace which occupies a middle position in the flue-space, the flame passing both above and below it.

Mid'ship-beam. (*Shipbuilding.*) The longest beam in the middle of a ship.

Mid'ship-bend. (*Shipbuilding.*) The *midship-section* or the largest of the cross-sections of a ship. When the middle of the ship has a portion of a uniform cross-section, such is called the *midship-body.*

Mid'ship-frame. The frame at the midship or largest section of a vessel.

Mil'i-ta-ry-bridge. A bridge, usually of a temporary character, designed for the passage of an army with its artillery and supplies or for maintaining its communications.

Probably the earliest on record is that thrown by Darius across the Bosphorus during his invasion of Greece, 490 B. C.

Ten years later, his successor, Xerxes, crossed his army, said to have been 1,700,000 strong, from Asia into Europe by similar means.

The bridge of Xerxes across the Hellespont consisted of ropes resting on galleys and supporting planks. The account given by Herodotus may be thus briefed: —

Two parallel bridges were constructed, one supported by 360 vessels and the other by 314. The vessels are classed as *triremes* and *penteconters*, and were anchored parallel, the prows facing up stream, that is, toward the Euxine. To each bridge were assigned six cables, "two of white flax and four of papyrus." These were stretched across the strait, lying upon the vessels, and drawn taut by wooden capstans on the Abydos and Chersonese shores. One bridge was for the army, and the other for the sumpter animals. "Trunks of trees were sawn into planks, which were cut of a length to suit the width of the bridge, and these were laid side by side upon the tightened cables and then fastened on the top. This done, brushwood was brought and arranged upon the planks, after which earth was heaped upon the brushwood and trodden down solid. Lastly, a bulwark was set up on each side of this causeway of such a hight as to prevent the sumpter beasts and the horses from seeing over it and taking fright at the water." — HERODOTUS, VII. 36.

The army was seven days and nights in crossing.

The bridge thrown across the Rhine by Cæsar, for the purpose of enabling him to cross that river in order to chastise the Germans, who, under their king, Ariovistus, had invaded the Gallic territory, was formed by driving piles 18 inches square into the bed of the river, in pairs 2 feet apart and slightly inclined. Opposite these, at a distance of 40 feet, was another pair of piles, inclined in the opposite direction. These were connected by beams 2 feet in diameter, on top of which were laid joists running in the direction of the breadth of the river, and covered with hurdles to form a roadway.

On the side below the bridge inclined piles were driven, serving as braces against the force of the current; and on the upper side were others to ward off floating objects, as trees or boats. The whole was completed and the army passed over in ten days. See BRIDGE.

Trajan's bridge over the Danube, erected 150 A. D., for the purpose of keeping in check the warlike Dacians, was one of the most remarkable structures of antiquity. It was built on stone piers supporting wooden arches, on which the superstructure rested. It was destroyed by his successor, Hadrian, who thought the Roman Empire was already large enough, and wanted no provinces beyond the Danube. The remains of the piers are existing at the present day. See BRIDGE.

Military bridges, of a temporary character, are made with piles, trestles, boats, pontons, or casks.

Pile-bridges are applicable in shallow rivers with deep mud, and where boats are not accessible or the stream not navigable.

Trestle-bridges are applicable under similar circumstances, where the material at hand suits better that mode of construction.

Boat-bridges are made by fastening them alongside each other to a cable moored on each bank of the stream. Over the boats are laid the *balks*, and crossing these the *chesses* or flooring-boards.

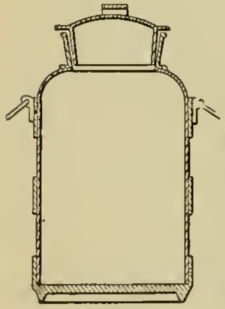
Ponton-bridges are laid upon *bateaux* or *pontons* carried by the army, and forming the *ponton-train*. They are laid like the boat-bridge or anchored.

Casks lashed to spars have been used as *pontons*. See PONTON-BRIDGE; TRESTLE-BRIDGE.

That end of the bridge toward the enemy is protected by a fortification (a *tête de pont*), a redan, or redoubt, according to the nature of the ground, and when practicable, by batteries arranged to command its approaches.

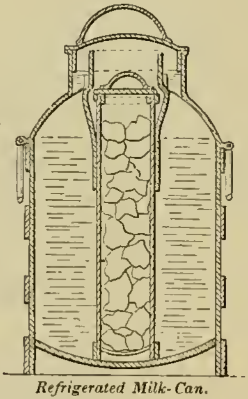
Milk-can. One adapted to the jars and blows incident to the conveyance of milk to market and to customers. In the example, the sheet-metal portion has strengthening bands, and is riveted to a cast-iron bottom, on which it may be rolled without bruising.

Fig. 3142.



Milk-Can.

Fig. 3143.



Refrigerated Milk-Can.

Fig. 3143 shows a can with an interior removable ice-chamber. This has a closely fitting stopper, secured in the can by a flange at the bottom, an annular band at the top, and springs to keep it in place. The inner vessel is filled with ice to keep the milk cool.

Milk, Con-densed′. Recipes for preserving milk: —

1. Add sugar; evaporate to one fourth; solder in cans.

2. Add carbonate of soda and white sugar; evaporate to dryness; cut into cakes.

3. Add sugar and alkali; evaporate to dryness; crush, powder, and bottle.

4. Evaporate to one half; beat up with white of egg; simmer, skim, strain, and boil.

English recipe, 1856. Fresh skimmed milk, 1 gallon; sesquicarbonate soda, 1½ drams; mix, evaporate to ¼ by steam-bath, accompanied by agitation; add powdered white sugar, 3½ pounds; complete the evaporation and reduce the mass to powder; add the cream, incorporate, and seal hermetically.

Old recipe. Carbonate soda, ½ dram; water, 1 fluid ounce; dissolve; add fresh milk, 1 quart, sugar, 1 pound; reduce to a sirup in a steam-bath, and finish the evaporation on plates in an oven.

At the works of the Aylesbury Condensed Milk Company in England 200 persons are employed, and the milk of 1,200 cows, each yielding 14 quarts, is daily evaporated. The milk is brought in tin cans by the surrounding farmers, is tested by taste, smell, and the lactometer, partially evaporated in a vacuum-pan, mixed with sugar, and finally condensed until its original proportion of water, 87 per cent, is reduced to 25 per cent. The condensed liquid has a semi-fluid consistence, and the "Lancet" gives the following analysis: —

Water	25.10
Butter	11.73
Caseine	15.17
Milk-sugar	16.24
Cane-sugar	29.46
Ash	2.30
	100.00

Borden's (American) process of condensing milk is protected by letters-patent. There are a number of factories for preparation of condensed milk in and about New York, where it is sold from house to house fresh from the condensing-vats. Thousands of gallons of milk are daily prepared to supply the demand in the army and navy, and for foreign consumption.

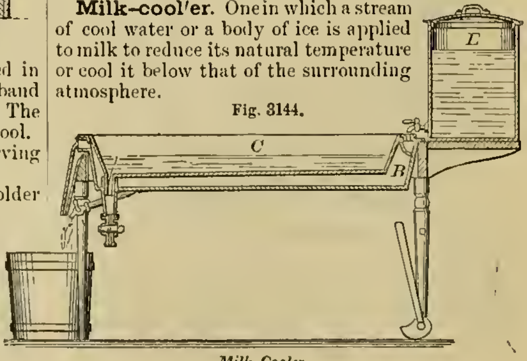
The usual process of evaporation is to place the milk in large shallow pans, each having a pump to exhaust the air. The water is driven off by a steam-heat of about 160 degrees. When the desired condensation is attained, sugar is added if the product is to be preserved beyond a few days, and other chemical agents according to the process.

Pure milk condensed to one third will remain sweet from 5 to 10 days in warm weather.

In Kirchofer's process the milk is not condensed, but as fresh drawn from the cow, is placed in cans or bottles, which are filled as nearly full as possible, immediately hermetically closed, and placed in a bath of water whose temperature is then slowly raised to between 160° and 170° Fah., and kept at this temperature for a greater or less length of time, according to the period during which it is desired to preserve the milk. The fire is then withdrawn and the bath allowed to cool down slowly.

Milk-cool′er. One in which a stream of cool water or a body of ice is applied to milk to reduce its natural temperature or cool it below that of the surrounding atmosphere.

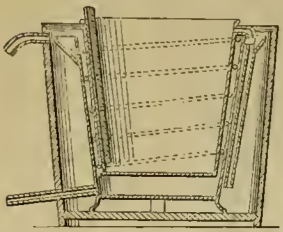
Fig. 3144.



Milk-Cooler.

In Fig. 3144, the water from a reservoir *E* passes through the pan *B* beneath the milk-pan *C*, and is discharged into the bucket.

Fig. 3145.



Milk-Cooler.

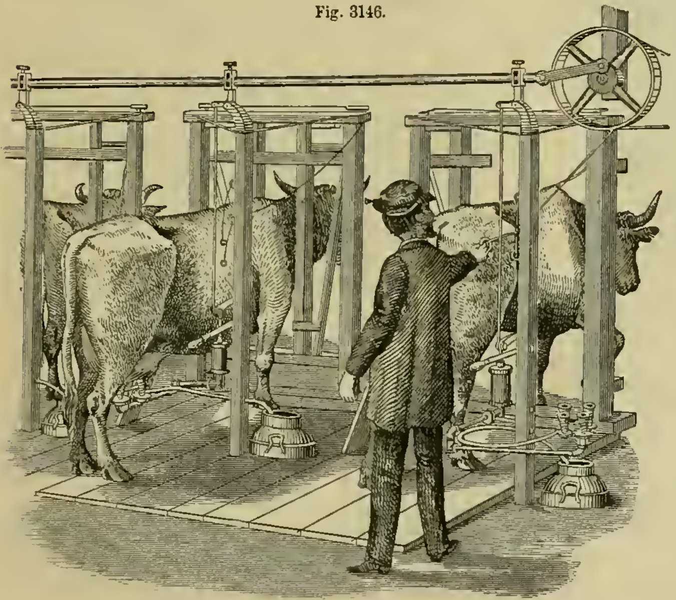
In Fig. 3145, the milk flows down a spiral track between the two metallic vessels, is cooled in its passage by the contents of the outer and inner vessels, and is discharged.

Milk'er. Cow-milkers are of two kinds: one of them depends upon a canula, which penetrates the lacteal orifice beyond the region of the sphincter muscles, which close the opening and prevent the involuntary emission of the milk; the other depends upon mere pneumatic pressure, the teat being inclosed in a cup whose lower end is connected by a pipe with an air-exhausting apparatus and a vessel to receive the milk.

Colvin's hydraulic cow-milker combines a cattle-stall and compound milking apparatus, operated by power. Several machines are ranged in a row, one to each stall, and are designed to be operated by one attendant. The power runs continuously, and the man allows a cow to pass through and admits another, which is secured in place, and the apparatus attached. The milk runs into large cans partially sunk in the floor. It is said that three machines are sufficient to milk sixty cows in the time it would take six men to milk them by hand.

The milkers are worked by pumps, the pistons of which are driven by power. They are attached by a jointed iron pipe to allow of the movement of the cow forward, backward, or sideways, always adapting itself to her motions. The teat-cups are of corrugated rubber, closely enveloping the teats of the cow. The pumps oscillate, giving the natural motion of the calf in sucking, or of the hand in milking; the space between the elastic diaphragm in the milker and the pump is filled with water, which, in working the pumps, oscillates in the tube and produces a vacuum at each alternate stroke of the piston.

Fig. 3146.

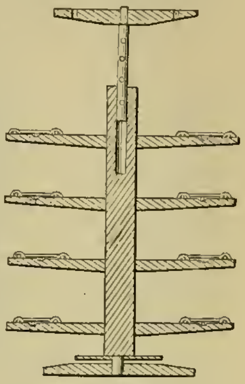


Calvin's Patent Hydraulic Cow-Milker.

Milk-glass. A kind of glass having a semi-translucent or milky appearance, and known by the names of CRYOLITE-GLASS or FUSIBLE PORCELAIN (which see).

Milk'ing-shield. A protecting plate over the breast, having a perforated cap over the sore nipple, to protect the same against actual pressure by the mouth of the infant when nursing. See NIPPLE-SHIELD.

Fig. 3147.

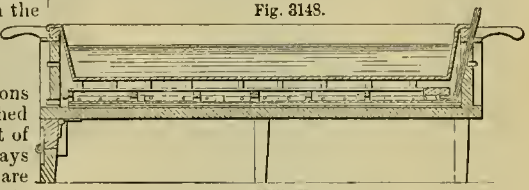


Milk-Rack.

Milk-rack. A series of shelves in a dairy to hold milk-pans. That shown is rotatable on its axis.

Milk-vat. A deep pan for setting milk to raise cream or curdle for cheese. In the example, steam and water pipes are introduced between the exterior and the interior vats to regulate the temperature of the contents of the latter.

Fig. 3148.



Milk-Vat.

Mill. 1. A machine for grinding.

2. A lapidary's grinding-wheel, known as a roughing-mill, cloth-mill, etc.

3. To serrate or dent the edges of coin.

4. To *throw* undyed silk.

5. A building or factory containing machinery.

6. (*Die-sinking.*) The hardened steel roller having the design in *cameo*, and used for impressing in *intaglio* a plate, — as in the bank-note system of engraving; or a copper cylinder, — as in the process of engraving cylinders for calico-printing.

The design is engraved on a small steel plate or roller, which is subsequently hardened by heating it to a cherry-red in an iron case containing pounded bone-ash, and then plunging it into cold water, its surface being protected from oxidation by a chalky paste. This hardened roller is called the *die*. The *die* is then placed in a transferring-press, where, by rotatory pressure, it is made to impress its design upon the surface of a softened steel roller placed in apposition to the said *die*. The soft roller has the design in *cameo*, is hardened, and forms a *mill*, which is capable of delivering an *intaglio* impression upon a plate or roller, as above stated. The process was invented by Jacob Perkins, and adapted to engraving cylinders for calico-printing by Locket of Manchester, England.

See under the following heads: —

Amalgamator.
Arrastra.
Bait-mill.
Bark-mill.
Barker's mill.
Barley-mill.
Battery.
Bean-mill.
Bone-mill.
Boring-mill.
Camp-mill.
Cane-mill.
Caoutchouc-mill.
Cement-mill.
Chilian mill.
Chocolate-mill.
Cider-mill.
Clay-mill.
Coal-breaker.
Cocoa-mill.
Coffee-huller.
Coffee-mill.
Corn-sheller.
Corn-mill.
Croze-mill.
Crushing-mill.
Current-mill.
Cylinder-mill.
Decorticator.
Devil.
Diamond-mortar.
Disintegrator.
Drug-mill.
Edge-mill.
Flatting-mill.
Flint-mill.
Fulling-mill.
Gig-mill.
Grain-bruiser.
Grain-huller.
Grinding-mill (varieties, see GRINDING-MILL).
Grist mill.
Gunpowder-mill.
Hand-mill.
Hominy-mill.
Horizontal mill.
Huller.
Indigo-mill.
Kibbing-mill.
Lead-mill.
Linseed-mill.
Malaxator.
Masticator.
Mill-wheel.
Molding-mill.
Mortar.
Mortar-mill.
Muller.
Oil-cake mill.
Oil-mill.
Ore-mill.
Paint-mill.
Pearl-barley machine.
Pearling-mill.
Peat-machine.
Percussion-grinder.
Pestle.
Plaster-mill.
Polishing-machine.
Polishing-mill.
Porcelain-mill.
Porphyrization.
Post-mill.
Powder-mill.
Pug-mill.
Pulp-mill.
Quartz-mill.
Quern.
Rasping-mill.
Revolving-pan mill.
Rice-huller.
Rice-mill.
Rock-pulverizer.
Roller-mill.
Roughing-mill.
Runner-ball.
Sand-crusher.
Sand-pulverizer.
Saw-mill.
Sheller.
Shingle-mill.
Shingling-mill.
Slitting-mill.
Smock-mill.
Smoothing-mill.
Smut-mill.
Snuff-mill.
Sorghum-mill.
Spice-mill.
Spinning-mill.
Stamp-mill.
Stamping-mill.
Steel-mill.
Stone-mill.
Sugar-mill.
Sugar-cane mill.
Throwing-mill.
Tide-mill.
Tread-mill.
Turning-mill.
Veneer-mill.
Warping-mill.
Water-mill.
Wheat-huller.
White-lead mill.
Windmill.

Mill-bar. The rough bar, as drawn out by the puddler's rolls. As distinguished from *merchant-bar*.

Mill'board. A stout pasteboard made of strong materials, such as refuse flax, cotton, and hemp, rope, or bagging; and used for the stiff portion of book-covers, and for other purposes. It is also used for packing between the flanges of pipes, being previously soaked in oil.

A commoner article is made of other coarse fiber, such as jute (cochorus), asclepias, sorghum, bark, straw, bamboo, grass, gama grass, New Zealand flax, and other materials.

Mill'board-cut'ter. A machine for cutting heavy board, for book-covers and pasteboard boxes.

Fig. 3149 shows a machine of this class. The sheets of pasteboard are fed between two shafts which carry disks or knives capable of adjustment at proper distances apart. The board is thus cut into strips, which are divided into parallelograms by a second feeding through the machine.

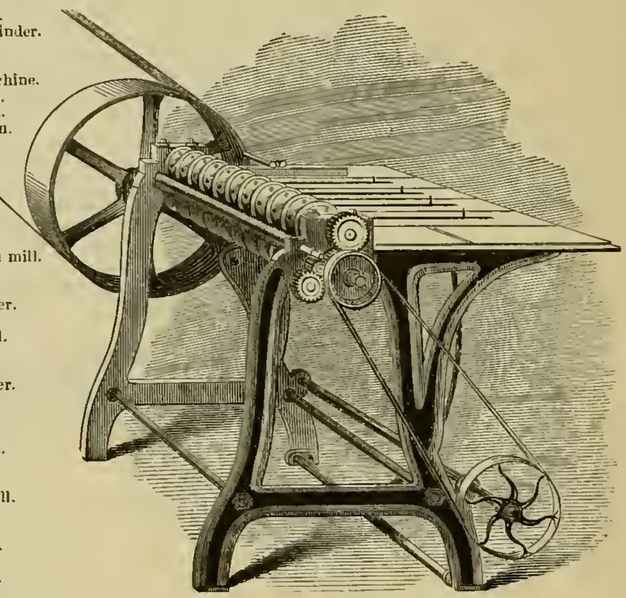
Mill-cake. 1. The incorporated materials for gunpowder; in the cake form, previous to granulating.

2. The mass of hulls and parenchyma remaining after the expression of linseed-oil.

Mill-dam. A wall or bank across the course of a stream to raise the level of the water and divert it into a mill-race. See DAM.

Milled Lead. Lead which has been spread into a sheet in the *rolling-mill*, in contradistinction to lead which is leveled while in a melted condition, upon a table with raised edges by means of a *strike* in the hands of two men.

Fig. 3149.



Chambers's Automatic-Feeding Board-Cutter.

Milled Cloth. (*Fabric.*) Woolen cloth which has been fulled or felted by beating, to thicken it.

Double-milled; the operation having been repeated to increase the density.

Mille-fi-o're-glass. A number of pieces of filigree, or tubes of glass enamel, are fused together, their sections representing stars, flowers, and other ornaments.

Sections of these tubes are imbedded in white transparent flint-glass, forming paper-weights.

It is a species of *mosaic* enveloped in a transparent bulb.

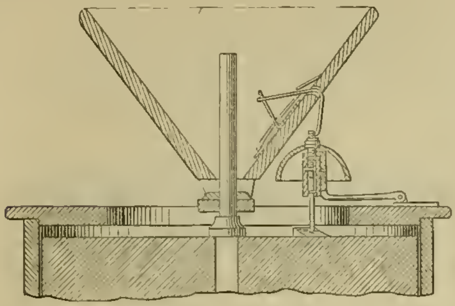
Mill-fur'nace. (*Metal.*) A reheating furnace. A furnace where the puddled metal is reheated, preparatory to again passing through the rolls.

Mill-gang. In warping; that part of the warp which is made by a descending and ascending course of the threads round the warping-mill.

Mill-hop'per A-larm'. An attachment to grinding-mills to indicate that the grist has about run out of the hopper. Mills have been burnt by the heat and sparks generated by the stones when running empty, and several devices have been patented to turn off the power and stop the machinery when the grist is expended. Other patents have been granted for arrangements by which timely notice is given of the fact that the hopper is nearly empty.

In the example, a plate hinged to the side of the hopper is held down by the grist until the latter is about expended. The plate then rises, and its attached cord allows a stud to drop so as to be struck by a projection on the stone at each revolution of the latter. This gives a rapid oscillation to the clapper, and sounds the alarm which announces that the grist is nearly expended.

Fig. 3150.



Taylor's Mill-Hopper Alarm.

In another case, a bell is so arranged within the hopper that when surrounded by the grain it is held stationary, but when uncovered is caused to ring by the tremulous motion of the hopper. The grain rests upon a float hinged near the bottom of the hopper. When the grain is about expended the float is raised by a weighted lever, and the spout of an upper hopper is opened to supply the lower one with grain.

Mil'li-net. A machine-made net. *Mill-net; bobbinet.*

Mill'ing. (*Machinery.*) 1. As in Webster, so in writers on mechanical construction, the term *milling* is applied: —

a. To an action such as that which upsets the edge of a coin, making the raised flanges which protect the ornaments in relief on the obverse and reverse sides of the coin.

b. To an action such as that which gives a fluting or crenation to the edge of the coin.

c. To a planing action by a circular cutter on metal. A mode of *shaping.*

The first is an expanding or upsetting, and the second is an indenting process, which is properly called *nurling.*

Milling, in the first sense stated, is performed upon an object in a lathe by the pressure of a burnisher or wheel, which turns over or upsets an edge, as in the case of the feather-edge on a tube or bezel which holds a lens or a jewel in its seat or setting.

The term *milling* is also applied to the machines in the mint which turn over the edges, at the expense of the diameter, and thus throw the faces a little into recess, so that the ornamental impressions are protected by the edges, and the coins when piled are enabled to stand steadily. The machine is described in its place under Coining (which see). Castaining's machine for milling coin was introduced into the French mint in 1685. See also *B*, Fig. 3151.

For *milling*, as a mode of planing to shape, see Milling-machine.

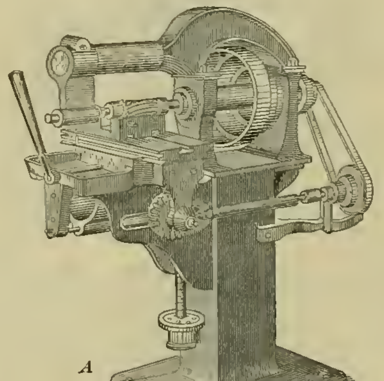
2. (*Porcelain.*) The mastication and grinding of slip for porcelain, giving it the final working to develop plasticity.

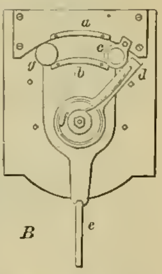
3. (*Cloth.*) A fulling process which condenses and thickens cloth at the expense of its area.

Mill'ing-ma-chine'. (*Machinery.*) A machine for dressing metal-work to shape by passing it on a traveling bed beneath a rotating serrated cylindrical cutter. The milling-machine occupies the same relation to metal that the planing or molding machine does to wood. In each case the work is reduced by a rotary cutter, whether the surface be plain or irregular. The use of the *milling-machine* has advanced greatly during the past ten years. They are now used as finishing tools in machinists' shops, but especially in the business of reducing to shape the forged, stamped, or cast pieces which are made by the thousands to an exact gage, and are built up into sewing-machines, fire-arms of various kinds, and other things too numerous to mention, which are made in pieces to size, and then *assembled.* They are largely used for finishing heads of bolts and set screws, shaping nuts, fluting taps or reamers, cutting key-seats.

Their use has been much facilitated by the contemporary improvement in grinding-machines with emery-wheels. It has been found that by the use of these grinding-machines, milling-tools could be kept in perfect cutting order without, as was formerly necessary, drawing their temper and retempering. It has thus been rendered possible to greatly widen the application of these tools and to adapt them to work which would have cost much more to finish by methods formerly in vogue.

Fig. 3151.





Milling-Machine.

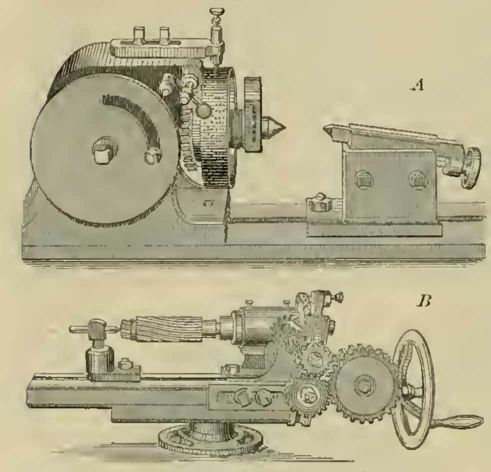
A (Fig. 3151) is a machine designed for milling where only a light or medium cut is required. The spindle is driven by a belt running on a cone-pulley without the intervention of gearing. The outboard center is supported by a stout cylindrical arm, secured to the head of the machine. The table is actuated by a hand-feed motion, and a rack and pinion worked by a lever in front constitutes the hand motion.

B (Fig. 3151) is a machine for lettering or milling the edges of coins. In that used in the French mint two arc-dies *a b*, on which the inscription is engraved in raised letters, one half on each die, but in reverse order, are immovably secured to the plate which bears the machine, and the distance between them is precisely equal to the diameter of the piece to be milled. *c* is a tube containing a pile of coins, which are successively pushed between the dies by the arm *d* attached to the lever *e*.

This lever, by its back and forth movement around the pivot *f*, also causes a rotary movement of the coin between the dies, during which the inscription, in sunken letters, is impressed on its periphery, after which it falls through the aperture *g* into a receptacle.

Fig. 3152, *A*, is a view, on a somewhat enlarged scale, of a *universal head*, which is adapted to be fastened to the platen of the machine. By chucking the object in this head, spur or bevel gear may be cut, and work milled at any angle or in any position.

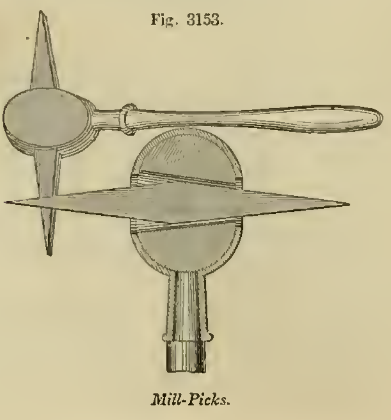
Fig. 3152.



Universal Head and Spiral Cutter of Milling-Machine.

B, in the same figure, is a *spiral cutter*, also designed to be attached, when required, to the platen of the machine. A piece of work is shown in position. By means of changeable gears the work is rotated beneath the milling-tool, so that a spiral cut is produced instead of a straight fluting. It is constructed to cut spirals 8 inches in length, right or left hand, of any pitch, from one turn in 2 inches to one turn in 6 feet. The spindle is hollow, allowing a $\frac{5}{16}$-inch rod to run through it.

Fig. 3153.



Mill-Picks.

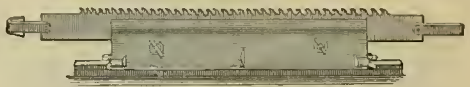
Mill′ing-tool. A small indented roller mounted in a stock and used to nurl objects, such as the edges of screw-heads, by pressure against the latter when they are rotating in a lathe. A *nurling-tool.*

Mill-pick. A miller's tool for dressing millstones, giving to the buhrs the slightly serrated surface; an operation known as *cracking*. The steel is necessarily hard and tough, great skill in heating, hammering, and tempering being required.

Mill-race. The canal by which water is conveyed to a mill-wheel. Below the wheel the water is conducted away by the *mill-tail* or *tail-race*.

Mill-saw Vise. A clamp to hold a mill-saw while filing. It is intended to be bolted to a bench, and the jaws work on centers to enable the saw to be placed at an angle.

Fig. 3154.



Mill-Saw Vise.

Mill-spin′dle. The vertical spindle of a grinding-mill, on which the runner is supported. See GRINDING-MILL.

Mill′stone. One of a pair of cylindrical stones for crushing grain in grinding-mills. The stone is peculiar, and comes mostly from France and from Georgia. See BUHR-STONE.

Many attempts have been made to introduce metallic cylinders, and stones differing from the buhr, in flouring-mills, but with indifferent success.

The stones are the "bed" and "runner," the upper being usually the moving stone, the lower being stationary. The relation of bed and runner is, however, sometimes reversed, the lower being the runner. See GRINDING-MILL, where illustrations occur.

The runner is supported by a *balance-rynd*, which stretches across the *eye* and rests upon the *spindle*. The upper part of the *spindle* is called the *cock-head*, and it is inserted into a cavity on the under side of the balance-rynd, called the *cock-eye*.

Millstones have various arrangements of grooves on their faces. The grooves are called *furrows*, and the intervening portions of the face are called *land*.

The system of *furrows* and *land* is called the *dress*, and this varies according to the custom of a country or the skill of the miller. Many varieties of dress are patented, and some will be cited presently. See Figs. 3154, 3155.

The *furrows* on the face of the millstone expedite the grinding action. The face of the millstone around the eye is usually somewhat sunken, so as to allow the grain to enter; this sunken space is called the *bosom*.

The *furrows* lead from the *bosom*, around the eye, to the *skirt* of the millstone, that is to say, to its periphery. It may be noted here, however, that in some modes of dressing, the *furrows* grow gradually shallower and disappear altogether before reaching the *skirt*, and leave a continuous *land* on the outer margin of the face.

A principal furrow leading from the eye to the skirt is called a *leader;* the branch furrow departing from the leader, nearest to the eye, is called a *second furrow ;* a branch furrow departing from the *leader* nearest to the *skirt* is called a *skirt-furrow.* A *furrow* concave at bottom is called a *gouge-furrow.*

A *furrow* has one steep edge and one slanting edge; the former is called a *track-edge*, and the latter a *feather-edge*.

A *leader* and its branches, occupying a segment of the face of the stone, is called a *quarter*, though not necessarily or usually occupying a fourth part of the face.

The operation of preparing the face of a stone is called *dressing*. Roughing the land face of a stone with a pick-hammer is called *face-cracking*.

The *draft* of a millstone dress is the degree of deflection of its furrows from a radial direction. Thus in a "7-inch draft" the *track-edges* are tangential to a 7-inch circle.

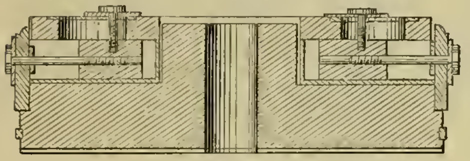
A 12-*quarter* or 14-*quarter dress* indicates a system of 12 or 14 sets of furrows.

One form of lower millstone at the Paris Exposition had sectoral openings covered with wire-gauze, to allow flour to escape as soon as fine enough without compelling it to pass clear to the outside.

The weight of an ordinary pair of millstones is from 1,300 to 1,700 pounds. They measure about 48 inches in diameter, are about 10 inches thick, and contain from 30 to 40 buhrs.

Mill'stone-bal'ance. A weight so placed as to balance other inequalities of weight in a stone, so that it may run true. In the example, weights placed opposite to the driving-point and to each other, at the four quarters of the stone, are moved in ways by set screws, operated from the outside on the band, and, being properly adjusted, the true balance is obtained.

Fig. 3155.



Millstone-Balance.

Mill'stone-bridge. The bar across the eye of a millstone by which it is supported on the head of the spindle. A *balance-rynd*.

Mill'stone-dress. (*Grinding.*) *a.* The arrangement and disposition of the furrows in the face of a millstone.

b. The draft given to the furrows.

The object of the various kinds of dressing is to secure the proper proportional quantity of material on the stone from the eye to the skirt. The kinds of dress are known as the *quarter dress* and the *circular dress*. In the former the face is divided up into a number of sectors, each of which is known as a *quarter*, and has its own set of furrows. The advance edge of a furrow is the *leading edge*, the other is the *trailing* edge. See Grinding-mill.

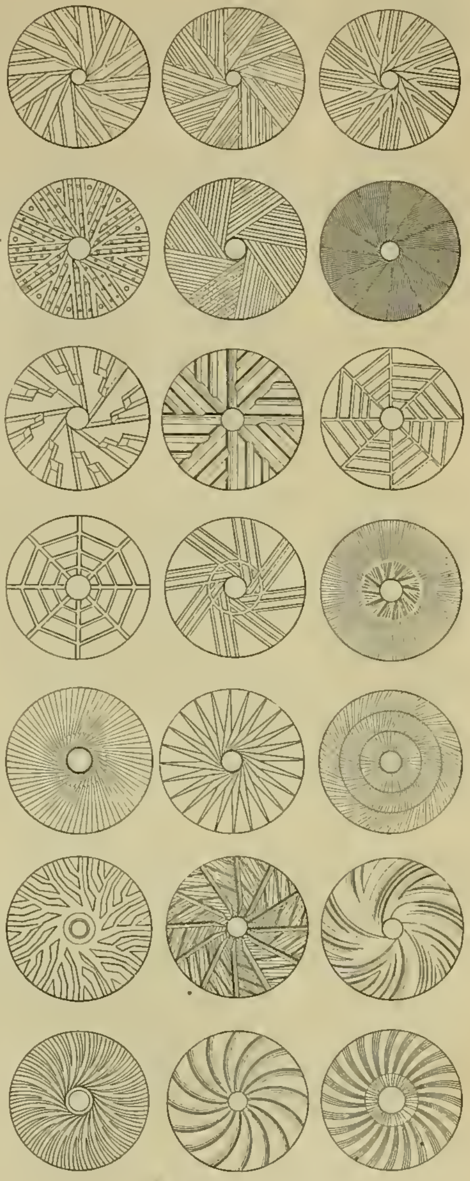
The querns of the Keltic and Roman inhabitants of Britain had notches, forming a *dress*.

Fig. 3156 is a collection of views of different millstones, which will not be described at length. The upper examples are *quarter* dress; then follow specimens of *radial-and-circular* dress, then a number of curved and circular systems.

In addition to the features involving direction are others, such as openings in the bed or runner, forming pockets, or for ventilation, or to allow escape of fine flour. Natcher's patent of 1858 is for ruling lines with a diamond on the *land* of the stone to give it a cutting quality.

In corn and feed mills with serrated iron plates for grinding, the dress is different, as shown in Fig. 3157. Many of these plates are frustums of cones or conoids.

Fig. 3156.



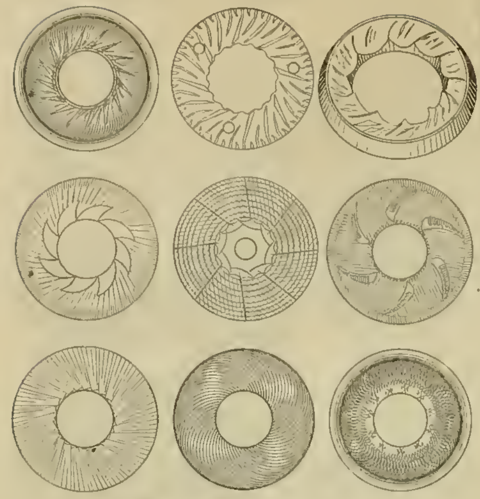
Millstone-Dress (Buhrs).

Mill'stone-dress'er. A machine for cutting grooves in the grinding-face of a millstone.

In one form of the machine, the lines radiating from the center are made by a tool raised and dropped by a cam and advancing automatically along a radial arm attached to a central axis.

A Swiss machine for dressing millstones is shown in Fig. 3158. The frame *A* has arms *b b* terminating in feet *c'*, which are provided with set screws. A tool-support *S* is pivoted to the center of *A*, and is adjustable by means of sector *B*, and slides on the arm *C* of the frame. Two disks at *K* carry diamonds

Fig. 3157.

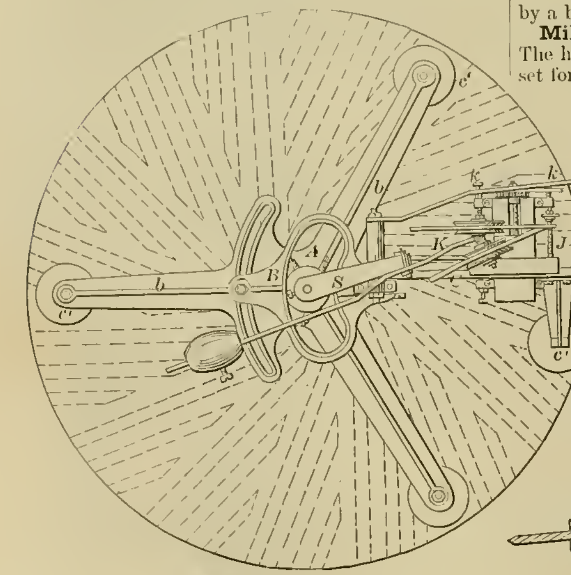


Millstone-Dress (Iron Plates).

or other hard stones on their peripheries, and are set in rapid revolution by belts from spindle *J*, which is revolved from any convenient shaft outside the millstone.

The cutting-disks being put in rapid revolution, the successive blows of the diamonds act in a manner similar to that of a hand tool, and parallel grooves are cut in the face of the stone. Three of these sets of parallel channels or grooves make one division of the stone. The guide-bar *C* is adjustable, so that the stone may have a right-hand or left-hand dress, as desired.

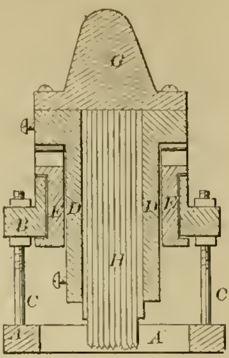
Fig. 3158.



Millstone-Dresser.

In the machine shown in Fig. 3159, a number of pick-plates of tempered steel *H* are held in a hollow block *D D*, which latter slides vertically in a holder *E E*. A cap fitting over the pick-plates and secured to the hollow block *G* is struck by a mallet when dressing, while the holder is pushed along on the guide. Standards *C C* with screw-heads permit the vertical adjustment of the holder when the points of the pick-plates become worn. *A A* is the bed, which rests on the millstone when the machine is in use.

Fig. 3159.

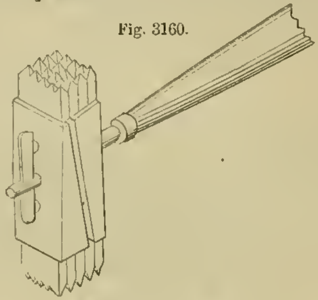


Millstone-Dresser.

Mill′stone-grit. A refractory sandstone of which the sides and hearth of a blast-furnace are composed.

Mill′stone-ham′mer. A tool for furrowing millstones. A millstone-pick. In the example shown, the blades have a central hole for the reception of the handle, and are inclosed by a box whose sections have a diagonal junction.

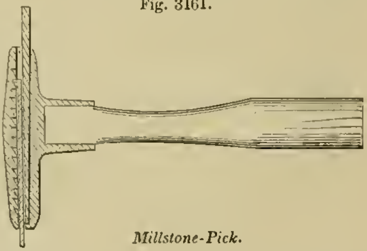
Fig. 3160.



Millstone-Hammer.

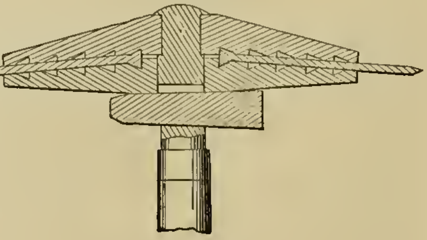
Mill′stone-pick. A tool for dressing millstones. The hard steel blade is held in a stock, and may be set forward as it wears away, a lip on the heel of the blade setting in one or another of the notches in the stock. A wedge holds the blade in any position.

Fig. 3161.



Millstone-Pick.

Fig. 3162.

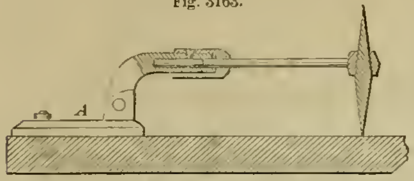


Millstone-Pick.

In Fig. 3162 the blades have conical heads, and are held by wedging the portions of the stock together.

Fig. 3163 is hinged to a bed-plate *A*, which slips over the stone while the pick is vibrated.

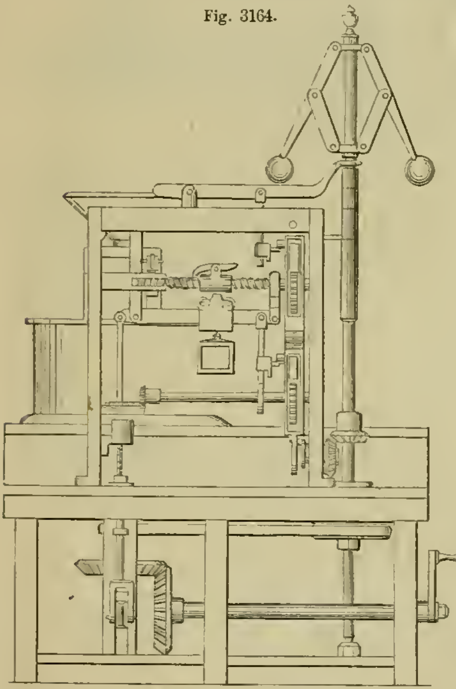
Fig. 3163.



Millstone-Pick.

Mill′stone-reg′u-la′tor. One for graduating the feed of the grain to the rate of motion of the runner. The governor is operated from the mill-gear, and connects, by means of a screw-shaft, a traveling poise, and a scale-beam that will adapt both the feed of the grain and the set of the stones to the varying speed of the runner, caused by changes in the motive power. When the mill is set to grind a particular grade of flour, if the motive power fails to exert the same force on the stone, the governor at once reduces the feed, so that the grade may be continued, though less grain will be ground. The principle is, that the greater the power the greater the capacity for grinding, the feed being increased in proportion the pressure of the runner on the bed-stone must be likewise increased; to do this, the poise is moved in allowing the spindle to sink a little, permitting a larger proportion of its actual weight to rest upon the grain and flour which intervene between the stones.

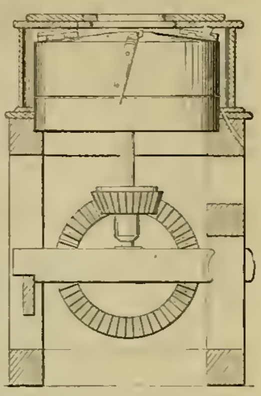
Fig. 3164.



Millstone-Regulator.

Mill′stone-ven′ti-la′tor. An arrangement for conducting a blast through the eye of the runner and out at the *skirt*, to cool the floor and facilitate delivery. The invention is described in the patent of Houyet and Gendebein, 1844; and there have since been many variations in the details. In Fig. 3165, the millstones are ventilated, while running, by hinged inclined wings upon the top of the runner, in connection with inclined wings upon the periphery of the stone. See also English patents, 10,163 of 1844, 11,084 of 1846; French patents of Cabanes, May 29, 1845, and May 26, 1846.

Fig. 3165.

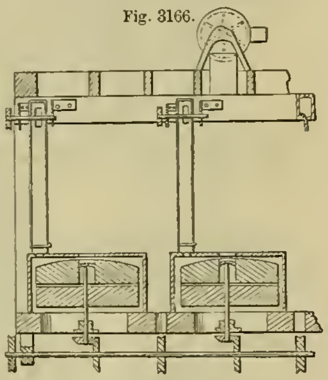


Millstone-Ventilator.

In Fig. 3166, the drums are made air-tight, except at the eye of the stones; the air is exhausted by fans placed in pipes connecting with the sides of the drums, and forced into a cooling-box from which it is drawn off by a large fan.

In Fig. 3167, the devices are shown somewhat more in detail. Air is introduced through an annular duct *T* around the feed-tube *S* into an air-chamber bounded by two cones *M N*, and thence by ducts *P* and spouts *P′ P′*, to the space between the stones.

Fig. 3166.



Ventilating-Millstones.

Mill-tail. The *tail-race* of a mill which conducts the water away from the wheel.

Mill-wheel. The water-wheel which impels the machinery of a mill.

For specific index of wheels, see WATER-WHEEL.

See also list under HYDRAULIC ENGINEERING AND DEVICES.

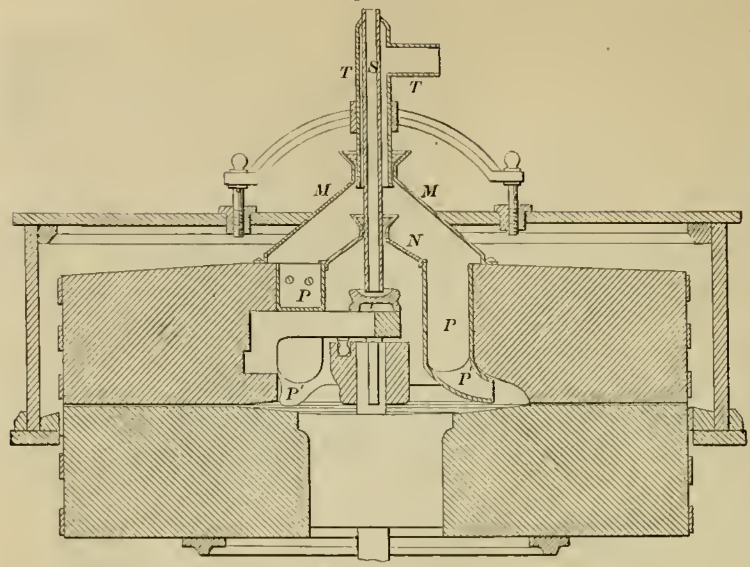
Mill′wright's Com′pass. A dividing and scribing tool used by millstone manufacturers in laying off the dress on the face of stones. See MILLSTONE-DRESS.

Min-ar′gent. Copper, 1,000; nickel, 700; tungsten, 50; aluminium, 10. The first three ingredients are melted together, then run off in a granulated form, and again melted, adding the aluminium and about 1½ per cent of a flux composed of one part borax and one part fluoride of calcium; these proportions of borax are reduced as the fusion proceeds.

It is one kind of aluminium bronze. (See list of Farmer's aluminium alloys, page 71.) In these copper is the first metal, aluminium the second, and silver, iron, nickel, and zinc in various combinations, so as to give the desired character to the metal, according to its intended duty.

A number of other jeweler's alloys are to be found in a table on page 63; white-metal alloys on same

Fig. 3167.

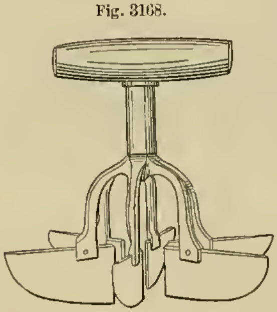


Millstone-Ventilator.

page ; alloys under specific names may be found in the list under METALLURGY.

Minc'ing-knife. A knife with a curved blade or blades for mincing meat and fruit in a wooden bowl.

Fig. 3168.



Mincing-Knife.

Minc'ing-ma-chine'. A machine for chopping food into small fragments. A sausage-machine.

Mincing-machines operate by revolving knives in a barrel which has stationary intervening knives; by guillotine knives acting upon a block rotating on a vertical axis. The *malaxator* or *masticator* is more truly a grinding process, its object being to mash and disintegrate the fibers. See MEAT-CUTTER ; MEAT-CHOPPER ; SAUSAGE-MACHINE.

Mine. 1. A subterraneous passage from which coal, metals, metallic ores, are obtained.

Depth of Mines.	Feet.
Eselchaet, Bohemia (silver)	3,778
Dunkenfield, England (coal)	2,504
Pendleton, England (coal)	2,504
Linden, Prussia (salt well)	2,331
Tresavean, England (copper)	2,112
Durham, England (coal)	1,773
Valenciana, Mexico (silver)	1,686
Crown Point, Comstock lode, Nevada (silver)	1,400
Santa Rosa, Mexico (silver)	1,200

2. Crude ironstone, known as *raw*-mine, *green*-mine, *burnt*-mine, etc.

3. (*Fortification.*) An excavation toward or under the rampart of a fortress to contain an explosive charge, to destroy or effect a breach in an enemy's works. Mines executed by the defenders of a fort, to intercept those of the assailants, are *countermines.*

The place of deposit is the *chamber* ; and the passage leading thereto the *gallery.*

Military mines are known as, —

Common. Double. Triple.
Defensive or *countermines.*
Offensive.
Conjunct, several acting simultaneously.
Suffocating or *camouflet.*
Undercharged.
Over or *surcharged*, producing a crater whose radius is greater than the line of least resistance.

Military mining was practiced in very early times. It is represented in the Assyrian sculptures. The Persians and Romans adopted it extensively ; the latter as early as the fifth century B. C. They had no explosives.

Herodotus mentions the Persian mines during the siege of Barca in Libya, and the skillful countermining of the garrison. (IV. 200.)

Mine-cham'ber. The place of deposit of the charge.

Min'er-al Cot'ton. A fiber formed by allowing a jet of steam to escape through a stream of liquid slag, by which it is blown into fine white threads, sometimes two or three feet in length. These threads, though somewhat elastic, readily break up into smaller ones, and, the color of the substance being white, the appearance is that of a mass of cotton.

Being a poor conductor of heat, owing to the retention of air in its interstices, it is suggested as a covering for steam-boilers and pipes.

Min'er-al Tar. Bitumen of a tarry consistence.

Min'er-al Wa'ters. Among the mineral waters are comprised the follows : —

Carrara, blue-lick, carbonic acid, chalybeate, Kissingen, lemonade, potash, Saratoga, seidlitz, seltzer, soda, Vichy. A number of the above are natural waters, but are simulated by adding to water the ingredients in the proportions of the natural, as ascertained by analysis.

Iron, sulphur, lime, soda, magnesia, lithia, are the usual ingredients of the natural mineral waters. The ingredients principally used in the artificial are, carbonic acid, carbonates of soda and magnesia, bicarbonate of potash, chloride of sodium, salts of iron, tartaric acid, tartrate of soda.

"The water was cool enough [a spring in the vicinity of Tolon Noor], but had a pungent hydrochloric odor, reminding me of some I had once drank in the Pyrenees, and which was so very nauseous and ill-smelling that it was sold in the chemists' shops in France at 15 sous a bottle." — *Abbé Huc's Travels in Tartary.*

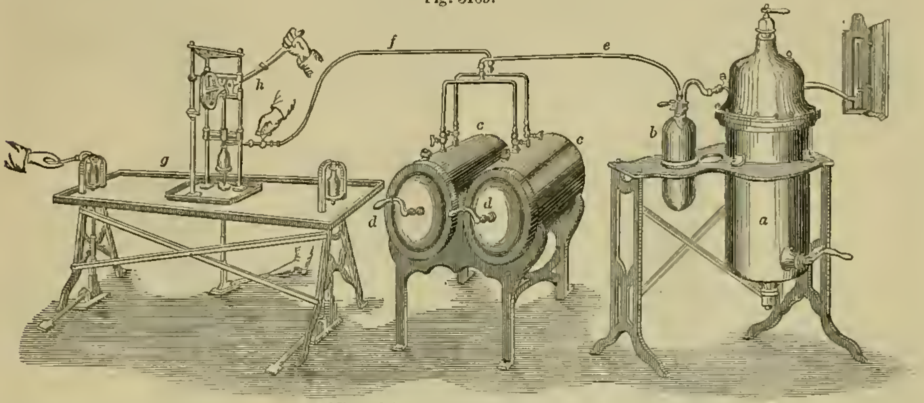
The passage in Genesis xxxvi. 24, properly rendered, favors the opinion that Anah made the discovery of warm mineral springs in the wilderness while hunting for the asses of Zibeon, his father. Moses records the fact as sufficiently worthy of mention, and it is probable that in the intervening 300 years they had acquired considerable notoriety in the cure of chronic complaints. See Dr. Thompson's "Researches in Palestine."

Berzelius, the Swedish chemist, a yearly visitor to the Carlsbad waters, is believed to have been the first to make a successful imitation of mineral water. Struve did the same shortly afterward. The first manufactory was established by Goser, an apothecary at Geneva, about 1790, who sold annually 40,000 bottles of Seltzer. Struve soon decided to devote himself to this speciality, and obtained patents in the chief European countries.

In the modern process of manufacturing mineral waters, carbonic-acid water is first made. The various chemicals are dissolved in a certain order, and some notable ingredients are produced by resulting chemical combinations, as, for instance, in a water containing chloride of sodium and carbonate of baryta, the latter would by itself dissolve with great difficulty, so that chloride of barium and carbonate of soda are introduced instead. By chemical reaction the chlorine and carbonic acid change places. By this means phosphate, and fluate of lime, flint, compounds of barytes, silicates, and other very insoluble materials may be dissolved. The chemicals are usually grouped together before being placed in the water; thus each spring requires two, and sometimes more, separate solutions or mixtures. These concentrated solutions are largely made by Hanbury Smith and others, and are sold to druggists with directions for use. The price of these solutions to the retailers is $ 1 per quart, sufficient to make five gallons, or eighty glasses. The cost to the retailer is about three cents per glass, for he must have an apparatus for the aëration of the water. The subject belongs to our scheme only as far as the apparatus is concerned. See Aërated Waters.

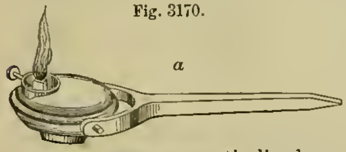
The accompanying engraving represents a full set of apparatus for the manufacture and bottling of mineral water. *a* is the gas-generator, which has an opening at top for introducing the chemicals, and at bottom an agitator and crank; it is also provided with a safety-valve and pressure-gage. From the generator the gas passes into the purifier *b*, containing a re-agent for absorbing other gases from the carbonic acid, and is thence conducted by the pipe *e* into the tin-lined copper fountains *c c*, containing the water to be aërated; these have cranks *d d* operating agitators in order to hasten the absorption of gas. The pipe *f*, provided with a cut-off cock, conducts the aërated water to the bottling bench *g*, where the cork is inserted by depressing the lever *h*, and wired by the device seen to the left of the bench.

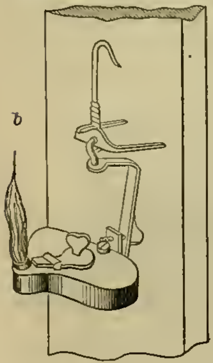
Fig. 3169.



Mineral-Water Bottling-Apparatus.

Fig. 3170.





Miner's Lamp.

See Aërator; Corking-machine; Bottling-apparatus.

Mineral water may be corked from common soda-fountains with nearly the same facility as from an apparatus constructed for this purpose.

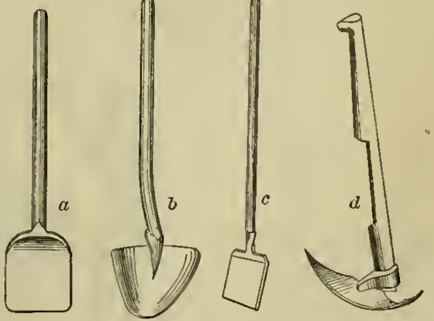
Min'er's Ham'mer. A form of hammer for the use of the miner. Some are shown at *h i j*, Fig. 3178.

Min'er's Lamp. In mines not subject to the collection of fire-damp unprotected lights are used. *a b*, Fig. 3170, are suspensory lamps of the French coal-mines. In many of the German mines the candle is carried on the front of the hat; in some others in a sconce; in others in a cleft stick. Customs vary.

Min'er's Pick. A form of pick or mattock used by miners. *a b c d e f g k l*, Fig. 3178.

Min'er's Shov'el. A form of shovel for miners. (*a b*, Fig. 3171.) See also *p q r*, Fig. 3178.

Fig. 3171.



Miner's Shovels.

c d are German miner's shovels.

Min'er's Wedge. A metallic plug used in opening seams, splitting masses, etc. See *m n o*, Fig. 3178. See also Gad.

Mine-tin. The natural tin found in gangues.

Min'i-a-ture. (*Fine Arts.*) A painted portrait on a small scale. A "picture in little," as Hamlet says.

Min'i-a-ture-tel'e-graph. One on a small scale, used for domestic, household, office, manufactory, or warehouse purposes. A size larger is the private telegraph, by which an office communicates with a distant manufactory, or a house with a police or fire-alarm station. See Office-telegraph.

Min'ie-bul'let. Invented at Vincennes by M. Minie about 1833. See Bullet, *c*, Fig. 969.

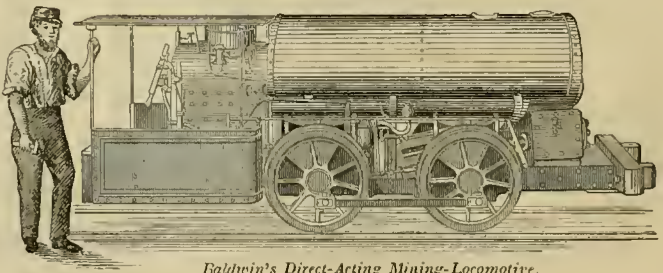
Min'i-mum Ther-mom'e-ter. A thermometer constructed to register the lowest point reached between observations; as Rutherford's or Six's. See Thermometer.

Min'ing Ap-pli'an-ces and Terms. See under the following heads: —

Adit.
Anticlinal line.
Arch.
Astel.
Astyllen.
Attle.
Auget.
Back.
Bank.
Bar.
Barrow.
Basset.
Batch.
Bed.
Bede.
Bedway.
Bend.
Blasting.
Blind level.
Bonney.
Bord.
Bottom-lift.
Bottoms.
Brace.
Branch.
Brattice.
Breast.
Brob.
Brood.
Bunch.
Burden.
Cage.
Case.
Cat-head.
Cauf.
Caunter-lode.
Channeling-machine.
Charger.
Cistern.
Claying-bar.
Coal-boring bit.
Coal-breaker.
Coal-cutting machine.
Coal-mining machine.
Coal-screen.
Coal-washing machine.
Coffering.
Coffin.
Corbond.
Corf.
Costeening.
Counter.
Course.
Cow.
Cradle.
Creaze.
Creep.
Cribbing.
Cribble.
Crop.
Cross-course.
Cross-cut.
Cross-lode.
Crow-bar.
Cutting.
Dan.
Day-level.
Dead-ground.
Deads.
Dean.
Dike.
Dip.
Dip-head level.
Down-cast.
Drift.
Dropper.
Drowned level.
Dums.
Fang.
Fanging.
Fault.
Flang.
Flookan.
Floran.
Fluke.
Foge.
Gad.
Gallery.
Gangue.
Ginging.
Goaf.
Gob.
Gobbing.
Gold-mining.
Gold-washer.
Grain-tin.
Grapnel.
Griddle.
Gunnie.
Gurnies.
Hade.
Halvans.
Hanging-side.
Hard pyrites.
Hard salt
Heading.
Hitch.
Hogger-pipe.
Holing.
Horns
Hushing.
Hutch.
Jamb.
Jinny-road.
Jump
Jumper.
Keeve.
Kibble.
Knock-stone.
Launders.
Lead.
Leader.
Leap.
Ledge.
Ledger.
Level.
Lode.
Lorry.
Madrier.
Maundril.
Measure.
Meir.
Mine.
Miner's lamp.
Miner's hammer.
Miner's pick.
Miner's shovel.
Miner's wedge.
Mining-machine.
Mining-pump.
Mining-tools.
Mouton.
Mother-gate.
Nicking-trunk.
Nip.
Nitro-glycerine.
Nog.
Outcrop.
Panel.
Pick.
Pick-hammer.
Pillar.
Pipe-vein
Pit.
Pitch.
Pit-work.
Platt.
Polroz.
Post.
Post and stall.
Prill.
Pryan.
Punch.
Quarrying-machine.
Ragging.
Rib.
Riddle.
Rider.
Rim.
Ringer.
Rise.
Rock-boring tool.
Rock-drill.
Rock-drilling machine.
Rolley.
Room
Safety-case.
Safety-fuse.
Scarcement.
Scraper.
Serin.
Seam.
Shaft.
Shambles.
Shearing.
Sheers.
Shift.
Shoad.
Shot.
Sill.
Skip.
Skip-shaft.
Slicking.
Slimes.
Slip.
Slope.
Smift.
Snoft.
Sole.
Sollar.
Sough.
Spalling.
Spawl.
Spend.
Spire.
Squat.
Stall.
Stannary.
Stemples.
Stone-channeling machine.
Stone-quarrying machine.
Stope.
Stopping.
Strake.
Stream-work.
Strike.
String.
Stull.
Sump.
Sump-fuse.
Sump-shaft.
Synclinal line.
Tacklers.
Tamping.
Thirling.
Thread.
Thrust.
Thurl.
Tram.
Tribute.
Trogue.
Trommel.
Trouble.
Trunk.
Trunking.
Tub
Tubbing.
Tug.
Tunneling.
Turn.
Tut-work.
Underlie.
Vein.
Vein-stone.
Vugh
Wall
Winch.
Winning.
Winze.
Witts.

Min'ing-lo'co-mo'tive. One adapted for drawing wagons on the tramways or rails of mines, made very low to adapt it to run in the galleries of passages. The one shown has a gage of two feet six inches; hight above rail, five feet four inches; width over all, five feet one inch; adapted to burn

Fig. 3172.



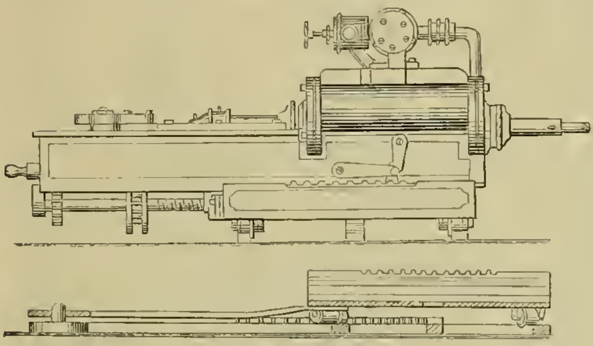
Baldwin's Direct-Acting Mining-Locomotive.

anthracite or bituminous coal or coke. It will pass curves of twenty-five feet radius, and haul on a level track in good condition three hundred and forty tons of cars and load.

Min'ing-ma-chine'. An apparatus provided with picks or cutters to cut grooves in rock or coal, after which the material is to be pried out or detached by wedges, as in coal-mining and working quarries.

In Fig. 3173, the engine moves on a track parallel with the breast of coal or stone, and a forward adjustment is made after each traversing cut. The chisels are worked alternately by their respective engines, their stocks being connected to a walking-beam, and have weighted pistons sleeved upon them. The steam is changed as the piston passes a certain point, and is the means of working the valve. The walking-beam actuates the traversing devices. The blow of the chisel is similar to that of a drill.

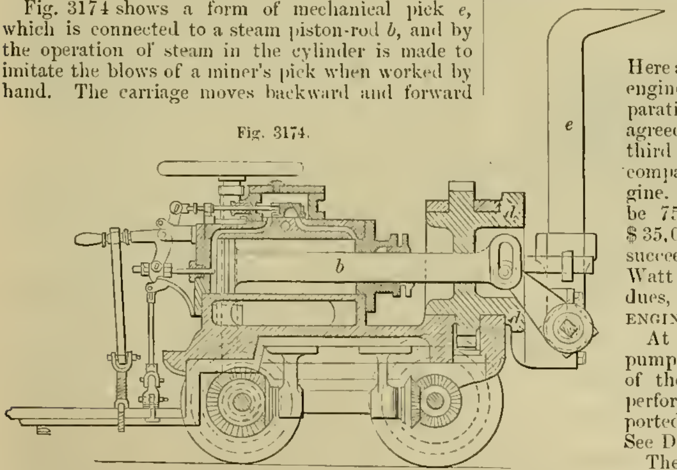
Fig. 3173.



Mining-Machine.

Fig. 3174 shows a form of mechanical pick *e*, which is connected to a steam piston-rod *b*, and by the operation of steam in the cylinder is made to imitate the blows of a miner's pick when worked by hand. The carriage moves backward and forward on wheels, and the pick or cutter slides sidewise in the ways *d d*.

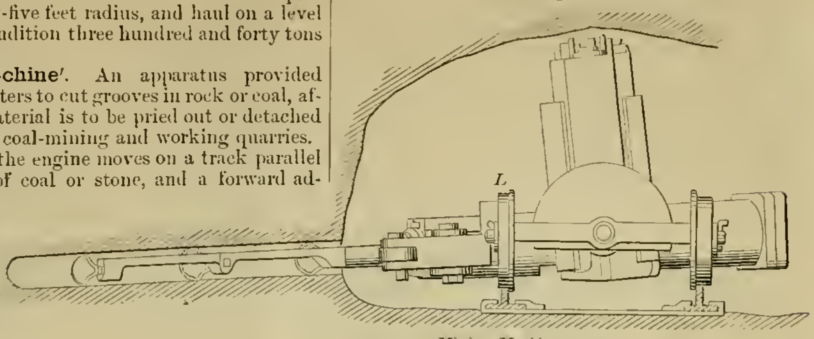
Fig. 3174.



Mining-Machine.

The machine shown in Fig. 3175 is operated by hydraulic pressure, in the cylinder *L*. The hydraulic engine gives a steady thrust-motion to the tools; the position of the machine during the thrust is maintained by a holdfast, which is pressed against the roof during the cutting action of the tool or tools, and released therefrom to allow the machine to move forward during the return or back stroke of the tool or tools; the movements of this head or feeler and those of the drill are obtained from the pressure of water in the cylinder.

Fig. 3175.



Mining-Machine.

For other machines of this character, see COAL-MINING MACHINE.

Min'ing-pump. Pumps for mines and water-works have been on the most extended scale, and the former were for a long time the principal objects upon which the steam-engine was employed. The successive improvements of Worcester, Savary, Newcomen, and Watt were all directed toward one object, that of lifting water, which preceded by many years the useful application of the steam-engine to the purposes of locomotion, either upon land or water. The mines of Cornwall (which were worked by the ancient inhabitants, 3,000 years ago) were drained by means of the Savary apparatus and the atmospheric engines of Newcomen. Here also Watt and Boulton sent their engines, with such a guaranty of comparative economy in fuel, that they agreed to take as pay the value of one third of the proved saving of coal as compared with the Newcomen engine. This saving was found to be 75 per cent, and amounted to $35,000 yearly. The Cornish miners succeeded in cheating Boulton and Watt out of the greater part of their dues, and became rich. See STEAM-ENGINE.

At the present day the Cornish pumping-engine stands at the head of the list in effective economical performance, and the "duty" is reported in tabulated form, monthly. See DUTY.

The useful effect of the Cornish pumping-engine has been more closely observed and recorded than that of any other engine.

When Boulton and Watt's patent expired, the best of their engines in Cornwall were doing an average duty of 24 millions of pounds of water raised 1 foot high by 112 pounds of Welch coal.

The rate deteriorated for a while, owing, it is said, to the absence of Mr. Murdoch and some other highly skillful men. Mr. Murdoch will be recollected as the great gas-engineer, and a successful builder of a locomotive in early times.

Captain Lean is credited with a general advance which soon afterward took place.

The tabulated results for the years 1812 – 1843 are as follows: —

Year.	No. of engines.	Average duty.	Average duty of the best engine.	Year.	No. of engines.	Average duty.	Average duty of the best engines.
1812	21	23.0		1828	57	44.1	91.4
1813	29	23.2	31.4	1829	53	49.6	91.6
1814	32	24.5	38.1	1830	56	51.5	92.8
1815	35	24.4	34.1	1831	58	51.6	84.6
1816	35	27.4	38.6	1832	59	52.6	101.1
1817	35	31.5	49.5	1833	56	55.4	100.3
1818	36	30.2	46.8	1834	52	56.9	108.1
1819	40	31.3	47.6	1835	51	56.9	109.1
1820	46	34.1	49.1	1836	61	55.4	101.6
1821	45	33.6	50.9	1837	58	55.9	103.8
1822	52	34.4	50.6	1838	61	58.0	100.2
1823	52	33.6	50.0	1839	52	65.4	92.6
1824	49	33.7	51.8	1840	54	64.3	97.2
1825	56	38.1	54.0	1841	56	65.1	121.3
1826	51	36.3	53.8	1842	49	64.0	127.9†
1827	51	38.2	71.0*	1843	36	71.4	114.4

* Wolf's and Grose's improvements.

† Wolf's combined double-cylinder engine, cut off at one-tenth stroke. United mines at Gwennap.

The following table, compiled by S. Hughes, C. E., gives the duty of a number of pumping-engines in different large cities on each side of the Atlantic: —

Duty of Condensing Pumping-Engines.

	Millions of lbs. raised 1 ft. high by 112 lbs. of coal.
East London Water-Works, single-acting Cornish engine, 1836	105.7
East London Water-Works, Boulton and Watt	46.6
Haarlem Mere, Holland	89.4
Average of 36 Cornish engines, 1843	71.5
Cincinnati direct-action	53.6
Buffalo Cornish bull engines	37.0
Boulton and Watt's non-expansive rotative engine, Albion Mills, London, 1786	25.8
Spring Garden, Philadelphia, 1832	24.6
United States Dry-Dock engine, Brooklyn	22.4
Grand Junction Water-Works engines in 1849	46.8
Southwark and Vauxhall engines in 1849	69.6
Beardmore's exemplar Cornish engine	83.4
Beardmore's duty of Cornish engines at London Water-Works	56.25
Fowey Consols 50-inch cylinder-engine of 103-horse power, experimented on by Mr. Wicksteed, and worked at a power of 26½ horses	130.2
Holmbush 80-inch cylinder = 251 horses, worked at a power of 62 horses	122.4
Estimated duty of 72-inch cylinder condensing-engine for Brooklyn Works	35.5
Engines at the East London Works in 1850 from Mr. Wicksteed's evidence	63.8
Engines at the same works before the use of the Cornish engines	26.9
Average duty of Cornish engines (Lean, 1854)	53.7
Duty of best engine, from Lean, 1854	77.0
Duty of Cornish engine (Browne, 1855)	69.7
Duty of best engine, from Browne, 1855	101.4
Pittsburg high-pressure non-condensing engines, 1852: —	
Upper Water-Works	19.9
Lower Water-Works	19.1
Allegheny City	19.2
Detroit	17.3
To which may be added, —	
Worthington duplex engine, Newark, N. J.	76.6
Brooklyn, N. Y., double-acting beam, No. 1	60.1
Brooklyn, N. Y., double-acting beam, No. 3	72.0
Philadelphia, Spring Garden, Cornish	58.9
Belleville, Jersey City, Cornish	62.8
Hartford, Conn.; crank. Mean of three experiments	61.7
Cambridge, Mass.; double-cylinder. (Mean)	67.2

In considering the above, it must be recollected that the quality of coal varies, and the bushel may vary in weight; calculations have unfortunately been made at 94, 100, and 112 pounds.

See also COMPOUND ENGINE; DUPLEX ENGINE; DRAINING-ENGINE; PUMPING-ENGINE.

Cost of raising Water by Steam-Power.

	Gallons.	Hight in feet.	Cost.	Coal per 2,240 lbs.
East London Water-Works	1,000,000	100	$ 3.00	$ 2.52
Liverpool	1,000,000	100	4.08	
Wolverhampton	1,000,000	100	8.40	1.80
Southwark	1,000,000	100	2.88	2.40
Grand Junction	1,000,000	100	5.52	3.84

Of the pumps for mining purposes may be cited, (1) the common lift-pump, made on a scale proportionate to its work, but in no essential respects differing from that in ordinary use. Its piston is a valved bucket, being perforated for the passage of the water. See LIFT-PUMP; CORNISH ENGINE.

(2.) A lifting-pump with a plunger; that is, one not perforated, but acting as the ordinary piston.

The piston *b* (see *A*, Fig. 3176) works in a barrel *a*, communicating by a passage *d* with a valve-chamber *e*, to which are attached the supply and discharge pipes *i h*. The chamber has two valves *g f*, which act as induction and eduction, — one opening to admit water from the well as the piston descends, and the other allowing the water to escape into the discharge-pipe as the piston ascends.

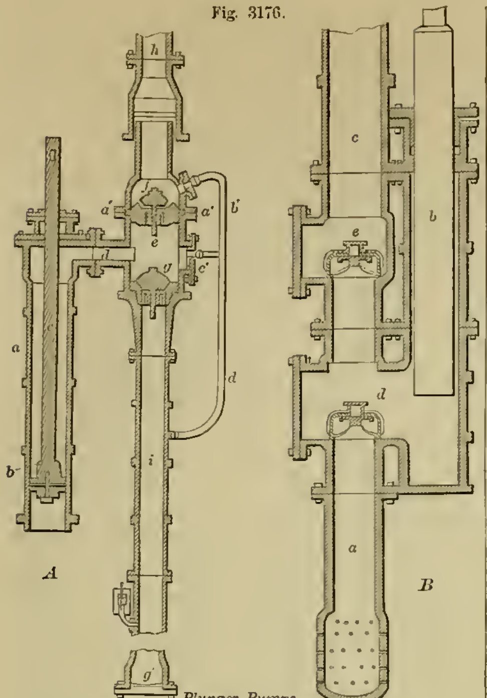
The illustration is from Combe's work on mines, and represents a pump erected by Juncker at Huelgoat. It raises water to a hight of 508 feet, and is calculated to raise it a farther distance of 246 feet when the mine reaches that depth.

The small pipe *b′ c′ d* is provided with stop-cocks, and is for the purpose of establishing communication between the pipes *h i* and the valve-chamber *e* in starting the pump.

A small side-valve is fitted to the descending pipe *i*, and loaded with a weight equal to about the pressure of the atmosphere. This valve is placed just above the surface of water in the well, and if the valve *g* does not shut properly, the pressure of the water which is raised during the up-stroke of the piston is transmitted to that contained in the descending pipe and causes the small valve to open.

By means of this, also, it can be ascertained if the upper valve *f* closes properly. For this purpose, the pump must be stopped and the valve-chest put in

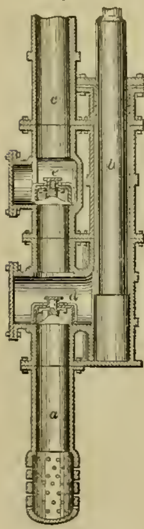
Fig. 3176.



Plunger-Pumps.

communication with the descending pipe, by opening the stop-cocks in the small pipe *c′ d*. Then, if the valve *f* closes imperfectly, the water from *h* will come through it and fill the descending pipe *i*, raising the small valve. This effect will, of course, not take place unless the foot-valve *g′* is in order, — a fact which can be readily ascertained.

Fig. 3177.



Single-Acting Plunger-Pump.

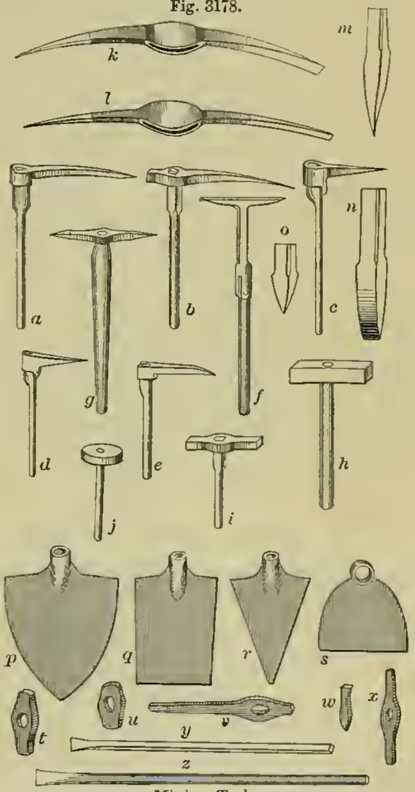
B (Fig. 3176) is a section of a force-pump, with solid plunger-piston, such as is commonly used for raising water from mines, rivers, and wells. *a* is the suction-pipe, *b* is the solid plunger-piston, shown near the bottom of its stroke, *c* is the ascending pipe going to the top of the well, *d* is the lower valve-chest, and *e* the upper valve-chest. The valves are double beat. When *e* is open in consequence of the descent of the piston having forced up the water and raised it into that position, the same pressure closes the valve *d*, which then sustains the whole pressure of the column in *c*. See Fig. 3177.

The plunger is raised by the pressure of the steam on the piston in the steam-cylinder; and as the cover of the pump-barrel through which it works is perfectly air-tight, no air can pass in from the outside to supply its place. A partial vacuum is therefore formed, which is supplied by the air beneath the lower valve and between this and the water. After each stroke this air becomes more and more rare, and the vacuum more and more perfect; till at length the water in the well, pressed by the atmosphere outside, follows the ascent of the piston, and rises through the foot-valve into the pump-barrel. When this is full of water, the plunger descends and presses on the water, which can neither go back through the lower valve nor escape through the cover of the pump-barrel. It can only escape through the valve of the ascending pipe, each successive stroke of the plunger sending into the ascending pipe a quantity of water equal to the volume of the plunger. This goes on till the ascending pipe is full, and then, at each stroke, it delivers a quantity equal to the volume of the plunger.

Min′ing-tools. *a b c d e f g*, forms of miner's picks.

h i j, miner's hammers. *k l*, long picks. *m n o*, miner's wedges. *p*, sharp-point shovel. *q*, square-point shovel. *r*, *bulling*-shovel for dressing ores. *s*, Spanish hoe. *t*, sledge for breaking ores. *u*, mallet for striking borers (*y z*). *v*, pick for driving gad. *w*, steel gad for wedging off pieces of stone. *x*, cobbing-hammer, used in the mines for breaking ore. *y z*, borers for jumping holes to receive blasting-charge.

Fig. 3178.



Mining-Tools.

Min′ion. 1. (*Printing.*) A size of type between Nonpareil and Brevier.

Nonpareil, 148 ems to the foot.
Minion, 123 ems to the foot.
Brevier, 112 ems to the foot.

2. (*Ordnance.*) An old 4-pounder gun, about 7 feet long.

Min-ion-ette′. A small fancy type.

Min′i-um. Red lead.

Mint. A place where bullion is made into coin. See Coining.

Mint'age. Duty paid for coining.

Mint'ing-mill. A *coining*-machine. See COINING.

Min'ute. 1. The sixtieth part of an hour.

2. The sixtieth part of a degree.

3. The sixtieth part of the lower diameter of the shaft of a column.

Min'ute-glass. The sand-glass running sixty seconds. *Half*-minute and *quarter*-minute glasses are used at *heaving the log*.

Min'ute-hand. The hand pointing to minutes on the dial of a clock or watch, and traversing the circle in one hour.

Min'ute-jack. (*Horology.*) A fanciful little figure in some clocks which strikes the gong at the prescribed times.

Min'ute-wheel. (*Horology.*) One of the wheels placed between the pillar-plate of a watch and the dial. Also called a *dial-wheel*.

Mir'ror. Mirrors are mentioned in the Book of Job (chap. xxxvii. verse 18), and Moses relates that the brazen laver or washing-basin was made from the mirrors of the women who assembled at the door of the tabernacle of the congregation (Exodus, chap. xxxviii. verse 8).

The ancients had drinking-vessels, the insides of which were cut into mirrors so disposed that the image of the person drinking from them was seen multiplied. A weighty silver cup of this description was presented to the Emperor Probus, when a tribune, by Valerian.

The mirrors of Egypt were of bronze, which, in certain proportions of copper and tin, is called by Ure the whitest, hardest, most brilliant and refractory of metals. See *speculum-metal* in ALLOYS.

A number of the Egyptian mirrors are preserved in the British Museum. They are from 5 to 14 inches in dimensions. They are generally furnished with handles, carved into ornamental or symbolic forms; resembling a tress of hair, a hawk's head, a column, a lotus scepter, or the goddess Athor. Several specimens may be seen in Abbott's collection in the possession of the New York Historical Society.

The mirror with a handle is emblematical of Venus, and is represented on the stones in the ruins of Al Hadhr on the Tigris, the Atra of Ammianus Marcellinus.

Silver mirrors were introduced by Praxiteles, 328 B. C.

A famous mirror of antiquity was that placed by Ptolemy Euergetes (247 B. C.) on the summit of the Pharos of Alexandria. The clearness with which distant objects were depicted caused observers to speak of it in exalted terms beyond any reasonable belief. Abulfeda, the geographer, who wrote 1,000 years subsequently, states that it was made of "Chinese iron," which Buffon supposes was steel, but was more probably one of the white alloys for which China was and is so famous. Probably nearly allied to speculum-metal.

The ancients knew, —

1. That the rays of light were projected in straight lines.

2. That the angle of incidence is equal to the angle of reflection.

These were their only contributions to the science of optics.

Alhazen, about A. D. 1100, shed a flood of light on the subject.

Silver is the most powerful reflector, absorbing but 9 per cent of the light (speculum-metal absorbs 37 per cent of the rays), and for this reason, as well as its durability, was largely employed by the ancients for making mirrors. Silver mirrors are enumerated in the Roman laws among other articles of plate; and Pliny, Seneca, and other writers who ridicule the extravagance of the times, tell us that every young woman of that period must have a silver mirror. These mirrors, judging from the specimens in collections of antiquities, were merely faced with a thin sheet of the precious metal.

Pliny speaks of mirrors composed of a mixture of copper and tin, and says that the best were constructed at Brundisium. A composition of copper, regulus of antimony, and lead, the first largely predominating, was also employed. Such stones as were capable of receiving a brilliant polish and reflecting a large proportion of the rays of light were sometimes made use of.

Mirrors of stone were found among the Peruvians when first visited by the Spaniards. Some of these were made of a black, somewhat transparent, vitrified lava, called by the Spaniards *gallinazo*, similar to the obsidian stone employed by the Romans for the like purpose. These mirrors were plane, concave, and convex. The Peruvians also made them of a species of pyrites called the Inca's stone, from its being much used in ornaments by the Incas or princes of Peru. Ulloa saw one which was 2½ feet in diameter; but they did not usually exceed 2 to 3 inches. This people had also, it would appear from De la Vega, mirrors of silver, copper, and brass.

The date of the invention of glass mirrors is not certainly known. From the account of Pliny, it would seem that they had been formerly made at the celebrated glass-houses of Sidon. These were probably of a dark-colored glass, having a resemblance to the obsidian stone. Transparent glass having a backing of black foil has also been found. The former of these kinds was inferior to metallic mirrors and was probably superseded by them. From the time of Pliny to the thirteenth century, the subject appears veiled in obscurity, and the first unequivocal mention of glass mirrors similar to those of modern times is by Peckham or Peccam, an English Franciscan monk, who, in a treatise on optics, written about the year 1279, speaks of mirrors of iron, steel, polished marble, and of glass covered on the back with lead, and says that no image was reflected when the lead was scraped off. Roger Bacon and others of that age also make mention of this description of mirror. The process of manufacture was by pouring molten lead or tin on the back of the glass plate.

The method of coating with tin-foil was known as early as the sixteenth century, and at Murano, where it was first practiced, the process was as follows: The tin, hammered into thin leaves, was spread out very smoothly: the quicksilver was poured over it and rubbed into it, either with the hand or a hare's foot; and when the tin was saturated it was covered with paper. The glass, wiped very clean, was then laid above it, and while the workman pressed it down with his left hand, he drew out very carefully with his right the paper between the tin and glass, over which weights were afterward placed.

The Venetians had for a long time a monopoly of the business, and till about the end of the seventeenth century their glasses were met with all over Europe and both the Indies. After that period, the improvements in glass-making in other countries, particularly in France, where it was discovered that glass could be cast into much larger plates than had been before prepared by blowing and rolling, destroyed the ancient supremacy of Venice in this art. An unsuccessful attempt was made in France as early as 1634 to establish glass-houses for manufacturing mirrors, and in 1665 Nicholas de Mayer obtained a patent from the French government, and proceeded to erect works for the purpose. This patent was in 1684 renewed for thirty years, but in 1688 Abraham Thevart succeeded in casting at Paris plates of a size which astonished all who saw them; they were 84 inches long and 50 broad, while the largest of those previously made had not exceeded 45 or 50 inches in length.

Among the more remarkable modern mirrors may be cited several of from 20 to 36 inches diameter. One made by Villette was tested by Drs. Desaguliers and Harris. It was composed of an alloy of tin, copper, and bismuth. It was 47 inches in diameter, and was ground to a sphere of 76 inches radius. Its effects were as follows: —

Tin was melted in	3 seconds.
Cast-iron	16 "
A silver sixpence	7 "
A half-penny of George III.	34 "
Slate	3 "
Granite vitrified	54 "
Copper ore	8 "
Bone, calcined	4 "

Tschirnhausen's mirror was 4½ French feet in diameter; its focus, 12 feet.

It vitrified pumice, slate, tiles, shells, pieces of crucibles; lighted green wood instantly, and dissolved an alloy of lead and tin like so much lard.

Newton's mirror had 7 concave glasses, each 11½ inches in diameter; one in the center, the others encircling it, so as to have a common focus. The diameter was 34½ inches, the focus 22½ inches distant. It vitrified brick in 1 second, and melted gold in 30 seconds.

Zeicher formed his mirrors by pressing disks on a hot convex former, to give them their curvature.

Buffon constructed a combination of 140 plane mirrors, each 4 × 3 inches, on a wooden frame 6 feet square. Three set screws to each mirror gave perfect adjustability, and the result was a vindication of the probability of the statement in regard to Archimedes. With but 24 of the mirrors in focus, he lit pitch and tow at a distance of 66 French feet. By a subsequent arrangement of 168 pieces of plane looking-glass, 6 inches square, he lit beech-wood at 150 feet distance and melted a silver plate at 60 feet.

His final attempts were with a frame of 360 plane mirrors, 8 × 6 inches; and one of 400 mirrors, 6 × 6 inches. Wood was kindled at 210 feet distance, tin melted at 160 feet. See BURNING-GLASS.

Petijean's patent (1856) is for a process of silvering by the use of a compound formed of nitrate of silver, ammonia, and tartaric acid. The solution is applied to a polished glass, and silver is precipitated to the amount of about one pennyweight to each square foot of glass. It is then protected by a dark varnish.

Walker (1869) uses the same ingredients in somewhat different proportions. The surface of the glass is thoroughly polished with whiting and washed with distilled water, when the plate is heated to about 120°, and the solution applied. After the silver is precipitated and dried, the plate is varnished with shellac, and then painted with a compound of red lead and litharge to protect the coating of silver. See SILVERING; PLATINIZING; LOOKING-GLASS.

Mi′ser. A large auger for excavating earth in wet situations, as in sinking holes for pier foundations. It is of cylindrical form, has a protruding lip, to enable it to scrape up the soil as it is rotated, and is lifted to the surface to discharge its load.

Mis-e-re′re. A projecting bracket in the under side of the seat of a church stall. It is often more or less ornamented with carvings of leaves and grotesque subjects.

Mis-pick′el. An ore of arsenic combined with iron.

Mi′ter. A joint where two pieces are framed together, matched, and united upon a line bisecting the angle of junction.

The term forms a part of several compound words which follow here.

Mi′ter-block. (*Joinery.*) One arranged for sawing pieces to an angle of 45°.

Mi′ter-box. 1. (*Printing.*) A box in which rules are placed while the ends are cut obliquely, so as to make a miter-joint with another rule.

2. (*Carpentry.*) A trough with vertical kerfs, which intersect the sides at an angle of 45°, to form guides for a saw in sawing the ends of pieces to make miter-joints.

Mi′ter-dove′tail. (*Joinery.*) A form of concealed dovetail which presents only a single joint line, and that on the angle. See DOVETAIL.

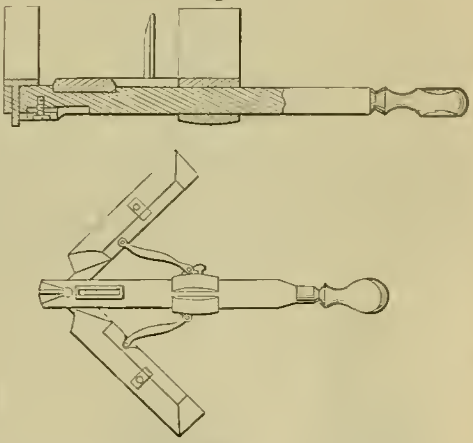
Mi′ter-drain. The transverse drain in the metaling of a road.

Mi′tered. (*Bookbinding.*) Said of fillet ornamentation when the lines unite exactly at their junction without overrunning.

Mi′tered Bor′der. The edging around the slab-stone of a hearth.

Mi′ter-gage. A gage to determine the angle of a miter-joint in picture-frames, moldings, etc. Fig. 3179 shows such a gage, having a pair of arms hinged to a stock, on which is a sliding clamp that carries the saw-guide, which is connected by links with the said arms, so as to allow them to be placed within and conform to any angle, and insure at the same time the proper position of the stock midway between the said arms.

Fig. 3179.



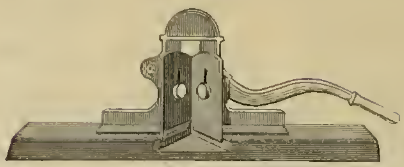
Miter-Gage.

Mi′ter-ing-ma-chine′. 1. (*Printing.*) A machine for mitering printers' rules, so that their ends may meet at a miter-joint. Various adjustments are found in the United States patents.

McDonald, July 3, 1855.
Grover and Pelouse, May 29, 1860.
Babcock, February 5, 1861.
Walker, December 3, 1867.
Ustich, July 21, 1868.

2. (*Joinery.*) A machine for mitering or slanting the ends of pieces which are to be united by a miter-joint. The machine illustrated is adapted for mitering frame moldings, panel moldings, etc. The irons

Fig. 3180.



Mitering-Machine.

work at right angles to one another, and cut the miters true and clean.

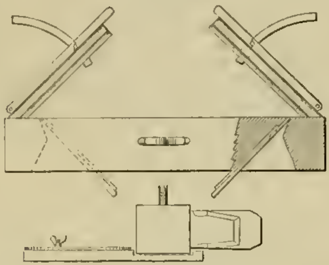
Mi'ter-i'ron. (*Forging.*) A number of bars of angular shape wedged together inside a hoop to form a fagot for a large forging.

Mi'ter-joint. A joint formed by the meeting of matching pieces in a frame, the parts uniting on a line bisecting the angle, which is usually 90°, but not necessarily. See *b c*, Fig. 3182.

Mi'ter-plane. (*Joinery.*) *a.* A plane whose bit is set obliquely across the face of the stock, so as to make a *draw*-cut.

b. A plane running in a race bearing a certain angular relation to the fences or gages which hold and present the stuff.

Fig. 3181.



Miter-Plane.

In the example, the plane works in a groove of the frame and has a cutter at each end. Pivoted adjustable guides hold the stuff at any required angle.

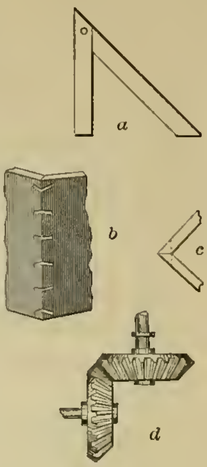
Mi'ter-post. (*Hydraulic Engineering.*) The outer vertical edge of a canal-lock gate, obliquely chamfered to fit against a similar surface on the companion gate.

Mi'ter-sill. (*Hydraulic Engineering.*) A raised step on the floor of a *lock-bay* against which the feet of the lock-gates shut. (See CANAL-LOCK.) The *head miter-sill* for the *head-gates*, and the *tail miter-sill* for the *tail-gates.*

Mi'ter-square. A *bevel-square* whose blades are set immovably at an angle of 45° with each other. The term is used somewhat loosely to denote a square whose blade is adjustable to any angle. A *bevel.*

Mi'ter-valve. A valve whose rim forms with the face of the seat a miter-joint; an angle of 45° with the axis of the valve-disk. See PUPPET-VALVE.

Fig. 3182.



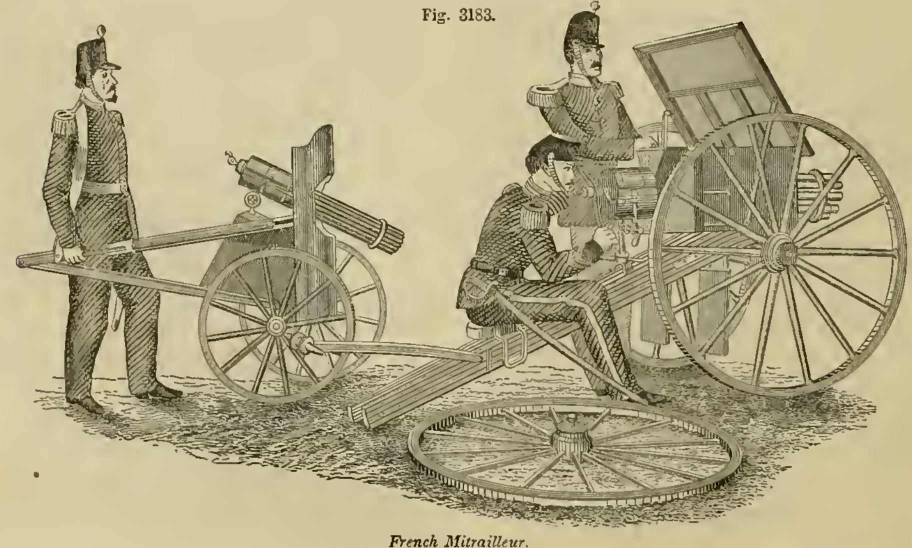
Miters.

Mi'ter-wheel. One of two bevel wheels of equal diameter, and whose working-faces have an equal obliquity to their axes, usually 45°. See *d*, Fig. 3182.

Mi'trail-leur'. (*Fire-arms.*) A French form of battery-gun which is loaded at the breech, by a block containing pockets for a number of cartridges. These are fired consecutively or in a volley. Charged plates are kept in reserve.

The object is to obtain greater accuracy and range than are attainable by the case or canister shot, discharged from cannon. These are contained in an envelope which is ruptured either by a bursting charge within or by the force of projection, and have consequently a tendency to scatter over a considerable area. The mitrailleur, or machine-gun, on the contrary, sends a large number of small projectiles independently, and with precision, to a considerable distance.

Fig. 3183.



French Mitrailleur.

The infernal machine with which Fieschi attempted to assassinate Louis Philippe in 1835, and succeeded in killing eighteen persons, including Marshal Mortier, and wounding a large number of others, besides severely injuring himself, was one of the earliest attempts with which we are acquainted for producing a simultaneous discharge from a number of gun-barrels. These were arranged side by side on a bench or stand, and fired by a train, much as in the mode of firing barrels in a proving-house.

That first tried in the French service was made by removing part of the breech from a brass field-piece and inserting twenty-five rifle-barrels, open at both ends, into the bore; these extended back, so that their rear ends were flush with the face of that part of the breech in front of the opening, into which was inserted a case having a number of cylindrical openings equal to that of the barrels, and filled with cartridges; from these, by means of an equal number of plungers operated by a hand-screw, the cartridges were forced into the barrels; the charging-case was then removed, and replaced by a firing-block provided with a lock and pin for each cartridge, by which they were successively fired on turning a cylinder in the firing-block.

A later form of the weapon is shown in Fig. 3183. It has 37 barrels, and ammunition-chests alongside the gun on the same axle. The 37 cartridges, intended for one charge, are contained in a small box. A steel plate with corresponding holes is placed on the open box, which is then reversed, and the cartridges fall points foremost into their respective holes. They are prevented from falling through by the rims at their bases. The loaded plate is then introduced into the breech-slot, and when the breech is closed by a lever, a number of steel pins, pressed by spiral springs, are only prevented from striking the percussion arrangement in the cartridges by a plate in front of them. When this case is moved slowly by a handle, the cartridges are fired one by one. If the plate be withdrawn rapidly, they follow each other so quickly that their discharge is all but simultaneous.

The projectile weighs 37 grammes, or a little over an ounce. The charge of powder is from 6 to 8 grammes. The last amount is that counseled by the inventors.

The mitrailleur of 37 barrels weighs 180 kilogrammes, or 400 pounds, without the carriage, and can be worked by two men. It was found, however, at Vienna, in December, 1869, that to obtain the most rapid firing, or 481 balls per minute, five men were necessary to work the piece.

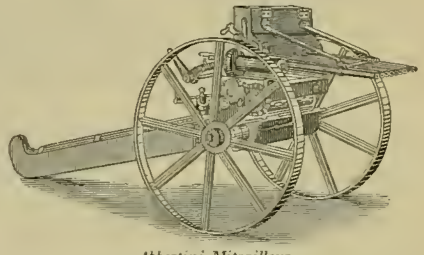
The front carriage contains from 48 to 56 boxes for loading, and the two caissons hold 16 breech-plates furnished with cartridges. The mitrailleur is, therefore, provided with 2,368 cartridges; and a battery of 8 mitrailleurs can hurl on an attacking column 3,848 effective projectiles per minute.

Another form of battery-gun employed by the French in the war with Germany consists of a series of barrels arranged side by side, the muzzles slightly diverging, and loaded at the breech by means of a rectangular breech-block containing two rows of chambers, one above the other. The cartridges are inserted into the upper row of chambers; the breech-block, which turns on an axis, is partially revolved, bringing the loaded chambers in line with the barrels, and the machine is fired, while at the same time the empty row of chambers is loaded; and these operations are repeated continuously. The machine was intended principally for defending the flanks of a column or line, or the angles of a square. It has no carriage, but is mounted upon a light frame of iron, with a pair of hinged legs in front and another in rear, which are locked in position for firing by a hinged brace, and which serve as handles for transporting it from place to place, two men performing this operation.

The Billinghurst and Requa battery, an American invention, consisting of 24 rifle-barrels arranged on an axle, and capable of parallel or diverging fire, was in use in the United States service in 1861.

The Abbertini, one of the forms of this weapon in use in Europe, has ten barrels similarly arranged; the working of the machine being performed by a crank which, through intermediate devices, conveys the cartridges to the barrels from the box-like magazine at the rear of the barrels upon the mounted frame or carriage. The barrels, after each discharge, are cleaned by special appliances; the entire number of barrels can be discharged from eighteen to twenty times a minute.

Fig. 3184.



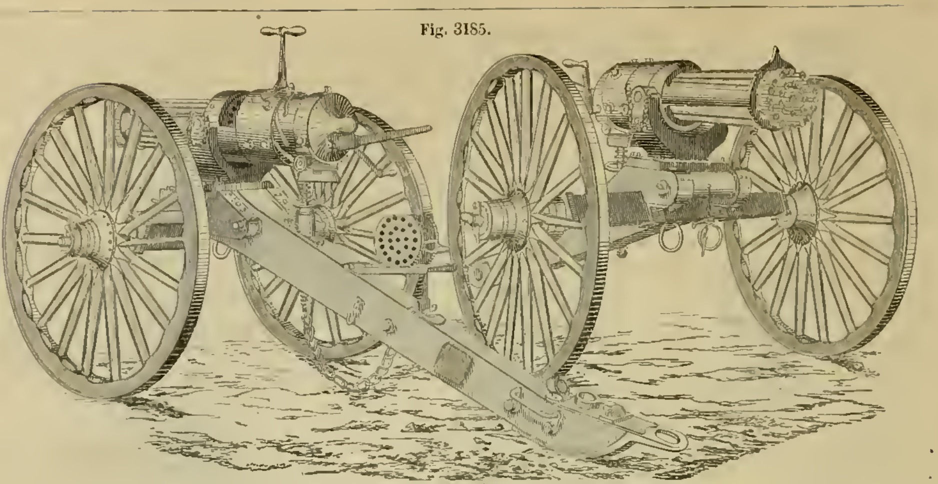
Abbertini Mitrailleur.

Hotchkiss's mitrailleur is a bundle of rifled cannon, throwing explosive shells weighing 23½ ounces at the rate of 60 in 48 seconds. It is mounted and rotated like the Gatling gun, but the loading and firing apparatus differ from the latter. It has been tried experimentally in France and Italy.

Taylor's machine-gun is shown at Fig. 3185.

The charging-blocks, one of which is shown on the shelf on the trail of the gun, are filled with cartridges automatically from a magazine carried in the caisson, the magazine having chambers corresponding with those in the charging-block, and containing springs to press the cartridges forward. The rear view shows the gun open to receive the charge. The handle, seen in a vertical position, is attached rigidly to a sleeve, which has a concentric reciprocating movement of about 90°, and imparts a longitudinal movement to the breech-block and cascabel by means of studs projecting from the interior of the sleeve into spiral grooves in the sliding breech. The charge-block being inserted, the handle is drawn down into horizontal position. The rotation thus imparted to the sleeve closes the breech-chamber, slides the breech forward, pressing and locking the block firmly against the rear of the barrels, and, by means of plungers projecting from the front of the breech, forcing the cartridges partially through the block and into the barrels. The front view shows the arm with its breech closed in readiness for firing. The discharge may be effected simultaneously in all of the barrels by depressing the longitudinal lever which projects backward from the breech, and carries a pawl adapted to catch and suddenly release a sliding hammer concealed within the cascabel. The hammer is then driven forward by springs, striking all the firing-pins at once. The barrels can be discharged in succession by means of the crank shown at the side of the breech. This crank rotates a tappet or cam-wheel arranged to retract and release all the firing-pins in succession. The barrels are arranged

Fig. 3185.



Taylor's Machine-Gun.

in concentric circles at back, but diverge slightly forward so as to spread the fire in a horizontal plane.

The empty cartridge-shells are held by the charge-block and withdrawn with it.

Mit'ten. A hand covering, with one cell for the thumb and another which contains all the fingers.

It is a common and evident plan with clumsy manufacturers or material, or for the warmth of association of the fingers, to give the latter a common compartment and a special pocket for the thumb. Abbé Huc found the Tartarian gloves thus made. As a Frenchman, he was surprised; but these fellows had not been battling with winds fresh from Siberia for so long to no purpose.

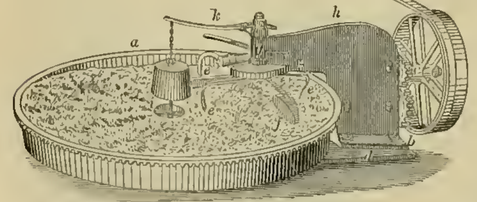
Mixed Fab'rics. Those in which two or more fibers are combined. The varieties are numerous; such as *tweeds*, *poplins*, *cassinets*, etc.

Mix'ing. 1. (*Cloth.*) Uniting wool of different colors for *mixed cloth*, called *medleys*.

2. Intimately compounding ingredients by stirring together, or passing together through sieves.

Mix'ing-ma-chine'. Poole's machine for mixing chemicals, fertilizers, etc., consists of a pan *a*, the upper edge of which is flanged, constituting a circular toothed rack, engaged by a gear-wheel on the same shaft with the wheel *b*, and turned by a wheel *c* on the driving-pulley shaft. A circular projection on the bottom of the pan fits a groove on the base-plate *d*, serving to steady the pan during its rotation; this may contain a lubricant. The stirrers or rubbers *e e* and scraper *f* are attached to an upright shaft, turned within the sleeve *g* on the arm *h* by bevel gears on it and on the pulley shaft. By this means they are constantly rotated during the revolution of the pan. When a charge of material is thus thoroughly mixed, the plug *i* is removed by lifting the lever *k*, when the material, guided by the scraper, passes through the central aperture into a discharge-pipe, or a vessel prepared to receive it.

Fig. 3186.



Mixing-Machine.

Mix'ing-sieve. One by which ingredients are intimately combined by sifting together.

Miz'zen. (*Nautical.*) The aftermost mast in a three-masted ship, or in those two-masted ships in which the forward mast is the larger; such as the *ketch* and *yawl*.

The *main* is always the larger mast. When the larger mast in a two-masted vessel is forward, the one abaft is the *mizzen*; when the larger mast is abaft, the one nearer the bows is the *fore*-mast.

The word *mizzen* indicates the relation of many parts, as *mizzen-top*, *mizzen-shrouds*, *mizzen-rigging*, etc.

The *bonaventure mizzen* is a second or additional mizzen-mast employed in some ships with four masts.

Moat. (*Fortification.*) A ditch around a rampart.

Moc'ca-sin. A deer-skin sandal, the sole and upper of which are formed of one piece of leather.

The Indian process is as follows: The skin is stretched and dried. The brains are dried in the sun. The skins are soaked, hair removed by a knife, placed with the brains in a pot and heated to about 100°. The skins are taken out, wrung, stretched with lines and pegs, and persistently rubbed with a hard stone to soften them. Among some tribes the leather is softened by mastication. The squaws of course do the chewing. See PAC.

Mock Gold. A yellow alloy. Factitious gold.

	Copper.	Platinum.	Magnesia.	Zinc.	Tin.	Borax.	Sal-ammonia.	Saltpeter.	Lime.	Tartar.	Putty.
Hermstadt's (resembles gold in color and specific gravity)	7	16		1							
Hackert's patent	16			2		2		2		16	2
Hamilton and Parker's	32			33							
Pinchbeck	4			2							
Manheim gold	16			4	1						
Red tombac	11			1							
Ormolu	48			52							
Prince's metal	2			1							
New formula	100		6		17		3.6		1.6	9	

See also JEWELERS' ALLOYS, page 63.

Mock Plat'i-num. Brass, 8; zinc, 5.

Mock Sil'ver. A white-metal alloy for jewelers.

	Copper.	Tin.	Bismuth.	Platinum.	Silver.	Nickel.	Zinc.	Antimony.	Lead.	Steel.	Aluminium.
Von Eckart's (same gravity as silver)	11.71			2.4	3.53						
Packfong or tutenag	40.4					31.6	25.4				
White tombac .	16	1		—							
				Cadmium.							
Tonca's patent .	5	1				4	1				
Tutania, German .	1	48						4			
Tutania, Spanish		28						2		1	
										Tungsten.	
Queen's metal .		9	1					1	1		
Queen's metal .	4	100	1					8			
Parisian white metal	69.8			4.7		19.8	5.5				
German white copper . . .	88					8.75		1			
Minargent . .	100					70				5	1

See also ALBATA; BRITANNIA-METAL; PEWTER; BIDDERY-WARE; POT-METAL; SPECULUM-METAL; and tables, pages 62–65.

We read of one copper alloy in Strabo, called by him a mock silver (*Pseud argyrum*). It is not clear whether the stone which was added to the copper was an ore of nickel or some other white metal. He calls the alloy *oreichalcum*. Brass and bronze were well known to him, and this alloy was of a white color.

Mod'el. 1. A pattern, usually on a diminutive scale, of a work which has been or is to be done.

Working-models are diminutive machines, with all the parts capable of performing work on a scale proportioned to their size.

The best and largest collection of mechanical models in any country or time is that in the United States Patent Office, where, since 1836, have been deposited the models accompanying about 200,000 applications for patents, excepting in that small proportion of the inventions consisting of processes and compounds in which no model is required. The model saloon occupies the whole upper floor, a circuit of 2,000 feet, the cases being arranged on both sides of the four long halls encircling the building. The cases are in double tiers with galleries.

Ingenious mechanics in all ages of the world have devoted much time and skill to the manufacture of minute mechanical devices. "In the twentieth year of Queen Elizabeth, a blacksmith named Mark Scaliot made a lock, consisting of eleven pieces of iron, steel, and brass, all of which, together with a key to it, weighed but one grain of gold. He also made a chain of gold, consisting of forty-three links, and having fastened this to the before-mentioned lock and key, he put the chain about the neck of a flea, which drew them all with ease. All these together, lock and key, chain and flea, weighed only one grain and a half.

"Oswaldus Norhingerus, who was more famous even than Scaliot for his minute contrivances, is said to have made sixteen hundred dishes of turned ivory, all perfect and complete in every part, yet so small, thin, and slender that all of them were included at once in a cup turned out of a peppercorn of the common size. Johannes Shad of Mitelbranch carried this wonderful work with him to Rome, and showed it to Pope Paul V., who saw and counted them all by the help of a pair of spectacles. They were so little as to be almost invisible to the eye.

"Johannes Ferrarius, a Jesuit, had in his possession cannons of wood, with their carriages, wheels, and all other military furniture, all of which were also contained in a peppercorn of the ordinary size.

"An artist named Claudius Gallus made for Hippolytus d'Este, Cardinal of Ferrara, representations of sundry birds sitting on the tops of trees, which, by hydraulic art and secret conveyance of water through the trunks and branches of the trees, were made to sing and clap their wings; but at the sudden appearance of an owl out of a bush of the same artifice, they immediately became all mute and silent." — *World of Wonder.*

Boverick, the French artificer, made a chain of two hundred links, with its padlock and key, all weighing together less than the third part of a grain. He was also the maker of a landeau, which opened and shut by springs. This miniature equipage, with six horses attached to it, a coachman seated on the box, with a dog between his legs, four inside and four outside passengers, a postilion riding one of the four horses, was drawn with all the ease and safety imaginable by a flea.

A writer in the "Gentleman's Magazine" gives the following account of a visit to the model-making workshop of Thomas Smith, on the Surry side of the river Thames, near Lambeth Palace, London.

"Beginning with the larger of his productions, the first object to which he directs our attention is a small steam-pumping engine for working a table fountain. All the adjuncts that pertain to a great pumping-engine are to be found in this diminutive model. There was even the gage glass on the front of the boiler, as slender as a good-sized needle, and fitted with taps at each end, in the nozzles of which a pin could hardly be inserted. The whole thing worked to perfection, without rattling or any escape of steam from the engine or water from the pumps, and will throw a small jet of water in a distant part of the room to a hight of twelve feet.

"At the time of our visit a number of diminutive garden-pumps, small enough to be carried in the waistcoat-pocket, are scattered over the work-benches in various stages of completion. These are for the use of agents and commercial travelers trading with such articles. But the above-described curiosities are huge compared with those next set before us. We are introduced to a model of the famous 'Great Britain,' made to a scale of $\frac{1}{40}$ of an inch to the foot, so that the length of the model is about 8 inches, and the breadth about $1\frac{1}{4}$ inch. It is full-rigged, with six masts and their accompanying spars, and all the hatchways and deck fittings. The deck of this tiny vessel is lifted off and a magnifier is handed to us; this resolves a little heap of metal scraps into an accurate model of the original engines with which the 'Great Britain' was fitted. So small is this model that it stands upon less space than the area of a shilling. An annular trough of water is produced, and the ship is launched into the watery circuit. A tap is turned, and compressed air rushes through a tube, and off goes the tiny ship to circumnavigate its little sea. The total weight of the boat, with deck and rigging, engines, boiler, and all entire, is less than a troy ounce! The actual weight of the working part of the engines — that is, all excepting the boiler — is just that of a sovereign."

One of the tiniest working models in the world is now in the possession of John Penn (of Greenwich), the eminent maker of the great engines of which it is the reduced counterpart. It will stand on an English silver 3 *d.* piece; it really covers less space, for its base-plate measures only $\frac{3}{8}$ of an inch by about $\frac{3}{16}$. The engines are of the trunk form introduced by Penn; the cylinders measure $\frac{1}{8}$ of an inch in diameter, and the trunk $\frac{1}{20}$. The length of stroke is $\frac{3}{40}$ of an inch. They are fitted with reversing gear, and are generally similar in design to the great machines with which ships of the "Warrior" class are equipped. From the extreme smallness of this model a few minutiæ — such, for instance, as the air-pumps — have necessarily been omitted; so small are some of the parts, that they require a powerful magnifying-glass to see their form. The screws which hold the members together are only $\frac{1}{40}$ of an inch in diameter, and these are all duly furnished with hexagonal nuts, which can be loosened and tightened by a Liliputian spanner. The whole weight of the model is less than a threepenny-piece.

A steam-pump, consisting of a steam and water cylinder, made by Charles Fichtel of Philadelphia, in 1860, was auxiliary to a model of a steam fire-engine. The steam-cylinder was $\frac{1}{8}$ of an inch in diameter, and the whole affair would go into a common thimble.

2. (*Plastic Art.*) The invention of the art of modeling in clay is attributed to Dibutades the Corinthian, about 985 B. C. His daughter traced the profile of her lover, by his shadow on the wall; and her father filled up the outline with clay, which he afterwards baked. Had Pliny known more of Egypt and Phœnicia he might have made a better statement. Pots and lamps had been made in rude resemblance of faces and figures for unknown ages past. Etruria, from which Rome received her agriculture, fine arts, armor, metal-working, astronomy, navigation, measurements, coins, weights, furniture, dress, habits, and medicines, was also her mistress in the ceramic art. Geodetical models, in which the contour of the earth is shown in relief, are among the most interesting of all geographical representations. The mountains of Switzerland were modeled in miniature, by General Pfiffer. In modeling a tract of country, it is usual, as in plotting a profile of a route, to exaggerate the hights to make them more observable. With such vast precipices and eminences as Switzerland affords, the necessity for vertical exaggeration is not so great; but it is apparent that in a modeled map of a country 200 miles square, having no elevation exceeding 1,760 feet, a rise of $\frac{1}{3}$ of an inch on a surface 16 feet square (one inch to the mile) would not be readily seen. The insignificance of the elevations on the earth's crust, compared with the area of the surface, is not generally appreciated, and it is common in plotting profiles of routes as in modeling the superficies, to give the rises and elevations ten times their actual proportion. This is to render them more visible. The largest attempt at geographical modeling was by Mr. Wyld, in his globe erected in Leicester Square, London, 1851 – 53. (See GLOBE.) The *interior* surface (for convenience of general view) was modeled to represent the chains of mountains, table-lands, river valleys and depressions. It was executed in sections, and castings therefrom were afterward associated on the interior of a vast shell, and painted.

Models of towns and ancient buildings in wood, plaster, and cork have excited much attention and interest, and are common in museums.

Mod′el-ing-board. A board used in loam-molding to give shape to the mold.

Mod′el-ing-plane. A short plane used in planing rounding surfaces. It has a length of from 1 to 5 inches, a width of from $\frac{1}{4}$ to 2 inches. The irons are from $\frac{3}{16}$ to $1\frac{1}{2}$ inches wide.

Mod′er-a′tor. (*Optics.*) A device, known as Rainey's, consisting of an opal glass or ground glass to moderate and diffuse the light passing from a lamp to an object on the stand of the microscope.

Mo-dil′lion. (*Architecture.*) *a.* An ornamental console beneath the corona in some orders.

b. One of the large flowers in a soffit or coved ceiling.

Mod′ule. 1. A measure of proportion. See MODULUS.

2. The lower diameter of the shaft of a column.

Mod′u-lus. In mechanics, a coefficient of some specified force or property.

"*Modulus of a machine*, a formula expressing the work which a given machine can perform under the conditions involved in its construction. The relation between the work done on a machine by the moving power and that yielded at the working points, either constantly, if its motion be uniform, or in the interval of time which it occupies in passing from any given velocity to the same velocity again, if its motion be variable. Called also the *efficiency* of the machine.

"*Modulus of elasticity*, the measure of the elastic force of any substance, expressed by the ratio of a pressure on a given unit of the substance to the accompanying compression. Or an expression of the force which would be necessary to elongate a prismatic body of a transverse section equal to a given unit, or to compress it within the limits of its elasticity.

"*Modulus of rupture*, the measure of the force necessary to break a given substance." — RANKINE.

Mo′el-lon. Rubble stone filled in between the facing walls of a structure, or between the spandrels of a bridge. It consists of clean, broken stone, and where it holds an important position, as in the latter-mentioned case, it is laid in mortar, and by hardening becomes equal to a solid mass of stone.

Mo′hair. (*Fabric.*) From a Hindoo word. *a.* A fabric made from the fine, white, silky hair of the Angora goat and allied species. Sometimes called *camlet*. The hair is said to be produced in perfect quality in no place excepting Angora in Asia Minor, and has long been a valuable article of export from that place.

b. A wool and cotton goods made in imitation of the above, in mixed colors or plain.

Moiles. The metallic oxide adhering to the glass which is knocked from the end of the blow-pipe.

Moi′neau. (*Fort.*) A small, flat bastion raised in front of an intended fortification, to defend it against attacks by small-arms.

Moire. Watered or clouded silk. The thick silk goods is damped, folded in a peculiar manner, and subjected to great pressure, say, from 60 to 100 tons. "Green watered moyre" is mentioned by Pepys in his Diary, 1660.

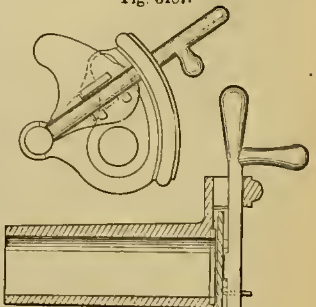
Moire An-tique′. (*Fabric.*) A heavy, watered silk.

Moire Met′al-lique′. Tin plate which has been acted on by an acid, so as to display by reflected light the crystalline texture of the tin.

A surface of tinned iron is rinsed in an alkali water, dried, warmed, washed in a solution of nitric and hydrochloric acid, dipped in water, washed, and dried. It is then covered with colored varnish. A film of peculiar crystallization is produced in larger or smaller patterns, according to the mode of applying the acid.

Mo-las′ses-gate. A faucet with a sliding lip at the discharge end, to cut off the flow positively and prevent drip.

Fig. 3187.



Molasses-Gate.

Mold. The matrix in which an object is cast. A templet or shaper by which an object is tested for shape or marked to a shape.

1. (*Founding.*) Molds for casting are of several kinds: —

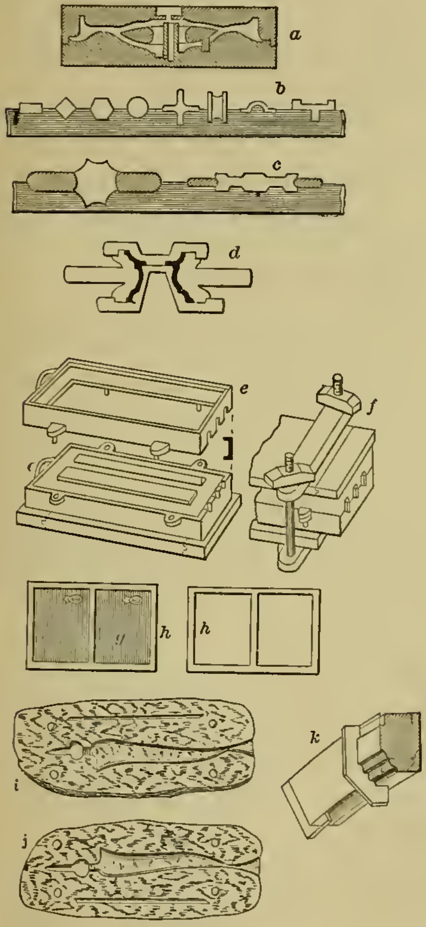
Open molds, into which the metal is poured, the upper surface of the fluid metal assuming the horizontal position. Such are ingots and some other objects.

Close molds of metal or plaster of Paris, with in-gates by which the molten metal enters. Such are the molds for inkstands, cannon-balls, bullets, type, and various other articles made of lead, tin, zinc, and their alloys which fuse at a moderate heat.

Close molds of sand, in which articles of iron, brass, bronze, etc., are cast. This is the ordinary foundry work, and includes machinery, stoves, ordnance, and the multitude of articles of domestic and agricultural hardware.

Loam-work casting, in which the mold is built up, instead of being rammed around a pattern, subsequently withdrawn. This is used in casting cylinders, tanks, bells, or ordnance of very large size.

Fig. 3188.



Molds.

For specific index see FOUNDING.

a is a mold of a car-wheel in sand, shown in section.

b is a section showing several small articles partially imbedded in the drag or lower portion of the mold.

c is a view of an article with undercut portions requiring a peculiar treatment by core pieces, which are taken away to remove the pattern, and laid back again before closing the mold.

d is a metallic mold for britannia and pewter ware.

c is a flask, the drag and cope being separated to show the parts. See FLASK.

f shows a portion of the same, with the parts of the flask fastened by a clamp.

i j is an ancient mold for bronze knives, found in the lake of Brienne, and belonging to a period of several thousand years past. It is a gray sandstone of great porosity, and has corresponding holes for the reception of wooden pegs to keep the parts of the mold in place. It is about 12 inches long.

Roman coins were (sometimes) cast in molds, hollowed out in a kind of stone. Molds were also used in making pottery, pastry, cheese, bricks, pisé walls, shoemaker's lasts.

The invention of molds for the casting of wax figures is ascribed to Lysistratus, about 328 B. C.

g h are molds for paper-making.

k is a plasterer's mold for shaping cornice.

The fusibility of metals and alloys is the basis of the founder's art, and furnishes one means by which they are given the varied forms which fit them for application in the arts.

The softer metals and alloys, such as lead, pewter, type-metal, britannia-metal, and even zinc, are usually cast into metallic molds which are used over and over again; but in a more restricted sense molding embraces the formation of molds in sand and loam only, and the filling of such with metals and alloys fusing above a red heat, as cast-iron, brass, gun-metal, bell-metal, etc. In all these cases the mold can be used but once; after pouring and cooling it is broken up to get out the casting, part of its sand only being used again.

The trade of the iron-molder is distinct from that of the brass-molder (who also deals with gun and bell metal), but the methods employed are so nearly identical, that a distinction in describing the several operations is not necessary.

a. Molds are made in *green-sand*, *dry-sand*, and *loam*. For the first two a *pattern* is required; in the latter it is generally dispensed with.

Patterns are mostly made of wood, although brass and iron are also common, especially when large numbers are required. A pattern always represents the appearance and dimensions of the casting as far as its external surface is concerned. This is also frequently true of its internal surface, but not invariably so, dry-sand *cores* made apart from the pattern being often introduced to form the cavities and internal spaces required. (See CORE.) Patterns are sometimes made in two or more pieces fastened together by pins or dowels, the object being to facilitate their removal from the sand.

The term *green-sand* molding is employed to express the fact that the sand is used pretty much in its *green* or natural state, and is not subjected to any drying or baking process before casting; it is the method followed for the great mass of castings, both iron and brass. The sand for this purpose is kept damp, sufficiently so to ball into a compact mass when squeezed in the hand, but it must not be wet, or approach that condition.

The brass-molder keeps his sand in a molding trough or bin, over which he works; small castings forming the bulk of his work: but in an iron foundry the whole floor to a considerable depth is formed of *old-sand*, and on this the surplus quantity for use is gathered together in large mounds.

In working from a pattern in green-sand the object in view is to produce in the finely packed sand a cavity identical in form with that of the pattern; the same being afterwards filled with molten metal and left to cool. To accomplish this the workman is provided with a large assortment of *flasks*, or *molding-boxes* of the most various dimensions; they are designed to hold the sand used in making the molds. Small flasks are simply rectangular frames resembling ordinary boxes, but without either top or bottom; each part being 3 to 6 inches high. They are connected together generally in pairs (often three or more), by *steady-pins*, which allow of their separation when full of sand, and their restoration to exactly the same relative position afterward. Large flasks are provided with cross-bars at suitable distances to prevent the sand, which has been rammed into them, from falling out of its own weight, or rising from the upward pressure of the fluid metal.

In this country, flasks are frequently made of wood; only in the larger foundries is iron used to any extent; but in Europe, and especially in England, wooden boxes are rarely seen. Even where iron is always used, wooden cross-bars are frequently employed with advantage, as they admit of being readily cut away to suit patterns of unusual form. The lower side, or *drag*, has generally only flat bars connecting its lower edges, so that it can be lifted, but not turned over after it is once full. See FLASK.

The following description will serve to illustrate the principles which govern and guide the molder working in green-sand. One flask being laid with its lugs uppermost is filled and rammed up with old-sand, and stricken off level with the joint of the flask: this is called a *false-part*. If now the object to be molded has an elliptical form, as shown in section *b c*, Fig. 3188, the sand in the false-part is cut away roughly, so as to imbed one half of the pattern. Some dry *parting-sand* is next scattered over the surface. This adheres to the damp sand, and prevents any union between such a surface and any other sand subsequently rammed upon it. After the parting-sand is blown off the exposed part of the pattern, the other side or *drag* is put on, its steady-pins entering the holes in the lugs of the false-part easily, but without shake. Newly prepared sand, *facing-sand*, is next sieved over the pattern in sufficient quantity to cover it completely; the box is filled with old-sand from the floor of the shop, and is carefully rammed up and stricken off. After provision is made for the escape of gases from the sand by prodding it all over with a sharp-pointed steel wire, known as a *vent-wire*, the two flasks are held together and turned over on a bed prepared for the drag upon the floor, or on a flat board if the boxes are small, and the false-part, having done its work, is lifted off and emptied. An exact *parting* is now made with the trowel along the median line, if the casting be symmetrical, the damp facing-sand being added to or cut away sharply up to the pattern as occasion may require. The *parting-line* is, as a general rule, that line upon the pattern, as it lies in the sand, above and below which the sides of the pattern run inward from the perpendicular. This is frequently an undulating line, but the parting surface always runs from it in all directions to the horizontal edge of the box. Parting-sand is now strewn over the whole, and the surplus blown off. The upper flask or *cope* being replaced, a short cylindrical *runner-stick* is thrust into the sand of the lower part at a convenient distance from the pattern; facing-sand is sieved on, the box filled up with old-sand, rammed up, and stricken off as before. The vent-wire is then used as with the drag, the runner-stick withdrawn, and the opening left, through which the metal has ultimately to pass to the mold, is given a bell-mouthed shape.

Having arrived at this stage of the work, the molder, either alone if the box be small, or with the help of other workmen or the crane itself if it be large, lifts the cope steadily upward, leaving the pattern in the sand of the drag. The cope is then usually turned over on wooden blocks for repairs and dressing. The pattern is now to be *drawn* from the sand. This is done with the help of spikes or screwed rods, temporarily attached to it; with one or more of these it is lifted, being made to vibrate the while by rapid tapping with a piece of wood or iron, for the purpose of causing it to leave the sand readily. The molder has now to repair with suitable tools any broken parts of the sand forming the mold, then to cut the *runners* or channels from the opening left by the *gate-stick* to the mold, along which the fluid metal finds its way; and lastly to dust finely powdered charcoal from a linen bag over the facing-sand surface, if the mold is for iron, and mill-dust or similar farinaceous substance, if for brass. Charcoal, when this is used, is slicked down with the trowel and slicker as far as possible, so as to bring it into intimate contact with the damp sand. The excess of dust in every case is blown off with the bellows. When the top part is *closed*, it occupies exactly the position it did before; the space then filled by the pattern being now vacant and in connection with the gate, the hot metal can therefore make its way so as to fill such space, the form of which it will be found to have taken when cold.

The foregoing may be regarded as typical of all solid work in green-sand, the imaginary case cited being almost the simplest possible. When hollow work is required, especially if the cavities are long or tortuous, dry-sand or loam *cores* (which see) are employed to form such openings. These are made either by pressing damp sand of suitable composition into a sort of wooden mold, known as a *core-box* (which see), from which it is removed and dried by artificial heat, or by attaining the same end by the use of plastic loam on a perforated barrel or *core-plate*. When such a core is perfectly dry, having received a thin coat of a mixture of clay, water, and charcoal-dust, called *black-wash*, it is placed in position in the mold. This is determined, and the core is held in its place by making it longer than the hole in the casting, and letting the added parts rest in suitable cavities in the sand, made by projections on the pattern known as *prints*. An ordinary water-pipe is a good illustration of this class of work. The pattern for such a casting is solid, and has cylindrical projections of the inside diameter of the pipe at its ends. The long core, through which runs a perforated barrel for the escape of gas, rests upon that part of the mold which is made by the prints, and completely fills those cavities; but it leaves a space all round which exactly represents the pipe, and which is finally filled by melted metal.

b. Dry-sand molding may be regarded as identical in all essential points with that in green-sand, save that the mold when finished is thoroughly and strongly dried by artificial heat. By this treatment the sand especially prepared for the work is baked to a hard compact mass. Dry-sand molding is chiefly used for heavy castings, where great solidity and strength are required. The drying is done in a heated room called the *stove.*

c. *Loam-molding* is entirely distinct from the preceding methods of working. *Loam,* as prepared for this purpose, is essentially to be regarded as a mixture of sand and clay, the latter in quantity sufficient to give a plastic character to the mixture when tempered with water to the consistence of mortar or plaster. This material is much used for the construction of large molds and cores, and, as has been previously stated, it obviates the necessity for patterns — generally very costly ones — and core-boxes. Loam cores are *struck* up, usually upon a hollow perforated spindle covered with a layer of hay-rope. The spindle — often consisting of common gas-pipe — is made to run in notched trestles upon which a board (*loam-board*) rests parallel to the axis of the spindle. The loam is heaped upon this board, while the spindle at a proper distance is made to revolve slowly before it by a simple winch-handle. After it is thoroughly dried in the *drying-stove,* it is turned to the exact size, black-washed, and dried again, when it is ready for use.

Loam-molding applied to large castings, such as cylinders, pans, or large water-pipes, is really conducted on principles quite analogous to the above. As a typical instance, the molding of a large sugar or soap boiler's pan is here described. Such a vessel is cast mouth downward. A heavy, flat, cast-iron plate (*loam-plate*) *b,* in the form of a ring, is laid upon the low carriage or truck which runs in and out of the drying-stove. The outside and inside diameters of this flat ring are respectively greater and less than that of the rim of the pan, and it is also provided with four heavy projections by which to move it and the mold upon it, by means of the crane, from the *stove-truck* to the pit in the floor where the casting is made. In the center of this ring rises a perpendicular spindle running in a long bearing provided for it in the carriage, and carrying a movable arm from its upper end. A hollow templet of wood of the exact sweep of the inside of the pan is now clamped to the cross-arm of the spindle, and the latter is lowered so as to bring one end of the templet down to the plate, and there it is fixed. In revolving through a complete circle, the edge of the templet will now describe a figure representing the inside surface of the pan. A rough dome of common brick set in loam is now built upon the ring, keeping it two or three inches clear of the templet, and leaving an opening at top large enough for the spindle to turn in. Loam is then applied to the dome in two or three coats, and it is finally *struck-up,* with the help of the revolving templet, to an exact form. This structure is dried, and then black-washed, and is known in loam-molding as the *nowel.* The templet used hitherto is now replaced by another which gives the form of the outside of the pan. With its help the *thickness* is struck-up upon the nowel, in loam which contains a good deal of clay. It will be seen that this application represents the thickness of metal required for the pan. When dry, it is likewise black-washed, and dried again; the last application in both cases being made to secure a parting. A second cast-iron ring, also provided with heavy ears or lugs, is lowered down till it rests upon that part of the first loam-plate which extends beyond the *thickness,* last applied. A coating of wet loam is then put on with the hand to the surface of the *thickness,* and a second dome of brick is built right against it. When all is dry, the position of the second ring is marked, or secured with pins. The crane is then made fast to it, and the *cope* is lifted off. In all probability the thickness-loam in doing this will break to pieces; if it does not, it is gently knocked away, and both surfaces, that of the *nowel* and *cope,* are repaired and dressed, and finally black-washed. Before this is done the spindle is lifted out, and the opening in the nowel carefully closed; that in the cope usually plays the part of ingate. When both parts of the mold are united, a space now remains corresponding to the *thickness* removed, ready to receive metal. By means of the crane, made fast to the lower ring, the whole is deposited in a pit, and old-sand rammed about it, so as to hold the cope down, and increase its power of resisting the lateral pressure of the metal, which is very great. Adequate provision is also made for the easy escape to the surface of the gases generated by the hot metal, especially those forced inwards through the dried loam and brick-work of the nowel. The formation of the ingate is also carefully attended to.

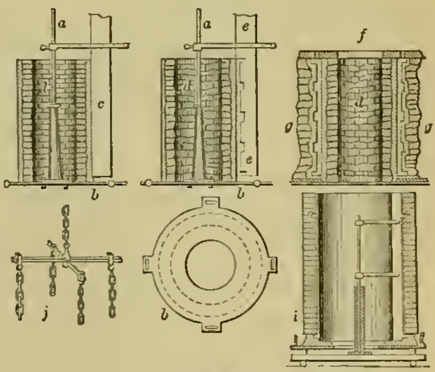
In smaller foundries, and sometimes in those with very perfect appointments, loam-molds are made so large as to render it necessary to dry them *in situ.* In such cases slow-burning fires are made under them in the open shop, and the evaporation of the water is accomplished as best it may.

The *pouring* of brass and iron castings is accomplished from crucibles or ladles respectively. In large iron works several ladles, each containing from two to four hundred weight of metal, are often used simultaneously; for still larger masses, crane ladles holding six or eight tons are employed, and when such are insufficient the mold is filled by leader channels direct from the furnace.

Fig. 3189 shows several stages of the process of cylinder molding by the loam-work process.

A vertical axis *a* is mounted upon a pedestal in the center of the plate *b,* as shown in the figure, or it may be attached to the building or a beam of the roof. A radial arm projects from this axis and carries a *templet c,* which is maintained in rigidly perpendicular position by firm attachment to the radial arm, which rotates with or around the central axis, so that the edge of the templet describes a cylinder in its rotation.

Fig 3189.



Cylinder-Molding.

d shows an interior cylinder built up of bricks and plastered over with soft loam, scraped into cylindrical form by the *templet c,* which revolves on its axis. When the surface is made smooth and fair, this part of the mold is dried; it is then brushed over with black-wash and again dried. The charcoal-dust of the black-wash acts as a parting, to prevent the succeeding layers of the loam-mold from adhering to the first.

The cylinder thus made by templet *c c* is the mold for the inner surface of the future cylinder. It is the *core* or *nowel.*

The next figure represents another templet *c e*, attached to the same axis, having an edge conformable in its outline to the *outside* surface of the future steam-cylinder. The distance of the edge of the templet *e c* from the blacked surface of the *nowel* is equal to the thickness required for the steam-cylinder. Loam is placed on the nowel, and smoothed to shape by the revolving templet *c*, which is then dismounted and the spindle removed. The thickness of this loam is represented white in the figure. This loam then receives a coat of black-wash, which prevents it from adhering to the coat to be placed outside of it.

f represents the mold in a farther stage. A wall of bricks *g g* is built around the previous construction, loam being carefully worked against the material which represents the thickness of the future cylinder. The new work or *cope* is now thoroughly dried, and afterward lifted off by means of a crane and a cross-beam with four chains, as shown at *j*. This part of the process usually drags off the thickness of loam which represents the cylinder, and this commonly breaks out during the removal. What remains is carefully picked out of the cope, as it has now served its purpose, and the interval existing between the *nowel* and *cope*, when the parts are restored to their proper relative positions, is to be filled with molten metal to form a cylinder.

When the cylinder requires *ports* at the ends, or the short tube with flanges for attaching the steam-pipes, models of the tube are worked into the cope, and are afterwards withdrawn; the cores are made in core-boxes, and are partly supported by the outward extremity and partly upon *grains*, or two little plates of sheet-iron connected by a central wire, the whole being equal to the thickness of the metal at that point. When steam passages are wanted, either along the side or around the cylinder, they are worked up in clay upon the thickness and duly covered in by the cope; their cores are supported, partly by their loose ends and partly by *grains*, which become entirely surrounded by and fixed in the metal when it is poured.

The mold is now put together in a pit sunk in the floor of the foundry, and the top covered in with a loam-cake, perforated with holes for the entrance of the metal and the escape of the air. The *core* is sustained by iron bars, and the *cope* by iron rings, so as to withstand the pressure of the column of metal.

With some large cylinders, such as those of the Cornish pumping-engines, 80 to 100 inches bore and 12 to 14 in length, also the cylinders of the large blowing-engines of blast-furnaces, the *nowel* and *cope* are made separately, as at *i*. The *cope* is built up and turned inside with a radius-bar; the *core* is erected on a plate on the floor and turned on the outside to a gage; when dried, it is lowered into the cope by a crane.

A modification of the plan for loam-work casting of cylinders and similar large hollow articles, is found in making the cope divisible by a vertical joint, so as to separate laterally into two semi-cylindrical portions which rest upon semi-annular plates, so as to slip back while the thickness representing the metal is removed.

Large water-pipes are cast upon cores, which are made of a layer of loam upon a hay-band wound upon a perforated pipe, the pipe being supported on a bearing, and the loam turned off to a smooth surface, which is dried and black-washed. The *thickness* is laid on and black-washed, and this substitute for a pattern is molded in sand. The core with its envelope is withdrawn, and the *thickness* removed; the core is supported in the mold by the *prints* at the ends and by *grains* with long wires.

Pipes are also made from wooden patterns cut in halves through the axis. The *drag* and *cope* respectively receive the impression of one half, and when the pattern is removed the mold is ready for the core and the making of the ingate.

The molds for crooked pipes and branches are frequently made in halves upon a flat iron plate. An iron bar or templet of the curve required is laid down, and a semicircular piece of wood, called a *strickle*, is used for working and smoothing the half-core; next, a larger *strickle* is used for laying on the thickness; the two halves are then fixed together by wires and molded from in the sand-flask; the thickness is now stripped off the core, which is fixed in the mold by its *prints*, and, if needful, is supported also upon *grains*.

The infinite variety of forms which the molder is daily called upon to reproduce, as well as the constantly varying conditions and materials with which he has to deal, renders his trade an arduous one, requiring much judgment, experience, and forethought. For this reason, also, it is not possible to explain or even enumerate in the space at my disposal the endless modifications of the above typical cases which are constantly occurring. As the best substitute for such exhaustive treatment, however, a list of materials and technicalities used in molding is appended, with explanations designed to elucidate this most important, interesting, and many-sided art.

d. (*Plaster-casting.*) *Waste*-molds are those which admit of but a single cast, from which they are subsequently removed by breaking. *Safe*-molds are those made in a number of pieces, which are so arranged as to be withdrawn separately from the casting and admit of being put together again for a repetition of the process. We are indebted for the invention to the Italians and French of the fifteenth, sixteenth, and seventeenth centuries. With some elaborate subjects the number of pieces required has exceeded 700.

See also STATUARY CASTING.

c. Soft and perishable objects may be so molded as to produce a single casting by one of the several following methods, which are adapted to procuring castings of small animals, insects, flowers, feathers, ferns, sea-weed, wax-models, etc.

1. Support the object in the center of a small box by means of needles, one or two of which should be sufficiently large to form *ingates.* Some fine river-mud is dropped into the box, and shaken around so as to adhere to the object. When partially dry, a coarser grade of silt is thrown in, and successively coarse qualities until the box is filled. The needles and ingate wires are now withdrawn, the mold burnt to reduce the object to ashes, which are shaken and blown out, when the mold is ready for pouring the metal.

2. Another method is to take the object itself or a wax model, such as that of a flower, and suspend it in a box while plaster of Paris is carefully poured around it. The application of heat causes the object to burn or the plaster to absorb the wax, or, if the latter be in excess, it can be poured out. The strings by which the object was suspended are withdrawn, and the mold is ready for casting. The castings may be covered with gold or silver by the electrotype process.

This plan was adopted in casting the feather of the equestrian statue of George III. at Pall Mall, London, and specimens of ears of wheat, flashy flowers, such as coxcombs, and other beautiful objects, have been exhibited.

Branson, of Sheffield, England, has pursued a somewhat analogous method in obtaining castings from ferns, algæ, etc. A slab of gutta-percha is softened by boiling water, laid on a smooth metallic plate, dusted over with fine bronze-powder, and the frond impressed thereon by a flat upper plate, imbedding the frond in the gum. When cooled, the leaf is withdrawn, and the mold is used to obtain a casting or an electrotype, from which impressions in ink are obtained by the copperplate process.

Auer's plan of *nature-printing* is to impress the frond into soft, polished sheet-lead, by passing between polished rollers. The impression is used for printing, or a copy in a harder material is obtained by the electrotype process.

Wallis's *autographs* were obtained by making drawings in a material which is salient upon the paper, so as to make an impression in the soft plate when the two are passed between the rollers. The plate is used as in Branson's and Auer's processes.

MOLDERS' TERMS.

(Referred to at greater length under their alphabetical heads.)

Air or *foul air.* The gases generated in casting, and driven through the sand.

Air-drain. A passage to conduct gases from molds deeply bedded in the floor of the molding-shop.

Air-gate. An opening at which displaced air escapes during pouring, and in which metal afterward rises.

Barm. Yeast used in the preparation of core-sand to render it adhesive.

Bellows. Used to blow loose sand or dirt out of the molds, or parting-sand from the pattern.

Blackening. Charcoal-dust applied to a mold to give smoothness to a casting.

Black-lead. Sometimes used for blacking molds or for mixing with sand.

Black-wash. A solution of clay and powdered charcoal applied to the surface of sand-molds, to give a clean skin to the casting; also used as a parting. See SAND.

Blow. The forcing of displaced air through the molten metal from insufficient vent.

Blown The condition of a casting containing cavities caused by inclosed air.

Bot. A pear-shaped piece of stiff clay used to stop the flow of metal from the tap-hole of the furnace.

Bot-stick. The rod provided with a long wooden handle at one end, and a small round disk at the other, to receive the clay, used for *botting-off* when the ladle is sufficiently full.

Box. A very common term signifying *flask;* a contraction of *molding-box.* See *Flask*, below.

Brick. Used largely in loam-molding.

Burned in. Union produced by flowing hot metal in quantity over cold.

Burned sand. Sand, the tenacity of whose clayey portion has been destroyed by the heat of the metal. See SAND.

Case. A *cope.*

Cast-gate. The *ingate* at which the metal is poured in.

Chaplet. A wrought-iron stud to hold a core in position in a mold. A *grain.*

Charcoal. Used in dust, as dry *blackening*, or in suspension with clay, as *black-wash* (which see).

Chill. A piece of iron in a mold to suddenly cool the metal flowing against it and render it hard.

Clay. Used according to quality, — fire-clay for walls and boshes of furnaces, commoner for bricks and for loam.

Clay-wash. Clay in solution for smearing the insides of molds and gaggers, to make the sand stick; for cementing the portions of cores; for strengthening loam and adding to charcoal to make *black-wash.*

Cleaner. A tool of thin steel or brass, from 6 to 18 inches in length. One extremity has a bent spatula blade; the other a short blade bent on the flat to a right angle. Used for smoothing the molded surfaces and removing loose sand.

Coal-dust. Powdered coal added in certain quantities to green-sand, according to the quality of the latter.

Coke-dust. The same in effect as coal-dust.

Cope. The flask which is uppermost at the time of casting. The *upper box* or *top-part.* The outside portion of the mold in *loam-work.* Also called the *case.*

Core. A mass of sand, molded and baked, and placed in a mold to form a cavity in a casting.

Core-bar. An iron bar to stiffen a core.

Core-barrel. A perforated iron tube to form a passageway for the gases passing off through the interior of a core.

Core-box. A mold in which a core is formed.

Core-pipe. A core-barrel.

Core-print. A portion of a core which rests in seats in the mold and supports the core in place

Core-sand. Coarse new sand with powdered loam.

Cotter. A key which locks the steady-pin of a flask.

Cow-hair. Used as a bond to increase the tenacity of loam.

Crane. The hoisting apparatus of a foundry to move heavy flasks, castings, etc. See CRANE; FOUNDRY-CRANE.

Deliver. A pattern is said to *deliver* well when it leaves the sand without breaking down the mold.

Drag. The lower box or bottom part of the flask.

Draw. The taper of a pattern which enables it to leave the sand without impairing the mold. To lift the pattern from the sand.

Drawback. A *false-core.*

Drop. The fall of sand from the top-part into the mold.

Dry-sand. That description of molding done with loam and sand in due proportion, the mold being oven-dried before casting. See SAND.

Drying-stove. A heated room for drying dry-sand molds or cores.

Face-dust. Powdered charcoal for iron castings, mill-dust or pease-meal for brass. It is dusted from a bag over the mold to improve the surface of the casting. Powdered soapstone, rottenstone, graphite, or chalk is sometimes used.

Facing-sand. New-sand used in immediate contact with the pattern, being sifted thereon and then backed up with old-sand and rammed.

False-core. A mass of molded green-sand placed against the side of a pattern which is under-cut. Before drawing the pattern, the false-cores are removed, and are restored before closing the flask. Also called a drawback. See *c*, Fig. 3188.

False-part. A flask temporarily filled with sand in which the pattern is sunk to a parting-line before ramming up the other side of the box which is to form the *drag.* After turning over, the false-part is broken up and the parting properly made.

Feeding-rod. An iron rod for keeping open the *head* or *riser* at which hot metal is added from time to time as the casting contracts in cooling.

Fettle. To clean castings, remove *gits*, *fins*, and *cores*

Fin. A thin sheet of metal extending along the *parting-line* of a casting where the metal has insinuated itself between the parts of the mold.

Flask. The box or frame which contains the rammed sand forming the mold. The upper part is the *cope*, the lower the *drag.*

Flow gate. An opening from the mold to the surface; in it the metal rises as it is poured into the cast-gate and fills the mold.

Gagger. A double hook hung to the cross-bars of the top-part of a flask, and entering the sand which fills the deep part of a pattern, to enable the sand to be lifted out.

Gate. The opening through a mold into which metal is poured. An *ingate.* Also called *git.*

Gland. A bent rod of iron forming a double hook to lock the parts of a flask together.

Grain. A piece of wrought-iron to hold a core in position. A *chaplet.*

Green-sand. The damp sand of the foundry prepared for molding. See SAND.

Hay-rope. A twisted hay-band wound about a core-barrel in making large cores.

Head. A *flow-gate* or *riser* over the largest part of a heavy casting, in which the hot metal rises, and into which metal is poured from time to time as the metal contracts.

Horse-dung. Introduced into loam, as hair into plaster, to form a bond in dry-sand molds.

Ingate. The opening through a mold at which metal is poured in. A *gate*, *git*, *runner.*

Ladle. An iron vessel, coated with loam, and used to convey molten metal from the furnace and pour it into the mold. One form is a *shanks.*

Lantern. A perforated core-barrel, short, and of relatively large diameter.

Lift. The separation of the cope from the drag.

Loam. A mixture of sand and clay used in molding. See SAND.

Loam-board. A board resting on trestles, and holding the loam used in making cores.

Loam-plate. A flat cast-iron ring on which the *nowel* and *cope* rest in *loam-work.* See *b*, Fig 3189.

Loosening-bar. A rod extending upward from the pattern through the sand, and which is struck from opposite sides to loosen the pattern in the mold before lifting the top-part.

Metal. The founder's term for cast-iron.

New-sand. Facing-sand next to the pattern.

Odd-side. A permanent *false-part.*

Old-sand. The sand of the foundry floor, killed by use, and not fit for *facing.*

Open-sand molding. A mode in which molds are made in the floor of the foundry without any cope, and usually filled direct from the furnace

Part. One portion of a *flask.*

Parting. The line of separation between the sand rammed in the respective boxes or parts of the flask.

Parting-line. The line upon a pattern below which it is imbedded in the *drag*, and above which it is in the *cope* or top-part

Parting-sand. Sand free from clay, which is scattered over a green-sand surface where a parting is to be made.

Pattern. The counterpart of a casting in wood or metal from which the mold in the sand is made.

Pease meal. Dusted on as *facing* for molds in brass casting.

Picker. A steel rod with a sharp point, used in picking out small patterns from the sand.

Pickle. Dilute sulphuric acid used in cleaning castings.

Piercer. A vent-wire.

Pot. A crucible, generally of graphite.

Print. A projection on a pattern which leaves a space in the sand for supporting a core in position.

Rammer. An implement for compacting the loam around the pattern in the flask.

Red brick-dust. Sometimes used as a parting-sand.

Riddle. A sieve to mix sand on the floor of the foundry.

Riser. An opening through a mold into which the metal rises as the mold fills, and through which more metal is poured in as the mass contracts.

Run. Said of a mold if the metal insinuates itself along the parting or otherwise leaks out.

Runner. A channel leading from the gate to the space left by the removal of the pattern from the mold.

Runner-stick. A pattern for forming the gate of a mold.

Run-through. When metal is poured in at one gate and runs out at another. A process sometimes adopted in casting a piece solid to another piece already in the mold.

Sand. Crystalline particles of silica mixed with clay which confers tenacity. Used as a material for ramming around patterns in molding. See SAND.

Sand-burned. Sand partially fused by the heat of the metal and adhering to the casting.

Scoring. The bursting of a casting due to strain in contraction.

Scrap-iron. The spattered masses of iron, wasters, and pieces of iron which have been previously cast.

Shanks. The ladle in which metal is carried from the furnace to the mold

Shovel. The implement for heaping sand into the flask.

Shrinkage. The allowance of one eighth inch to the foot, which patterns are made larger than the casting required, to allow for shrinkage of the metal.

Shuttle. A spade-shaped implement by which the molder stops the flow into the mold in casting direct from the furnace

Sieve. A wire-cloth sifter for distributing the sand over the pattern.

Skimmer. A bar to keep back slag and dross when pouring from the ladle.

Slag. A basic silicate of iron floating on the metal in the furnace or ladle, and which it is the business of the skimmer to push back in pouring.

Slicker. A small, polished tool for smoothing surfaces of sand in the mold.

Sow. A large channel in the floor of a foundry to hold metal, when heavy castings are to be made without the use of the ladle.

Staple. A piece of iron driven into the sand and projecting therefrom to hold a core

Steady-pin. One of the dowel-pins which form a part of the locking device securing together the parts of a flask

Stove. The drying-chamber for molds and cores.

Strickle. A straight-edge used to remove superfluous sand from a flask after ramming up.

Strike. The same as strickle.

Strong sand. Tenacious from abundance of clay.

Sullage. The scum, slag, dross floating on metal.

Sullage-piece. An additional length on the upper end of a casting to insure compactness of the lower part. The sullage-piece is afterward removed.

Swab. A soft brush of frayed rope, used in wetting the parting-edge before drawing the pattern.

Swab-pot. An iron vessel to hold water for the swab.

Tap-hole. The opening from which iron flows from the cupola.

Tapping-bar. One for opening the tap-hole by removing the *bot* of clay.

Thickness. The portion of loam, in loam-molding, which represents the object to be cast.

Trestles. Frames on which the perforated core-barrels rest in pipe-molding

Trowel. A flat-bladed implement used in slicking and parting sand in the mold.

Under-cut. The parts of a pattern in which the sand would be broken by drawing the pattern perpendicularly. The difficulty is avoided by cores, drawbacks, or an additional part to the flask.

Vent. A channel by which air escapes from the mold.

Vent-wire. A sharp-pointed steel wire for piercing sand in the mold to allow escape of air.

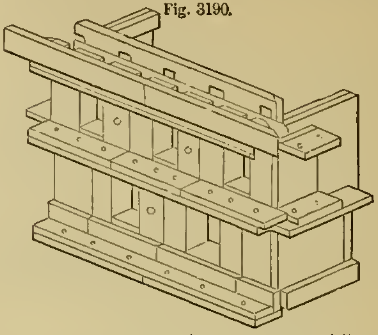
Waster. A spoiled casting; goes to the scrap-heap.

Watering-can. One with a rose to damp the molding-sand.

Weighting. Blocks put on a flask to keep the cope down under the upward pressure of the body of iron poured into the mold.

2. (*Building.*) A frame to give shape to a structure, as in the building of houses in concrete, béton, clay, cement, and what not. In the example, the molds are made in inner and outer sections, which sustain the joists and door and window frames, and between which the concrete walls are formed. The molds are perforated for admission of air, which supplies carbonic-acid gas. Composition used: sand, 19; hydraulic lime, ½; quicklime, 2.

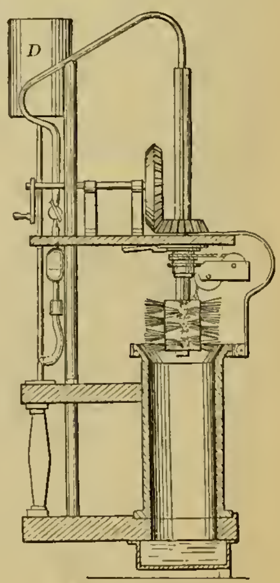
Fig. 3190.



Sectional Mold for Pisé and Concrete Walls.

3. (*Paper-making.*) Hand-made paper is made by a *mold g* and *deckle h*, Fig. 3188. The mold is an open, square frame with a wire-cloth bottom, and a little larger all round than the required sheet of paper. The *deckle* is an open frame, whose inner margin determines the size of the sheet of paper. The *deckle* being laid on the mold, the two are dipped into the pulp, of which a quantity is raised, the superabundance flowing over the edge. The mold being shaken, the water drains away through the wire-cloth, and the fibers become felted together and settle upon the wire. The *dipper* then removes the *deckle* and passes the mold to the *coucher*, who lets it drain a few seconds, and then *couches* the sheet of pulp upon a felt cloth. A stack of alternate sheets and felts to the number of 6 quires of paper, = 144 sheets, forms a *post*, which is placed in a screw-press and consolidated.

Fig. 3191.



Mold-Blacking Machine.

4. (*Plastering.*) A thin board cut to a pattern and used in forming cornices, etc. (*k*, Fig. 3188.)

5. (*Shipbuilding.*) *a.* A full-sized pattern of the same figure and dimensions with the molding side of the piece which it represents. The mold may be of skeleton form, and may serve for several frames.

It is usually a thin plank cut to the form of a ship-timber, and serving as a templet for scribing the timbers for the workmen who saw, hew, and adze them into shape.

6. (*Gold-beating.*) The package of gold-beater's skin in which gold-leaf is placed for the third beating. It is first enveloped in vellum, 150 leaves with interposed ribbons of gold, one inch square, forming a *kutch.* The pieces, spreading to the size of the vellum, are cut into four pieces and interleaved with gold-beater's skin; 600 pieces and their skin form a *shoder*, for the second beating.

Being again divided into four pieces, they are again interleaved with gold-beater's skin, making 2,400. These are divided into three packages of 800 each, called *molds*, and receive the third beating.

Mold-black'ing Ma-chine'. One by which a loam-mold is blacked to give it a thin carbonaceous surface; the solution is known as *black-wash*, and is usually put on by a hand-brush; but in pipe and cylinder casting, the insides of the *copes* may be reached by a reciprocating and revolving cylindrical brush supplied through a hollow shaft and tube from an upper reservoir *D*.

Mold-board. 1. (*Plow.*) A curved plate extending back of the share, for overturning the furrow-slice.

The mold-*board*, as its name indicates, was originally of wood, and was first made of iron by James Small, of Berwickshire, Scotland, about 1764. He was the first to make a complete plow of iron and steel, all but the hand-holds for the grasp of the plowman.

Plows are called *right* or *left*, according to the direction in which the furrow-slice is laid. *Double mold-board* plows are those in which the breast is formed by two mold-boards meeting at an acute angle in front of the sheth, and turning the soil equally in each direction.

2. (*Founding.*) A board on which the pattern lies while being rammed. A *follow-board.*

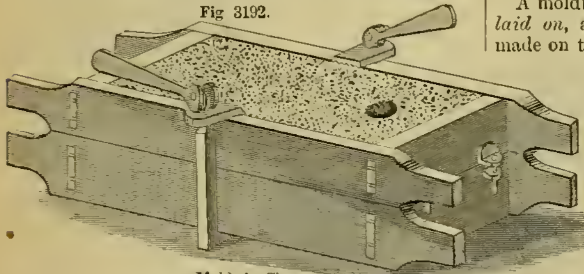
Mold-cis'tern. (*Sugar-making.*) *a.* The vat which receives the drippings from the sugar-loaves.

b. A tank in which the molds are soaked after being used.

Mold'er's Clamp. (*Founding.*) A frame by which the parts of a flask are tightly secured together, ready for the pouring of the metal into the mold.

In Fig. 3192, the parts of the flask are clamped by a hook and a sliding plate, which is depressed by an eccentric pivoted to the shank of the hook.

Fig. 3192.



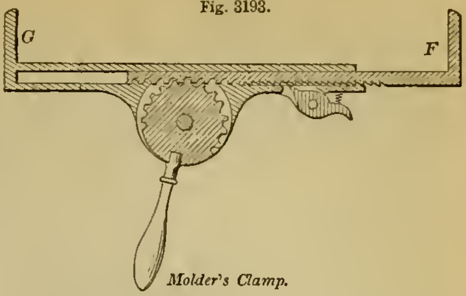
Molder's Clamp.

Fig. 3193 has hooks *F* and *G*, which are drawn against the parts of the flask by pinion and ratchet. The ratchet-arm is worked within the hollow arm by a cog-wheel operated by a lever. Each arm has a hook on its outer end. The spring pawl engages the ratchet-arm to keep it in position.

Mold'er's Flask. (*Founding.*) The frame containing the mold in which metal is poured in casting. See *e*, Fig. 3190. See also MOLD; COPE; DRAG; FLASK, etc. See list under FOUNDING.

Mold'er's Ta'ble. (*Founding.*) A bench at which a workman stands in molding small objects.

Fig. 3193.



Molder's Clamp.

Mold-fac'ing. (*Casting.*) A fine powder showered upon a pattern before covering the latter with loam. It is intended to increase the smoothness of the face of the casting.

Mold'ing. 1. (*Architectural Joinery.*) A mode of ornamentation by grooved or swelling bands or forms, following the line of the object.

a, *bead*, if small; *torus*, if large.

b, *astragal* or *bed*.

c, *cavetto*, *hollow*, *casemate*, or *cove*, according to circumstances or size.

d, *apophygé*, *scape*, *spring*, *hollow congé*, the *echinus* or quarter round. The *echinus* is a *swelling congé*.

e, *fillet* or *list*, if small; *fascia*, if large; *band*, when solitary; *cincture*, when separating the shaft from the capital or base.

f, *Roman ovolo* or *quarter-round.*

g, *Grecian ovolo* or *echinus.*

h, *cyma-recta*, *ogee*, *talon.*

i, *cyma-reversa.*

j, *scotia* or *trochilus.*

k, *quirk.*

l, *cable.*

m, *double bead.*

n, *bolection molding.*

o, *canted molding.*

p, *torus.* See JOINERY-FRAMING.

A molding is said to be *stuck on* or *laid on*, according to whether it is made on the edge of the frame or on a detached strip. See STUCK-ON.

A *reeding* is a form of molding resembling a number of bands.

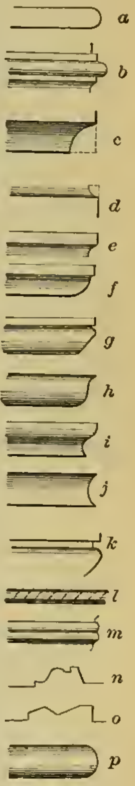
Lamb's tongue is a form sometimes adapted for window-sash.

A *raking* molding has a slanting overhang.

A *crowning* molding is a top member.

A *plain* molding is a mere band.

Fig. 3194.



Moldings.

The student of paleontology finds numerous anticipations of architectural and other ornamentation in the strata of the earth. "In what is known as the modern Ionic the spiral of the volute is not all on one plane; it is a Euomphalus: in the central volutes of the Corinthian the spiral is an open one; it is a Lituite or Gyroceras: in the ancient Ionic it is either wholly flat, as in Planorbus or the upper side of Maclurea, or slightly relieved, as in the ammonites. There is no form of the volute known to the architect which may not be found in the rocks, but there are many forms in the rocks unknown to the architect. Nor are the spire-like shells less remarkable for the rich and varied style of their ornamentation than the whorled ones. They are spires, pinnacles, turrets, broaches; ornate, in some instances, beyond the reach of the architect, and illustrative, in almost all, of his happiest forms and proportions. We detect among the fossils the germs of numerous designs developed in almost every department of art; but merely to enumerate them would require a volume. One form of the old classic lamp was that of the nautilus; another, that of *Gyphæa incurva;* the zigzag moldings of the Norman Gothic may be found in the carinated oysters of the green-sand; the more delicate frettings of similar form which roughened the pillars of a somewhat later age occur on Conularia and the dorsal spines of Gyracanthus. The old corals, too, abound in ornamental patterns, which man, unaware of their existence at the time, devised long after for himself." — Hugh Miller.

2. (*Pottery.*) Articles of clay are molded upon a Whirling-table (which see), or in molds which open and close, like those used in casting metals. In the latter case, the clay is usually rammed into the mold, but for some delicate objects the *slip* or creamy clay is poured into the mold, which is made of plaster, so as to quickly absorb the superfluous water of the filling adjacent. The central fluid portion being poured off, the clay adhering to the mold is allowed to dry, and the process repeated until the required thickness is obtained.

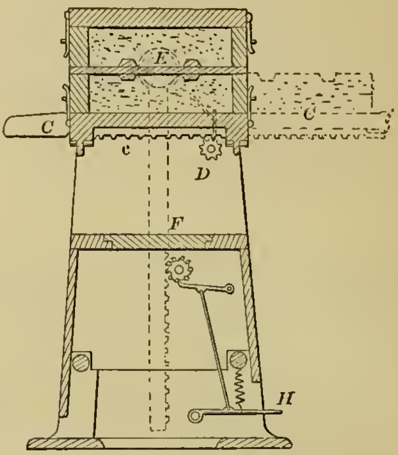
3. (*Shipbuilding.*) Giving the correct outline and depth to ship's timbers, etc. It is one part of the operation of Forming (which see).

Mold'ing-ap'pa-ra'tus. (*Founding.*) A device or machine for molding. In that represented in Fig. 3195, the operations of molding, facing, drying, coring, casting, and stripping are carried on consecutively, without interfering with each other. The empty flasks from the part *A* of the C-shaped trench *A D D*, which is made somewhat shallower than the rest, are lifted by the crane *F* into *B*, where the molds are cored, tamped, and faced, after which they are lifted by the same crane into the oven *C* and dried. The oven has a door at each end, one communicating with *B* and the other with *D D*, into which, after drying, they are deposited by the crane *G*.

Here the metal is poured by a pot suspended from the crane *G*. When cool, the flasks are lifted by this crane on to the trestles *H H*, where they are delivered, cleaned, and replaced in *A* to again undergo the same series of operations.

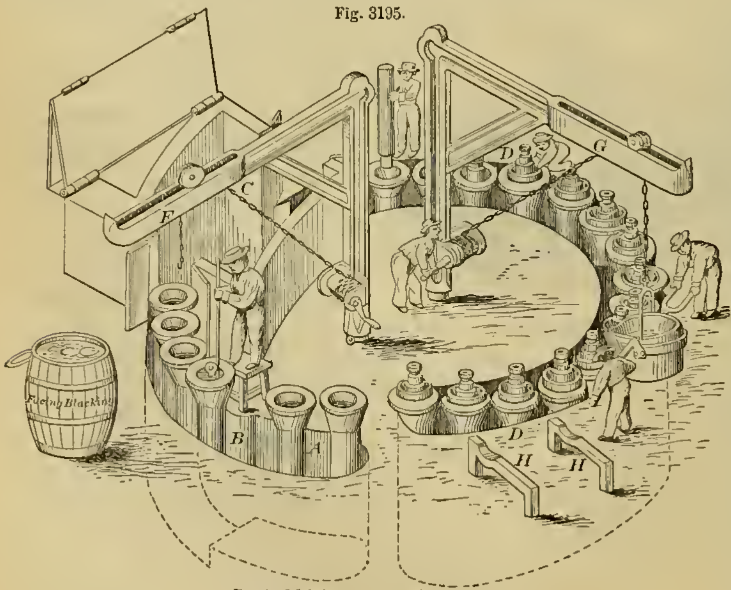
In Horrobin's machine (Fig. 3196) the flask is placed on a sliding carriage moved by a rack and pinion *C D*. The follow-board *E* is journaled on top of the rack *f*, so that it and the flask may be lifted and turned over, in order that a mold just made may be examined while another is being made on the other side. The rack *F* is raised or lowered by depressing the treadle *H*, which releases a pawl from the rack-pinion, and turning a crank on the pinion-shaft.

Fig. 3196.



Founder's Molding-Machine.

Fig. 3195.



Ross's Molding and Casting Apparatus.

Mold'ing-board. (*Founding.*) The board on which the pattern lies when ramming the loam. A *follow-board.*

Mold'ing-box. (*Founding.*) See Flask; Molding.

A *flask* in which the sand is rammed.

Mold'ing-crane. One for handling molds and flasks in a foundry. See Foundry-crane.

Mold'ing-edge. (*Shipbuilding.*) That edge of a ship's frame which comes in contact with the skin and is represented in the draft. The other edge is the *beveling-edge.*

Mold'ing-file. A file with a concavity adapted to dress and finish molded surfaces. It is made by a swage and afterward cut.

Mold'ing-frame. (*Founding.*) The templet by which an object is shaped in loam-molding.

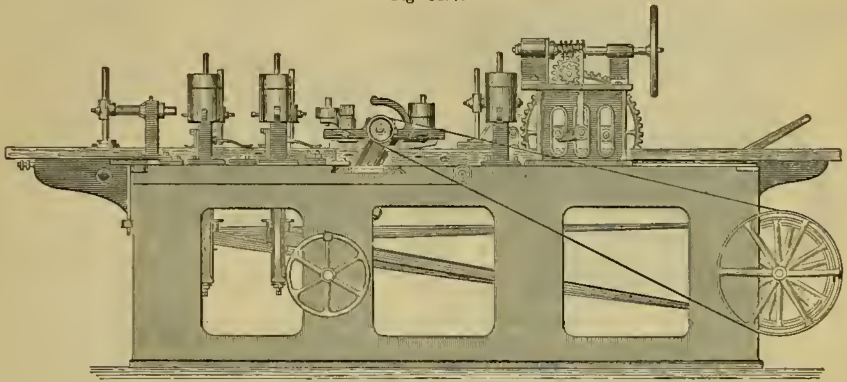
Mold'ing-hole. (*Founding.*) The cavity in the floor of a foundry in which large castings are made.

Mold'ing-loam. (*Founding.*) The mixture of sand and clay used in loam-molding.

Mold'ing-ma-chine'. 1. (*Wood-working.*) The rotary molding-machine for wood is enumerated among the inventions of General Samuel Bentham, previous to 1800. It had rotary cutters. One form of his machine was for making wave-moldings, and had an undulating bed.

There are several forms of the machine, one of which is a modified planing-machine; the other is an outgrowth of the same, but has a peculiar construction.

Fig. 3197.



Richard's Molding-Machine.

Fig. 3197 is a side elevation of a molding-machine to plane four sides of the lumber. A roughing cylinder is placed in front of the main profile cylinder, to smooth the bottom of the lumber before it reaches the bed under the main cutters. The profile cutting on the under side is performed by the cylinder at the rear end of the machine. The cutter-heads are five in number, on steel spindles. The feeding mechanism is on top of the machine, raised above the cutting mechanism. The lumber is fed in at the end of the machine, gripped by the feeders, supported by the bed, and passed in contact with the revolving cutters in turn. See PLANING-MACHINE, WOOD.

Fig. 3198 is a perspective view of a machine for working heavy moldings, either three or four sides at one operation. The revolving head on the main spindle is slotted to receive a number of cutters, so as to make a molding of the profile required. The main feeding-roll is in the bed, and does not show in the figure; the adjustable swinging feeding-roll above is made in sections, and is so hung and geared as to be parallel with the lower feeding-roll. The lower horizontal cutter-head is in the bed, and does not appear; the upper head and the side cutters, on vertical spindles, are shown. The latter are driven by crossed belts.

Fig. 3199.

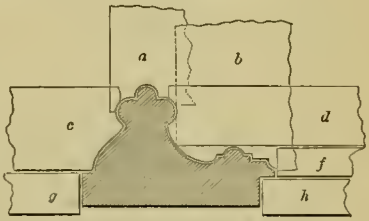
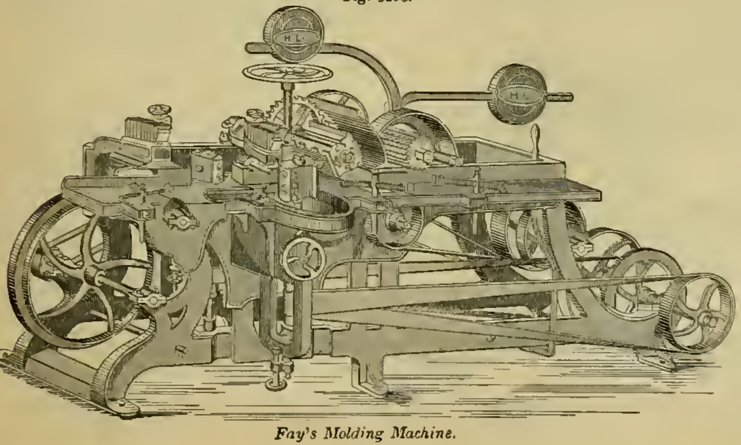


Diagram of Cutters for Molding.

Fig. 3198.

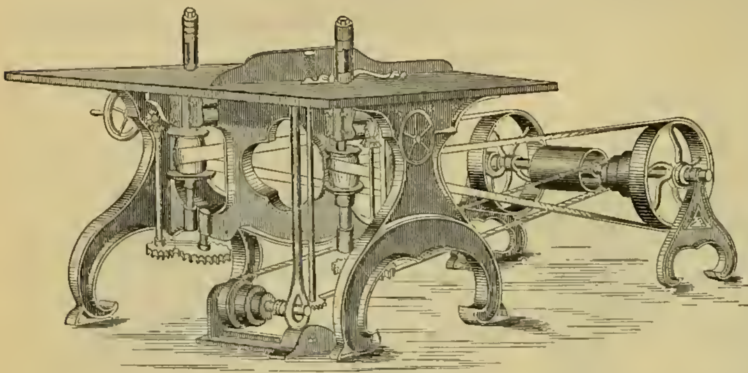


Fay's Molding Machine.

Fig. 3199 is a diagram showing the arrangement of cutters and their relative position to make undercut picture-frame molding, with rabbet for the glass and picture. It will be seen that of the side cutter-heads one has three knives and the other two; the upper head has two knives.

Another type of *planing and molding machine* is shown at Fig. 3200. A broad table rests upon an iron frame at the usual hight of a carpenter's bench, and rising from the surface near one end are the heads of two vertical spindles or shafts, which project but a few inches. In the heads are planing-irons, shaped to suit the work required, and the heads form a guide or gage to the pattern to which the material to be dressed is temporarily attached by a few metallic points. The pattern being carried past and against the heads while rotating, the material upon it is planed and molded to the shape of the pattern and knives used. By the graduation of the knives, the machine may be adapted to work of any size, making the heads even from one half of an inch to four inches in diameter; so that the machine may be used in doing delicate irregular woodwork.

Fig. 3200.



Variety Planing and Molding Machine.

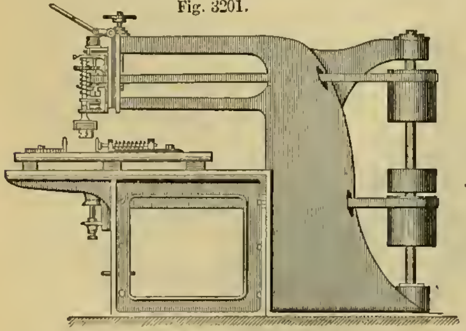
It is now used in planing the wood handles to hair-brushes, and also in dressing plow-beams and the knees of ships.

The engraving represents upon the table-top of the machine a guide, connected with which is a feed-roll, which receives power to move it from the pulleys beneath the table, and when attached completes the machine for doing straight as well as irregular work.

By the hand-wheel arrangement, represented at each side of the machine, the spindles are raised or lowered, as occasion requires, adapting the cutters to the thickness of the material operated upon.

This machine is analogous to the *milling-machine* for metal.

Fig. 3201.

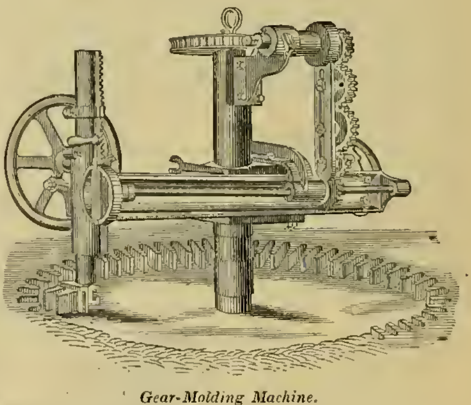


Molding, Shaping, and Recessing Machine.

Fig. 3201 is a side elevation of a molding, shaping, and recessing machine, applicable to a number of purposes, among which may be mentioned cutting curvilinear moldings, sticking circular and straight sash-bars, molding, rebating, and grooving square or circular sash-frames, forming moldings round raised door-panels; molding, chamfering, or edging flat ornamental balustrades, to patterns; forming the housings in string-boards for stairs; sinking recesses of any design, etc. The machine is furnished with top and bottom vertical cutter spindles, driven from an intermediate shaft at the back. The upper spindle is lowered into the work by depressing a handle; directly the handle is released, the cutter rises from the work through the agency of a strong spring affixed to the slide. For recessing, suitable stops are provided, to regulate the depth. When striking moldings, a fixed table is employed, but for recessing, curvilinear work, etc., a table on friction rollers is substituted. The lower cutter-spindle revolves in a reverse direction to the upper, and is useful for certain kinds of work. See CARVING-MACHINE.

2. (*Founding.*) Fig. 3202 is a view of a molding-machine for gear-wheels, in which a pattern is used corresponding to a small portion of the gear to be molded. This pattern includes two teeth and the interdental space, when spur-gears are to be molded. It is attached to the lower end of a vertical guide-bar, which slides in ways formed at the end of a horizontal support, which has a radial position relatively to a central vertical spindle or arbor. By this means the pattern is carried around, and, being made to descend, makes the proper impression for that portion of the gear-wheel or pulley which corresponds to it. It is used to mold gear-wheels from nine inches up to six feet in diameter, — either spur, bevel, miter, mortise, or worm wheels, plain or shrouded, — and it is also equally applicable to molding fly-wheels or pulleys, either whole or fitted in segments.

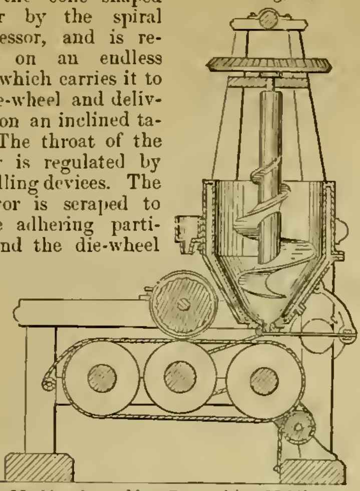
Fig. 3202.



Gear-Molding Machine.

3. (*Plastic-work.*) A machine for the manufacture of composition-molding. The material is driven

Fig. 3203.

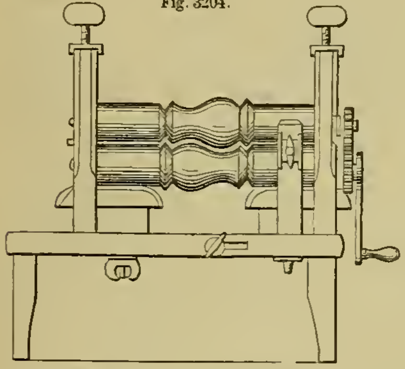


Machine for making Composition-Moldings.

from the cone-shaped hopper by the spiral compressor, and is received on an endless apron which carries it to the die-wheel and delivers it on an inclined table. The throat of the hopper is regulated by controlling devices. The conveyor is scraped to remove adhering particles, and the die-wheel oiled to prevent adherence of the composition. The principle is the same as some of the brick, tile, and pipe machines (which see).

4. (*Sheet-metal Working.*) A kind of rolling-machine for molding sheet-metal to shape for cornices, balusters, and other purposes. It consists of a pair of rollers of counterpart form, between which the sheet of metal is passed to give it the required outline.

Fig. 3204.

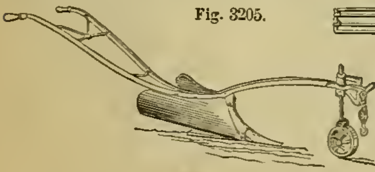


Molding-Machine for Sheet-Metal.

Mold′ing-mill. A planing-mill for shaping timber. See Molding-machine, 1.

Mold′ing-planes. Joiners' planes for making moldings, and having various patterns, or concave and convex soles to form parts of moldings. Such as *hollows* and *rounds*. *Match-planes.*

Fig. 3205.



Molding-Plow.

Mold′ing-plow. A plow with two mold-boards to throw the soil right and left. A *ridging-plow*. Used for molding or forming ridges, striking water-courses, or hilling-up potatoes; so constructed as to thoroughly turn the soil, burying the surface and bringing up the bottom. That shown is made entirely of iron, having a trussed beam and front wheel, and may be used for splitting ridges; the breast is laterally expansible, and the penetration of the share is regulated by the draft-chain at the clevis.

Mold′ing-saw. One or a number of circular saws for blocking out strips for ornamental moldings.

The strips are fed repeatedly to the saw at different angles, and the general outline of the desired molding approximated. The work is generally completed by revolving planes.

Mole. 1. (*Husbandry.*) A cylindrical plug of iron, three or four inches in diameter, and with a sharp point, drawn or driven through the subsoil to make a drain.

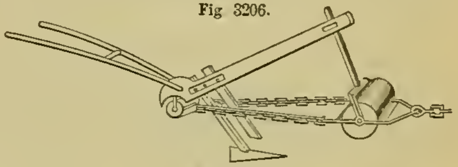
2. (*Maritime Engineering.*) *a.* A jetty or structure erected before a port so as to partially inclose a harbor or anchorage, and protect it from the violence of the waves in the offing.

b. A pier of masonry; one is described by Herodotus as extending around the harbor of Samos.

3. A mausoleum of peculiar form, as the mole of Hadrian, now known as the Castle of St. Angelo, Rome.

Mole-plow. The mole-plow has a pointed iron shoe, which is attached to the end of a standard and drawn along underground, making a track like that of a mole, establishing a duct to lead water from the subsoil, pressing the earth away, but not purposely disturbing the surface.

Fig 3206.

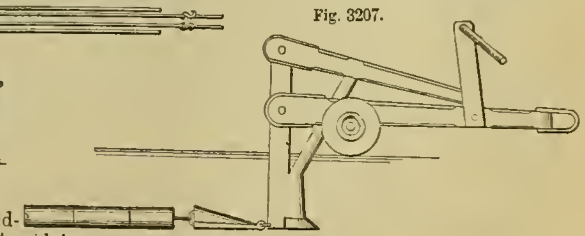


Mole Plow.

It is said to have been invented by Adam Scott (British), and will be easily understood by the illustration. The work is all beneath the soil, in positions where a surface drain is inadmissible, the thin colter to which the *mole* is attached only making a mark which is soon obliterated. It was used in draining the marshes of Essex, England, during the latter part of the last century.

In a modification, the mole is attached by a short chain to the bottom of the sharp standard, to permit the *mole* to avoid obstacles, and by lessening its rigidity increase the ease of traction. Fig. 3207 is a tile-laying mole-plow. The cutter-bar is pivoted to the carriage, and adjustable to vary the presentation of its foot by means of an upper beam to which it is attached and braced. A mole trails behind the

Fig. 3207.



Tile-Laying Mole-Plow.

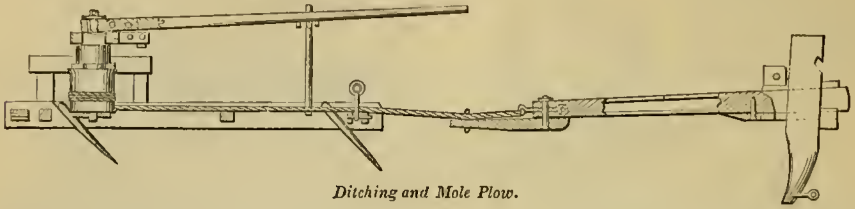
cutter-foot, and by means of a cord, hooks, and cross-bar the tiles are drawn in behind the mole.

A mole-plow for laying tiles was made about 1850, and exhibited by Foules, the inventor, at the meeting of the Royal Agricultural Society of England of that year.

Attached to the mole was a rope, upon which the sections of tile were strung, and the mole as it progressed drew in 300 feet of tiling after it. A hole was dug at each commencement of operations. See Drain-tile.

It is sometimes drawn by four or six horses, and, perhaps, more often by a rope from a capstan, as in Fig. 3208, in which the capstan is shown anchored in position, and the standard of the mole-plow has a clevis for the attachment of the mole.

Fig. 3208.



Ditching and Mole Plow.

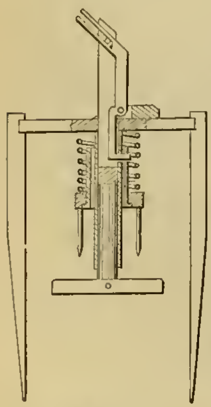
The *mole-plow* is described in White's English patent for a draining implement, 1797. It is thus described in a report, November, 1797: —

"The principle of this invention consists in the patentee's mode of forming a sort of subterraneous channels, cavities, soughs, or drains, from every part of the ground to be drained, which channels run into a principal drain or ditch, cut by hand in the usual way. These subterraneous channels he forms by a particular species of share, foot, or wedge, affixed to a sort of plow, which is drawn by horses in the usual way.

"In the beam of the plow is fixed a vertical plate of iron, about 24 inches long, and called, from its sharp steel edge, the *cutter*. To the bottom of this cutter is fixed a solid *wedge, foot,* or *share* of cast-steel or wrought-iron, 12 inches in length, 2¼ to 3 inches thick, and 2½ to 3 inches deep at the base, and terminating (forward) in a sharp point. This *wedge*, before the plow is put in motion by the horses, is introduced into the ground as deep as may appear to be necessary; and, by its passage under the surface, it forms the subterraneous channels which carry off the moisture to the main or principal drain.

"To lessen the resistance against the sharp edges of the cutter and wedge, in their passage through stiff soils, a circular or rolling cutter may be fixed immediately before the perpendicular cutter, or a shorter vertical cutter, at the pleasure of the maker."

Fig. 3209.



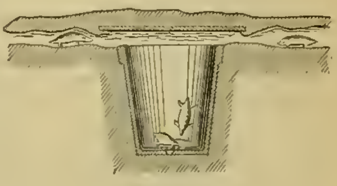
Mole-Trap.

Mole'skin. (*Fabric.*) A strong cotton twilled goods for men's wear. A kind of fustian, cropped or shorn before dyeing. *Beaverteen.*

Mole'trap. One placed in a mole-burrow to catch the mole. There are several kinds. In one, the mole, in attempting to effect a passage underneath the cross-bar on the lower end of the trigger-staff, actuates the trigger, and releases the tube carrying the prongs, and is consequently impaled by the latter.

Fig. 3210 shows a flower-pot placed with its mouth on the level of the track of the mole. Over the top of this receptacle a piece of board is placed, leaving a space of about three inches between it and the edge of the pot, so that dirt from above will not fall into the latter. The openings of the run lead into this space. The earth is replaced and the surface of the ground restored. The mole, in following his usual road, blindly comes to the orifice leading to the pot, into which he tumbles.

Fig. 3210.



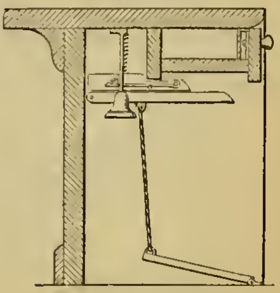
Mole-Trap.

Mol'le-bart. (*Agriculture.*) A Flemish implement consisting of a large shovel drawn by a horse and guided by a man. A *mold-board* or *earth-scraper*.

Mol-yb-de'num. A metal: Equivalent, 46; symbol, *Mo.*; specific gravity, 8.62; it gives a greenish flame under the blow-pipe; a salt of this metal is used as a test for soda. It is not much used in the arts.

Its sulphide is a soft black mineral frequently mistaken for graphite. In 1778 the Swedish chemist Scheele decided that it was really a different mineral; and in 1782, Hjelm prepared from it a new metal, to which was given the name molybdenum, the sulphide having received the name of molybdenite. It may be distinguished from graphite as follows: On unglazed porcelain the former gives a greenish streak and graphite a black; molybdenite is decomposed by nitric acid, leaving a white or grayish residue; graphite is unacted upon by acids; on charcoal before the blow-pipe the former gives a strong sulphurous odor and coats the coal with crystals of molybdic acid; graphite is infusible, but at a high temperature with access of oxygen burns without flame or smoke. Molybdenum is not usually met with in large quantities, but has been found in crystals and plates at various places in the United States. See Graphite.

Fig. 3211.



Till-Drawer Alarm.

Mon'ey-draw'er A-larm'. A device which strikes a bell when the till-drawer is opened. A cleat on the lower rear portion of the drawer engages a latch, and rings the bell, when the drawer is opened or closed. A treadle withdraws the latch to avoid the noise. A spring wire locks the drawer, and is unlocked by the motion of the knob.

Mon'ger. A small fishing-vessel.

Mon'i-tor The popular name for a class of American iron-clad vessels, having one or more turrets, and a peculiar formation of hull. So called from the first vessel of this construction, built for the United States by Captain John Ericsson, and launched early in 1862.

The original "Monitor" was based on a system proposed by Captain Ericsson to the Emperor Louis Napoleon in 1854. In 1855 Captain Coles of the Royal Navy proposed a system of revolving turrets to the British government, which was adopted after the "Monitor" had demonstrated the value of the invention. Captain Coles was lost in the iron-clad frigate "Captain," a vessel of his own construction, in a gale off Cape Finisterre in 1870. See Plate IV. for a view of the *Captain.*

Prior to the inventions of Ericsson and Coles was a proposition of Mr. T. R. Timby, of Massachusetts, who sent drawings of his proposed turret ships and batteries to the United States Patent Office in 1843. His right to the invention was afterward recognized by the United States, and a royalty paid to him. The evidence tends to show that neither one of these engineers was aware of the invention of the others prior to the completion of his own.

The contract for building the "Monitor" was awarded September 16, 1861. Captain Ericsson says: "In order not to lose time, the Secretary ordered me to 'go ahead at once.' Consequently, while the clerks of the department were engaged in drawing up the contract, the iron for the keel-plate of the 'Monitor' was drawn through the rolling-mill."

The contract for Captain Ericsson's battery specified that she was to be 172 feet long, 41 feet beam, 11½ feet hold, 1,255 tons displacement. She was to be completed in 100 days.

The construction of the "Monitor" was different from that of any vessel preceding her. Besides the revolving turret and low deck, the upper part of the hull had a square projection over the lower part, some 6 feet wide on the sides and 25 feet astern. This "overhang" served to make her much steadier in a sea, but was supposed to be the cause of her final loss. The deck was 18 inches above the water-line, and composed of one-inch plates of rolled iron. The turret was 20 feet in diameter and 9 feet high, built of thicknesses of one-inch rolled plates, and covered with a grating of railroad bars supposed to render it bomb-proof, with a roofing above to keep out water. The turret was pierced for two guns, and carried two 11-inch Dahlgrens. The guns and turret rested on a post or pivot amidships, which supported the whole weight, and was turned by the engines. The boilers and engines were aft, leaving the forward part of the hold for quarters for the crew and storage of ammunition. The pilot-house was forward, and had lookout-holes for the steersman or commander. (See also Plate IV., opposite page 150.) She was described by the Southern journals as "a black Yankee cheese-box on a raft."

The engagement of the "Monitor" and "Merrimac" in Hampton Roads, March 9, 1862, was an event of history, and need only be mentioned here as having decided the fate of wooden vessels for naval contests. At that time the "Monitor" undoubtedly proved herself the most formidable craft afloat.

Subsequent engagements with shore batteries pointed out a few defects in construction, the worst one being the location of the pilot-house forward of the turret, interfering with the pointing of the guns in that direction. In subsequent monitors the pilot-house was mounted on the turret. Some other minor changes were also made. The original "Monitor" maintained her supremacy until her loss in a heavy storm off Hatteras, December 31, 1862. She is supposed to have been strained in falling with the seas, and parted between the lower hull and the overhang, carrying down four officers and twelve men with her. A part of the crew were saved by the steamer "Rhode Island."

After the success of the "Monitor," a large number of iron-clad vessels of similar or analogous construction were built for the United States government. The "Weehawken," one of the earliest, was plated with 6-inch armor on deck, 11 inches turret, and carried one 11 and one 15 inch gun.

In an engagement between the "Weehawken" and the Confederate iron-clad steamer "Atlanta," June 13, 1863, the latter was disabled at the fourth shot from her antagonist, and surrendered, having lost 16 men wounded and 40 knocked down by a 15-inch shot which broke through her 4-inch iron and 18-inch timber armor, although striking at an angle of 50°.

In the various engagements with the fortifications at Charleston, the "Weehawken" was struck 187 times by shot and shell without serious damage to vessel or crew.

Admiral Dahlgren reported that the nine iron-clads of the monitor pattern, during the operations against Morris Island, fired 8,000 projectiles, weighing 365 tons, and were struck 882 times, mostly by 100-pound shot, without receiving any very severe injuries. In giving his opinion as to the comparative value of iron-clad vessels, Admiral Dahlgren says: —

"The armament of the monitors could be perfected to give all desirable rapidity of fire, but by no contrivance could a broadside vessel be enabled to use much heavier guns than those now mounted. . . . . There remains to the monitors the advantages of lighter draft, choice of guns from the heaviest to the lightest, defensibility, and direction of fire around the whole circle; consequently the ability to carry a heavy battery into the least depth of water, with equal power of offense and defense in any direction, and that with half the number of guns carried in broadside by another vessel."

Admiral Porter, after a lengthened experience with all sorts of iron and wooden vessels in action under almost all possible circumstances, gave his opinion that the monitors built on the Western rivers were the most powerful vessels of war ever launched. He says: "The first monitor was a perfect success, and capable of defeating anything that then floated." The one first completed at Cincinnati, in 1864, he thought, "could commence at Cairo and, going down the river, destroy everything we have on these waters, unless they ran away"; and this without disparagement to the powerful fleet of vessels then on the Mississippi, several of which had received over a hundred shots each, while under the Admiral's command, without apparent damage. Of the monitors at Charleston, he says: "They have done what no other vessels ever built could possibly have accomplished."

Some 50 monitors were built for the United States government, between the years 1861 and 1867. Of these, some have one, some two, and some three turrets, each turret to contain two guns. The general principles were substantially the same in all, and the Ericsson plan of iron-clad vessels may be said to cover nearly everything in the way of armored ships now in the United States navy. The guns mounted on the monitors are generally 15-inch Dahlgrens, carrying a projectile of 450 pounds. A few 20-inch guns, to throw a shot of 1,100 pounds, have been made, but these are now at the Navy Yard in Brooklyn, and none have yet been tried on shipboard.

The British Admiralty adopted a modified form of monitor or turret vessel, constructed according to the plan of Captain Coles, who built some very formidable vessels; but, in his efforts to increase the offensive efficiency, overloaded the vessels with upper works. This was most apparent in the "Captain," which is shown in Plate IV. (opposite page 150), in a group of iron-clads, American and British. This vessel capsized off Cape *Finisterre*, July, 1870, and was indeed the "end of earth" to the crew of 500 officers and men, and also to Captain Coles, who went down with her. The "Captain" was a double-turreted vessel, each turret carrying two 25-ton guns; armor of from 6 to 10 inches thickness, and had other upper works, fore and aft, also pierced for guns.

The same plate also shows the very formidable vessel, the single-turreted "Glatton," which was selected to be a target for 600-pound elongated projectiles of the "Palliser" order. She bore it very satisfactorily. In the same group is also the "Thunderer," a double-turreted vessel of a favorite class. It may be described as a monitor based upon the American models, but with variations introduced with a view of removing the more objectionable features of the monitor system. Thus, instead of having as low a freeboard as possible, a hight of four feet six inches has been allotted to the hull above the water-line; the turrets, instead of being exposed, are protected by a powerful breastwork; and, instead of being constructed upon as small a scale as possible, she has been built on a scale sufficient to enable her to carry an armament of four 35-ton guns, with the capacity of storing during a voyage a supply of 1,750 tons of coal. With such capabilities as these, she has a burden of 4,500 tons, a length of 285 feet, and an extreme breadth of 62½ feet; and, large as these proportions are, one of the few defects the British Committee of Ships' Designs find in her is that she is not large enough, and that in future such vessels should be built upon a larger scale than either the "Thunderer" or the "Devastation." See IRON-CLAD.

Mon'i-tor-car. (*Railway.*) One having a central longitudinal raised portion in the roof, on the sides of which portion are openings for ventilation and panes for light.

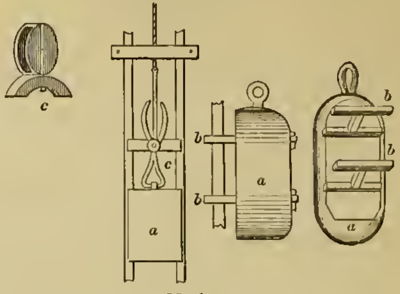
Monk. (*Printing.*) A blacker portion in a printed sheet; a dark patch. A blackened, wasted impression.

Mon'key. 1. The weight (*a*, Fig. 3212) of a pile or post driver, which is raised by a grapple and chain, and, being detached, is allowed to fall in its guides on to the head of the pile. The weight is attached to the chain by a dog *c*, which is caused to relax its grip by a trigger, or by coming in contact with a stop placed at the required hight.

At the back of the *monkey*, or *ram*, are two frames *b b* in the form of an H, which serve to guide the weight when rising or falling. See PILE-DRIVER.

2. (*Forging.*) A vertical hammer, consisting of a long bar of iron, running loosely through an eye, several feet above the anvil, and terminating at foot in a mass of iron, called the *ram*. The shaft is raised by a chain and drum driven by the engine, and has an automatic releasing apparatus, which is regulated to drop the monkey at the required hight, say with a range of from 2 to 5 feet. The monkey has a horizontal range of, say 20 inches, and is made to drop upon the spot required by means of guy-rods in the hands of two workmen.

Fig. 3212.



Monkey.

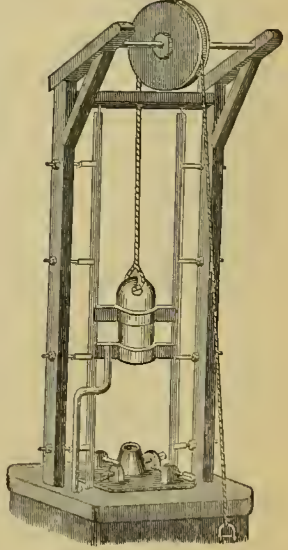
Mon'key-block. (*Nautical.*) A single block (*c*, Fig. 3212) strapped to a bridge-piece which is bolted to the deck or other object.

Mon'key-boat. A small boat used in the docks.

Mon'key-en'gine. A form of *pile-driver* having a *monkey* or *ram* weighing about 400 pounds, moving in a wooden frame. The monkey is held by a staple in a pair of tongs, and is drawn up 10 or 15 feet, or higher if necessary, by means of a winch. At the top of the lift the handles of the tongs come in contact with two inclined planes, which cause the tongs to open and drop the monkey. The tongs, being then lowered, become self-engaged with the staple, and so the work proceeds. See PILE-DRIVER.

Mon'key-ham'mer. A drop-press in which the hammer is a falling weight; called by the same name as the hammer of a pile-driving machine. In it various articles of jewelry, etc., are stamped out, the strip of gold being laid upon the lower die and impressed between it and the upper die, which descends in guides when the workman slacks the rope by raising the stirrup.

Fig. 3213.



Monkey-Press.

Mon'key-press. A hammer in which the driver consists of a *monkey* which is alternately raised and dropped, sliding in guides. One form of *power-hammer.*

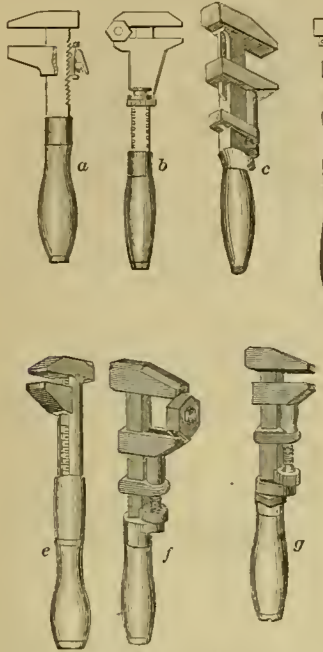
Mon'key-pump. The sailor's name for the sucking straw introduced at a gimlet-hole in a wine-cask. This is as old as Xenophon, who describes this mode of pilfering from the wine-jars of Armenia.

Mon'key-rail. (*Nautical.*) A supplementary rail, above and lighter than the quarter-rail.

Mon'key-tail. A small iron crow-bar used by naval gunners.

Mon'key-wrench. A spanner with a movable jaw. The cut shows several kinds.

Fig. 3214.



Monkey-Wrenches.

a has a spring-dog on the back, catching into a ratchet.

b has one jaw for hexagonal and another for square nuts.

c shows a strong form with a spline.

d has a serrated jaw to grasp a pipe.

e has a screw concealed in the stock.

f has a capacity for gripping a hexagonal nut by the points of its jaws.

g is an ordinary machinist's wrench of good quality.

Monk-seam. (*Nautical.*) A double seam of a sail made by overlapping selvages and sewing both edges.

Mon'o-chord. (*Music.*) 1. An ancient instrument with one string which was played as a guitar. It grew into a *manichord*, in which numerous strings were played by quills. See MANICHORD; PIANOFORTE.

2. An instrument for experimenting upon the mathematical relations of musical sounds. It consists of a single string, stretched between two bridges, one or both of which are movable, and which stand upon a graduated rule, for the purpose of readily changing and measuring the length of the part of the string involved in the vibration. (WEBSTER.) Sometimes called the *harmonical canon*.

Mon'o-chro-mat'ic Lamp. A lamp fed with a mixture of a solution of common salt and alcohol. It gives a yellow light and a ghastly appearance to the human face, objects appearing yellow or black. Useful in photographic studios.

Mo-noc'u-lar Mi'cro-scope. A microscope adapted for one eye, in contradistinction to a *binocular* instrument.

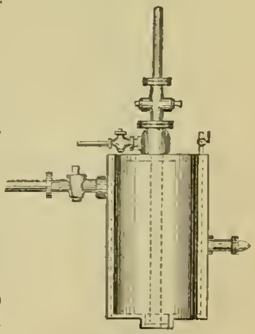
Mo-noc'u-lus. (*Surgical.*) A bandage to retain a topical application over the eye.

Mon'o-gram. A cipher composed of two or more letters interwoven as an abbreviation of a name. Monograms were common as distinctive marks on ancient coins, and were also used as devices on seals.

Mon'o-lith. A single column or block. The term is applied to such erections as the obelisks of Egypt, some of which are now in Rome and Paris. (See OBELISK.) The term *monolithic* is also applied to structures in which the blocks are immense, in some cases reaching from the foundation to the entablature, as in the United States Treasury, Washington. This building is said to have larger stones than any used in the pyramids of Egypt, and to be of a more massive construction in respect of the size of its stones than any other building in the world, except the church of St. Isaac at Petersburg, Russia.

The largest existing monolithic temple in Egypt is that of Tel-el-mai, on the Delta. It is 21 feet 9 inches high, 13 feet broad, and 11 feet 7 inches deep. This size is much exceeded by the dimensions given by Herodotus of the temples of Amasis and Latona, which were also, we are informed, on the Delta. The former one, he states, required three years to transport, with the aid of 2,000 laborers, from Elephantine to Saïs, a distance ordinarily of twenty days' Nilotic navigation. The temple of Latona was still larger. "The most wonderful thing," says Herodotus, "that was actually to be seen about this temple was a chapel in the inclosure made of a single stone, the length and hight of which was the same, each wall being forty cubits square [sixty feet], and the whole a single block. Another block of stone formed the roof, and projected at the eaves to the extent of four cubits." According to these measurements, supposing the walls to have been only six feet thick, and the material granite, as in all other monoliths, this monument would weigh 7,000 tons, being 76,032 cubic feet, without the cornice, which was placed on the roof. This capstone would weigh 2,400 tons, if six feet be taken for its thickness. If any doubt exists respecting the ability of the ancients to transport and uplift such enormous masses of stone as these, it is set at rest by M. Jomárd, the celebrated Egyptologist, who gives a sketch, in his work on Egypt, published by the French government, of a huge block of granite situated almost a quarter of a mile from the modern town of Syene, where it was abandoned for some unknown reason while on its way from the quarry. It bears numerous traces of instruments in the work on its surface, as well as evidences of its having been intended for a colossal statue. M. Jomárd's dimensions are, — the largest, 22 $\frac{2}{10}$ meters, and for the body and back 6½ meters, or about 72, 21, and 21 English feet, which, at 13 cubic feet per ton, yields nearly 2,500 tons. See also MASONRY, where the stones of Baalbek are noticed.

Fig. 3215.



Monte-Jus.

Monte-jus. (*Sugar.*) A force-pump by which the juice from the cane-mill is raised to the clarifiers on the story above. It consists of a vessel with a sunken well in the center of the bottom, and having three pipes: one by which the juice is received; another whose open lower end is near the bottom of the vessel, and by which the juice is discharged; a third by which steam is admitted. Each has a valve. The cistern being charged and the induction valve closed, steam is admitted, which presses on the surface of the liquid and drives it out by way of the ascending pipe. The valve in the steam and eduction pipes being closed, the steam condenses, the induction pipe is opened, and the cylinder refills. Repeat the operation.

Mon'ton. A heap of ore; a batch under process of amalgamation, varying in quantity in different mining districts.

Moon-knife. A knife employed by skinners. The blade has a crescent shape, and is sharpened on its convex edge.

Moon-rak'er; Moon-sail. (*Nautical.*) A sail sometimes carried above the sky-scraper.

Moon'stone. A variety of adularia of a white color and opalescent reflections.

Moor'ing. (*Nautical.*) *a.* A sailor's bend for a cable or hawser to a bollard, post, or ring, for a ship or a flying bridge.

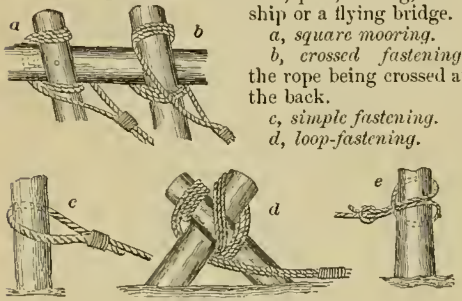
a, square mooring.

b, crossed fastening, the rope being crossed at the back.

c, simple fastening.

d, loop-fastening.

Fig 3216.



Mooring-Bends.

e, Lark's-head fastening to running knot. See BEND; CHAIN-FASTENING; WATERMAN'S-BEND.

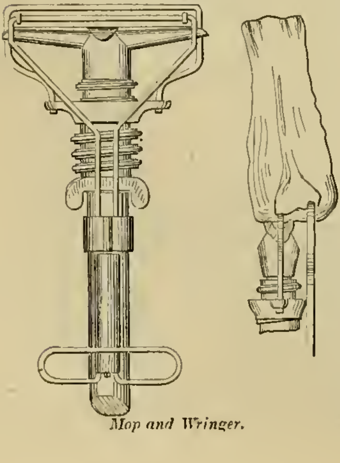
b. A submarine holdfast in the ground. See ANCHOR; SCREW-PILE; MUSHROOM-ANCHOR.

Moor'ing-swiv'el. (*Nautical.*) A chain over the bow, having the strength of the two cables to which it is swiveled. It enables a ship to ride from two anchors and swing without fouling.

Moot. (*Shipbuilding.*) *a.* A gage-ring for determining the size of tree-nails.

b. A piece of hard wood, hooped with iron at both ends, used in block-making.

Fig. 3217.



Mop and Wringer.

Mop. A scrubbing-rag or bundle of junk secured by a handle.

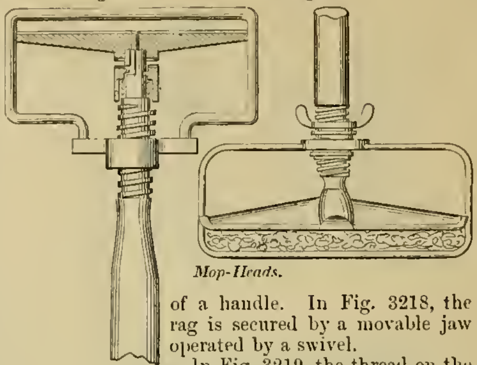
In the example of a domestic mop, the rag is held between jaws, one of which is movable, by means of a screw. A wringing device is attached, consisting of a bent wire, which is passed through the mop and secured to the handle; to use the wringer, detach the wire and turn it in the hand, twisting the mop-rag.

Mop-board. (*Carpentry.*) A wall-board next to the floor of a room. A *skirting-board.*

Mop-head. A clamp for a mop-rag on the end of a handle. In Fig. 3218, the rag is secured by a movable jaw operated by a swivel.

In Fig. 3219, the thread on the handle has its socket in the thumb-nut, and the reverse thread on the latter has its socket in the collar of the yoke.

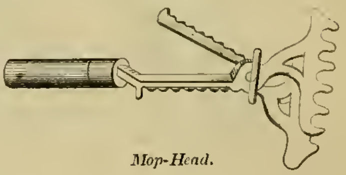
Fig. 3218. Fig. 3219.



Mop-Heads.

In Fig. 3220, the mop-cloth is clamped between toothed jaws, whose shanks are hinged and fastened by a ring.

Fig 3220.



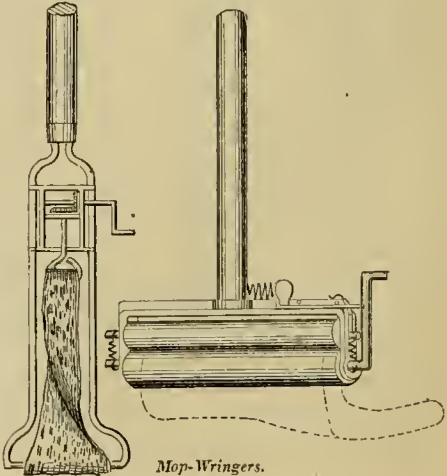
Mop-Head.

Mop-nail. A flat-headed nail, used in securing a bunch of junk or rope-ends to a handle in making a mop such as sailors use.

Mop-stick. (*Music.*) A vertical damper-rod at the end of the key in the old piano-forte movement, single action. When the key was depressed, the mop-stick was raised and the damper therewith. As the key rose, the damper fell back on to the string.

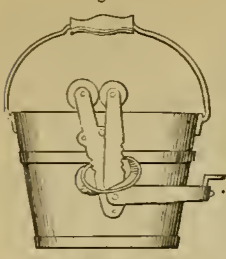
Mop-wring'er. (*Domestic.*) A device to wring

Fig. 3221. Fig. 3222.



Mop-Wringers.

Fig. 3223.



Mop-Wringer.

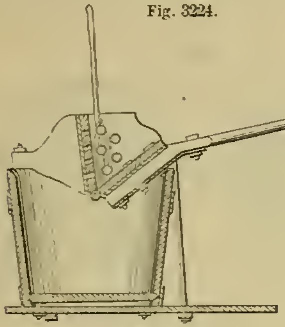
or squeeze the water from a mop. In Fig. 3221, the sliding frame with the twisting device is drawn up near the handle when the mop is to be wrung.

The example (Fig. 3222) has a pair of wringing rollers.

In Fig. 3223, the roller jaws are attached to a pail, are approached by a clasping spring, and opened by pressure on a treadle.

In Fig. 3224, the perforated boards are hinged together, the lower one is fixed, and the upper one has a lever and side-strips. The mop is pressed between them and drains into a bucket.

Fig. 3224.



Mop-Wringer.

Mo-quette′. A fine tapestry or Brussels carpet. A species of Wilton carpet.

Mor′dant. A substance applied to a fabric to give a fixity to the dye.

1. (*Dyeing.*) Mordants were known to the natives of India, and perhaps of Egypt, in the time of Pliny, who was suffocated by sulphurous fumes or carbonic acid in the year 79. "Their fabrics are first imbued, not with dyes, but with dye-absorbing drugs, by which, though they seem to be unaltered, yet when immersed in a caldron of the boiling dye-liquor they are found to be painted. Yet, as there is only one color in the caldron, it is marvelous to see many colors imparted to the robe, in consequence of the influence of the pigment. Nor can the colors be washed out."

He farther remarks to the effect that a number of colors in the caldron would only give a neutral, blended, or confused effect; but, owing to the previous treatment, which made no visible stain, capacity was conferred upon the cloth for so appropriating the color, that different parts obtained different tinctures, according to a specific faculty for adoption and conversion due to the previous preparation in each case.

2. (*Gilding.*) A sticky substance to cause gold-leaf to adhere to an object.

Mo-reen′. (*Fabric.*) A watered woolen or wool-and-cotton goods, for hangings, curtains, upholstery, and heavy skirts.

Morn′ing-star. A weapon used in ancient times and as late as by the train-bands of London, in the time of Henry VIII. It consists of a ball with spikes, united by a chain to a staff.

Mo-roc′co. A fancy leather tanned with sumach and dyed. Used for bookbinding, ladies' shoes, upholstering furniture, cushions, etc.

The Saracens, on their expulsion from Spain, carried with them into Africa their art of preparing leather, and it is now named from the place to which the manufacture was then removed, — Morocco.

True morocco leather is prepared from goat-skins, but sheep-skins are extensively used in the preparation of an inferior quality. The coast of Barbary yet yields a large supply of goat-skins for the morocco-leather manufacturers of France and England.

For some centuries the principal supply was from the Levant, which still yields a large quantity of goat-skins and morocco leather.

The operations in the manufacture of morocco are substantially similar to those through which hides for upper leather are passed.

The *unhairing* process is followed by treatment in a tumbling cylinder in which the hides are agitated and beaten to remove some of the lime, and this is followed by *bating*, which neutralizes the remainder of the lime and renders the leather pliable.

The coloring, if red, precedes the tanning; dyeing with other colors follows tanning.

In dyeing red, two skins are sewed together by the edges, the flesh sides facing each other. The bag thus made is inflated with air, and the distended bag is dipped into the mordant and then into the dye.

The mordants and dyes are according to the color.

For red morocco, —

Mordant: alum or chloride of tin.

Dye: cochineal with or without saffron.

For morocco of other colors the skins are tanned previous to dyeing. They are placed in a revolving cylinder, with a warm solution of sumach. The process takes 24 hours, and the hide is then rinsed, dried, and dyed.

For dyeing, two skins are united by their edges, flesh sides in, so as to prevent the waste of dye by coloring both sides.

The dyes used are campeachy wood, indigo, or Prussian blue.

Quercitron for yellow.

Sesquiacetate of iron for black.

Blue and yellow baths in alternation for green.

Blue and cochineal for violets and purples.

Quercitron and cochineal for orange.

The dyed skins are pressed in a hydraulic press to remove superfluous dye-stuff, *beamed*, *dried*, *slicked*, *pommeled*, and *grained*.

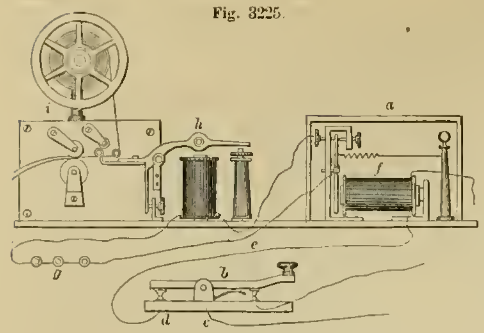
The latter confers the peculiar appearance on the leather, and is done by hand or by machinery. The leather is indented by rollers which have raised parallel, straight, or diagonal threads, producing a wrinkled appearance.

See Muspratt's Chemistry, II. 530.

Morse Al′pha-bet. The telegraphic alphabet contrived by Professor Morse, and which has practically nearly superseded all others on land routes in the United States and on the continent of Europe, is composed of a series of dots and dashes. Though adapted for being instrumentally recorded on paper, it is usually read by sound, the receiving telegraphist writing down the words as they are transmitted.

Fig. 3225 is the Morse telegraph apparatus, with relay *a*; the invention of Professor Henry of the Smithsonian Institution. The key *b* being up, a current arriving by the line-wire *c* passes from *c* to *d*, thence through *e* to the coil of the relay *f*, and through this to the earth. The electro-magnet of the relay attracts an armature, whose contact completes the circuit through the local battery *g*, in which the coil that operates the armature *h*, constituting the indicator, is included. *i* shows that part of the appara-

Fig. 3225.



A	·—	M	——	Y	—·——
Ä	·—·—	N	—·	Z	——··
B	—···	O	———	Ch	————
C	—·—·	Ö	———	Understood	···—·
D	—··	P	·——·	1	·————
E	·	Q	——·—	2	··———
É	··—··	R	·—·	3	···——
F	··—·	S	···	4	····—
G	——·	T	—	5	·····
H	····	U	··—	6	—····
I	··	Ü	··——	7	——···
J	·———	V	···—	8	———··
K	—·—	W	·——	9	————·
L	·—··	X	—··—	0	—————

Morse Apparatus and Alphabet.

tus by which the message may be impressed on a slip of paper, if required.

Mor'tar. 1. (*Grinding.*) A vessel, generally in the form of a bell or conical frustum, in which substances are pounded by a pestle. When large, they are made of cast-iron ; a smaller size is made of bronze, and those for more delicate pharmaceutical operations are of marble, pottery, porphyry, or agate. They are used in connection with a pestle, which in the larger mortars is of iron and in the smaller is of porcelain or agate. The Wedgewood ware has long been a favorite for this purpose.

The difficulty is to find a material for mortar and pestle which will not scratch. Scratching is abrading, and adds a dust of the material of the mortar to the ingredients under treatment. This may be unimportant in many cases, but sometimes may fatally impair the chemical purity of the substance.

In the accompanying illustration, *c*, Fig. 3226, is from the tomb of Rameses III. at Thebes, and represents a man working in an Egyptian kitchen. The man is pounding something to be used in cooking.

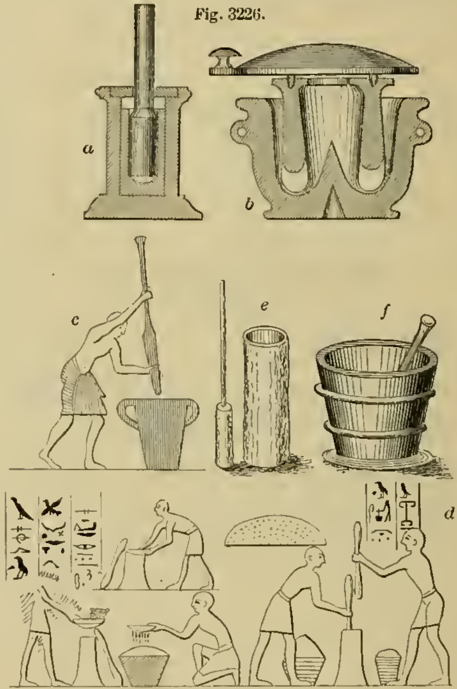
In ancient Egypt, as in modern, pounding substances in stone mortars in the public streets was and is an ordinary sight. The articles are brought to them by the inhabitants, and may consist of grain, salt, etc., which are pounded, sifted, and delivered. The figures *d* fairly represent the operation. One man appears to have a pan of the crude material in his hand and to be about to tip it into his mortar. In another place two men are using the pestles, giving alternate blows. Another man is sifting the stuff, whatever it is. Overhead is a piece of perforated metal which gives an indication of the nature of the process. The pestles are of metal, the mortars of granite, scooped out to about half its depth. The public practice of this industry is stated by Wilkinson to continue to this day.

The upward growth of the soil of Egypt by the deposits of the Nile has no doubt hidden thousands of these heavy tools, which were too heavy to move and had nothing in them to tempt the predatory bands by which that unfortunate country has been overrun at and since the time of Cambyses.

The mortar and pestle probably constitute the original appliance for grinding grain.

In many parts of the United States, and doubtless in foreign countries, remain many large, hollowed stones on which the grain of a community or tribe was pounded. Among the North American Indians the corn was reduced by this means to hominy or coarse meal, so as to be fit for making into cakes or mush. The present generation yet points to these stones in the neighborhood of the former sites of Indian villages. They are usually large surface stones of the bowlder type of rock, and probably had an incipient hollow, of which advantage was taken in forming the mortar. Besides this, or in place of it, some tribes had hollowed sections of tree-trunks, as among the Japanese of the present time. Throughout that country rice is *hummeled* in a wooden mortar.

Fig. 3226.



Mortars.

Wedgewood ware appears to fulfill the requisitions for a good mortar better than any other substance, porphyry excepted. The great difficulty in working the latter has been a bar to their introduction. The French have made them as large as 29 inches in diameter.

A mortar should be able to resist scratching by steel, quartz, or flint. Should not be stained if sulphate of copper or muriate of iron be left in it for twenty-four hours. Should not be abraded by the rubbing down of an ounce of sharp sand to a fine powder. The pestle should possess the same character.

Mortars of iron, brass, marble, dolomite, and glass are acted on by particular solvents, especially acids.

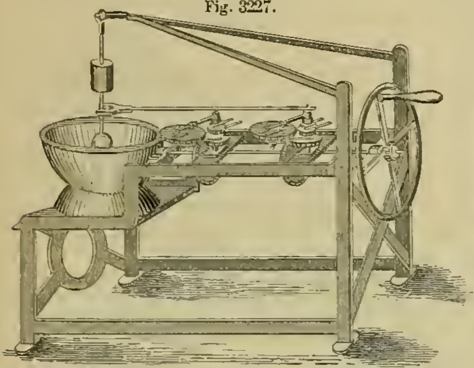
They are also too soft for many purposes. The color-mortar *b*, used in the porcelain manufactory of Sèvres, has a projecting conical piece in the center, which forms with the sides of the mortar a circular trough in which the pestle rotates. The pestle is a cylinder of porcelain, rounded at the bottom, and weighted with a disk of lead at the top, to which the handle is attached.

The colors are finished on a porphyry slab.

The mortar *a* for crushing diamonds for lapidaries' use is of hardened steel with a cylindrical cavity, and has a hardened steel pestle fitting neatly therein. The pestle is pounded with the hammer, being partially rotated between each blow. The diamond, though hard, is brittle, and is reduced to powder of the required fineness by this means.

A machine in which the pestle receives a motion similar to that imparted by hand is shown at Fig. 3227. As it traverses a different surface each rotation, no scrapers are required to keep the powder constantly under action.

Fig. 3227.



Goodall's Grinding and Levigating Apparatus.

A weighted lever secures the pestle at the top, and gearing from which it derives motion is driven by bevel gear from the main driving-shaft. The mortar is in front, to be out of the way of dust from the moving parts of the machinery. The pestle is attached to the driving-shaft by a screw, and may be removed when required.

B, Plate XXXV., Ore-mills, shows a form of mortar with a pestle traveling in a circular groove around a central post to whose horizontal arm the upper end of the inclined pestle axis is journaled. This block is of very hard stone, preferably porphyry, and has a grinding as well as a mashing action.

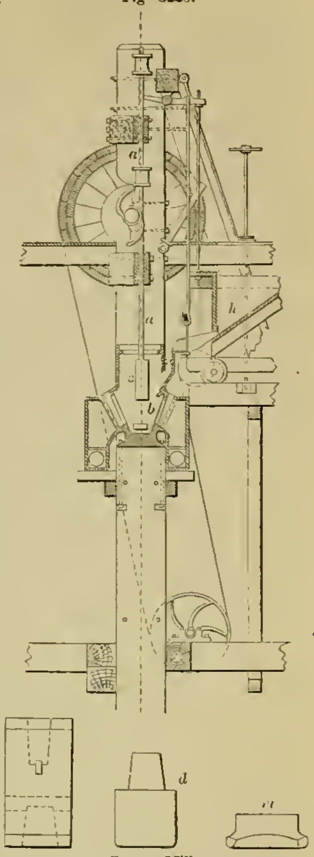
In the same plate is also a form of pulverizer known as the Chilian mill, having a stone traveling around its circular track and rotating on the horizontal axis rigged out from the vertical axis which is stepped into the middle of the table. See also Chilian Mill.

Fig. 3228 is a view of a stamp-mill for silver ores, in which *a* is the stamp-stem, *b* the mortar, *h* the hopper-car with the argentiferous rock, the feed being automatic by a tappet on the stamp-stem when the ore has become reduced to *slimes* and has floated off. The cut is a general view of the stamp, frame, and driving machinery.

Below are shown on a larger scale the *socket* or *stamp-head*; *d* is the *shoe*; *m* is the *die* which is placed in the bottom of the mortar. The shoe and die are removable.

2. (*Cement.*) A calcareous cement. It differs in its characteristics according to the nature, proportions, or treatment of its constituents.

Fig 3228.



Stamp-Mill.

The Romans are remarkable for their great use of calcareous cements, both the ordinary lime mortar and that mixed with volcanic matter from Puteoli, now Pozzuoli, from whence the name *pozzuolana*, commonly known as Roman cement. This material consists of porous, half-concreted volcanic matter, which is mixed with lime or common mortar to give it the property of hardening under water. It is mentioned by Vitruvius and Pliny.

The use of lime in England, as we gather from the accounts of Julius Cæsar, was not known previous to the Roman conquest. The oldest limestone quarry in England was opened by the Romans at Tadcaster in Yorkshire, called Calcariæ in the Roman itineraries. The quarry is still used.

Lime most commonly occurs in the state of carbonate, such as marble, calcareous spar, oolite, limestone, or chalk.

Some limestones include in their composition so large a proportion of iron and clay as to enable them to form cements which have the property of hardening under water, and are called hydraulic limestones. The proportions of clay vary in different quarries, and often in the same from 8 to 25 per cent.

The pozzuolana consists of oxide of iron and burnt clay, and performs the same office as the clay in the above-cited limestones, acting with great energy in "setting" under water.

Limestone reduced to the finest powder is inefficient in the composition of mortar, but requires that the carbonic acid shall be eliminated by heat. This begins at the outside and proceeds to the center of the masses of stone. As the lime grows cold it commences to absorb carbonic acid, and, if time permit, will return to the state of carbonate.

When cold water is poured on a piece of well-burned lime, a large quantity is rapidly absorbed, the lime heats, exhales steam, and falls into dry powder. The weight of the lime is increased about 24 per cent, and it becomes a hydrate, or slaked lime. This hydrate is the ingredient in mortar. Carbonate of lime, as has been said, is not efficient in this connection.

Hydrate of lime may be made into a paste, but will powder or dissolve when dry. The admixture of sand gives it the character of cement. The proportion of sand to lime, cited by Pliny, is round grained sand, 3; lime, 1; or sharp pit-sand, 4; lime, 1. He also recommends the use of pounded tiles. This is bringing in the clay element, cited above.

The common London mortar is sharp river sand, 2½; white chalk-lime, 1.

The cohesion of the two is due probably to something more than mere mechanical contact, as is proved by the fact that while a paste of chalk and sand is nearly as coherent as a mass of hydrate of lime and sand, the former will not harden into a cement and the latter will.

The moles and other marine structures of the Romans were cemented with a composition of lime, 1; pozzuolana, 2. Smeaton used, in building the Eddystone Lighthouse, hydrate hydraulic lime, 1; pozzuolana, 1. It was rendered plastic by continued beating.

Aiken states the general theory as follows: In the white limes or nearly pure carbonates of lime the only effect of burning them is to drive off the carbonic acid. By slaking, the lime becomes a hydrate, and in this state is capable of acting chemically, though feebly, on the surface of pure siliceous sand. This combination causes the first setting of the mortar, which is also strengthened by the mere mechanical action of the sand. The greater part, however, of the lime has not combined with the sand, but remains in the state of a hydrate. In proportion as this latter absorbs carbonic acid from the air, it gives out its water and passes to the state of carbonate; such mortar, therefore, acquires its final induration and dryness when the whole of the hydrate has been decomposed and the water has been replaced by carbonic acid. In losing 22 per cent of water it combines with 46 per cent of carbonic acid, and, therefore, the mortar becomes the more solid and strong.

In the blue limes, part of the calcareous matter combines during the burning with the silica, alumina, and oxide of iron constituting the intimately mixed ferruginous clay, forming a compound that gives to the cement made of it the property of setting speedily in the air or under water. The rest of the lime passes, by slaking, into the state of hydrate; and, if only siliceous sand is present, acts on it in the same manner that white lime does; but if ferruginous sand or burnt ferruginous clay be present, the hydrate acts more rapidly and powerfully on the clay, sooner gives out its water and consolidates. Whether this latter compound is afterward decomposable by exposure to the carbonic acid of the air, it is difficult to determine.

In those limes which contain naturally so much ferruginous clay as, after burning, to form cements without the addition of sand or other ingredient, the greater part of the lime is probably combined with the clay in the act of burning, a very small quantity of hydrate formed, and very little carbonic acid reabsorbed.

Dr. Artus's method of making mortar is to take well-slaked lime, 1 part, and mix carefully with it finely sifted sand, 3 parts; just before using add one quarter as much fine unslaked lime as there has been sand used, and mix thoroughly. While it is being mixed the mass heats and the silicates form through which it quickly stiffens and becomes very hard in a short time. This mortar resists all action of water, and can be used wherever durability is an object.

The Egyptian mortar, in some instances, was destitute of siliceous sand, its place being occupied by coarse powdered gypsum or native sulphate of lime.

Stone mortar. 8 parts cement, 3 parts lime, and 31 parts of sand.

Brick mortar. 8 parts cement, 3 parts lime, and 27 parts of sand.

Brown mortar. Lime, 1 part; sand, 2 parts; and a small quantity of hair.

Khorassar, or *Turkish mortar*, used for the construction of buildings requiring great solidity. ⅓ powdered brick and tiles, ⅔ fine sifted lime. Mix with water to the required consistency, and lay on layers of five and six inches in thickness between the courses of brick or stones.

3. (*Ordnance.*) A short gun with a large bore, used for throwing bombs. Said to have been used at the siege of Naples in 1435, and to have been first made in England in 1543. A colossal mortar constructed by Mallet was tried at Woolwich, October 19, 1857, with a charge of 70 pounds of powder, and it threw a shell weighing 2,550 pounds 1½ miles horizontally, and about ¾ a mile in hight.

Shells of 1,000 pounds are said to have been thrown into the citadel of Antwerp, 1832, when it was taken by the French in the war of the Revolution, 1830–32.

Mortars are constructed with a chamber of smaller diameter than the bore, for containing the charge of powder, which is poured in loose. Thin, tapering slips of wood, termed splints, are used for fixing the shell accurately in the bore, no sabot being employed.

Mortars in the United States service are divided into three classes, sea-coast, siege, and coehorn. To these may be nominally added the stone mortar, which is, however, only employed in regular sieges; none, we believe, were ever cast in this country. This and the Coehorn are of brass; the sea-coast and siege mortars of cast-iron. The two former classes are made upon the same general model, differing only in relative length and thickness of metal. The chambers of all are semi-ellipses, having their minor axes of the same diameter as the bore of the mortar.

The 13-inch sea-coast mortar (*a*) weighs 17,000 pounds, and its shell about 200 pounds.

The 10-inch light mortar (*b*) weighs about one ton, and throws a shell of 88 pounds.

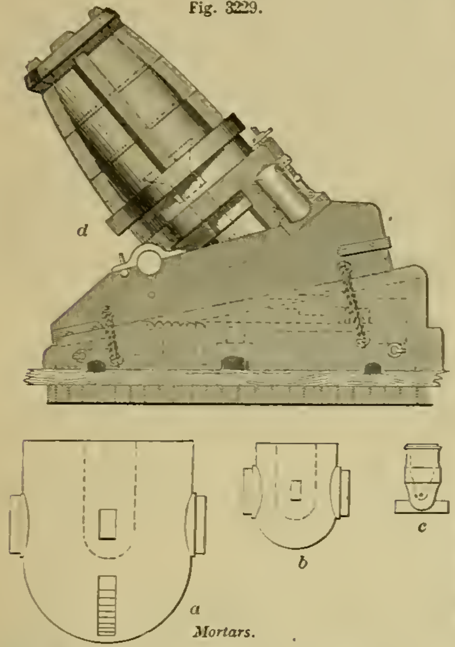
The Coehorn (*c*) weighs 165 pounds, and its shell 24 pounds.

The length of bore of mortars seldom exceeds two or three calibers, and is often much less. They are intended for firing shells at high angles of elevation, generally 45°, the crushing and explosive power of their shells falling from great hights being relied on for destructive effect. They are principally used in sieges for destroying buildings, blowing up magazines, etc., and for keeping an enemy under cover within his bomb-proofs, reaching him where direct shots would fail to penetrate. Four sizes of iron mortars are used in the United States service, 8 and 10 inch "light" and 10 and 13 inch "heavy." The two former can be readily transported on wagons contrived for the purpose, and may accompany an army in the field; but the latter, in consequence of their great weight, are more particularly designed for permanent positions or for use on shipboard. The 13-inch was much employed in this way during the Rebellion, and on board the mortar-schooners fully demonstrated its efficiency, under favorable circumstances, in the operations against the forts below New Orleans. For firing, mortars are mounted on beds, at present made of wrought-iron in our service, resting on platforms of stout scantling and plank, no ordinary carriage being capable of resisting the immense downward shock of even a light mortar fired at a great angle with a full charge of powder.

Stone mortars are of large caliber, from 10 to 22 inches, and have a small chamber. They are light in proportion to their size, to admit of shifting from one part of a fortification to another, and are intended for firing baskets of stones at very short ranges, or, in place of stones, 6-pounder or other small spherical case-shot may be used. They are specially designed for use in the attack and defense of fortified places when the besiegers have succeeded in establishing themselves very close to the works. We are not aware of any instance of their employment in recent warfare.

Coehorns (*c*) are small mortars, likewise intended for attacking and defending fortifications. They are made light enough to be carried from one spot to another by hand as required, and generally carry a 24-pounder shell with a maximum charge of ½ pound of powder, though they are sometimes smaller.

Fig. 3229.



Mortars.

That employed in the United States service is of brass, 24-pounder caliber, and weighs about 160 pounds. It is mounted on a wooden bed, having four handles at its sides, by which it can be readily carried by four men. It derives its name from the celebrated Dutch engineer officer Coehorn, to whom the invention is attributed. See Coehorn.

In some European services much smaller mortars than these are recognized, weighing no more than 15½ pounds, and attached to a stock.

A small mortar of this kind was invented by Captain Goodwin of the United States service, and threw a shell with great effect in an experiment at the Washington Arsenal, 1864.

Coehorns are, owing to their lightness and portability, very efficacious in dislodging an enemy from covered positions.

During a war waged by the English against some of the Maori tribes of New Zealand, about the year 1843–44, one of the native chiefs with his forces intrenched himself in a "pah" or corral on the top of a hill, whence the means in the hands of the troops failed to dislodge him. In this emergency an engineer officer was dispatched to Sydney and caused twelve small mortars to be constructed, which effectually accomplished the desired object.

These were carried by men to within a few hundred feet of the "pah" to be attacked, and pitched their shells into the heart of the camp.

With a charge of 8 ounces of powder these mortars were found capable of throwing a 5-inch shell 550 yards.

The mortar, of gun-metal, weighed 65 pounds, and the bed, of cast-iron, 28 pounds; this was fixed on a piece of 2-inch plank, 24 × 16.

When loaded, the shell projected half-way beyond the muzzle of the piece.

The chase of Mallet's great mortar (*d*, Fig. 3229) is formed of short cylinders or compound rings; the chamber being of wrought-iron let into a huge mass of cast-iron. Each of the two lower rings is composed of seven rings, and each set of these again of three smaller rings rabbeted together; the top ring consists of five rings, each composed of three smaller rings rabbeted together.

There are two light rings acting as a sort of key-ring for the six bolts or staves, the bolt-head resting on the muzzle-ring and secured with steel collars in the cast-iron mass around the breech-piece.

The weight of the whole without bed is 42 tons.
Weight of bed, 8 tons.
Weight of shell, 24 cwt.
Caliber, 36 inches.
Charge of shell, 480 pounds of powder.
Cost of shell, charged, about £25.
Length of chamber, 2 feet 6 inches.
Bore at top of chamber, 18 inches.
Bore at bottom, 14 inches.
Length to top of chamber, 8 feet.

With a charge of 70 pounds of powder, a shell weighing 2,395 pounds was thrown 2,759 yards, burying itself eight yards in the ground on its fall.

The monster mortar employed by the French at Antwerp in 1832 had a total length of 4 feet 11 inches; its outside diameter was 39½ inches; caliber, 24½ inches; length from top of chamber, 27 inches; depth of chamber, 19 inches; diameter of chamber, 9 inches. The weight of the mortar was 14,700 pounds; that of the bed, 16,000 pounds; of the empty shell, 916 pounds; and the bursting-charge, 99 pounds.

The chamber would contain about 30 pounds of powder, but 12 pounds were found to project the shell to a distance of 800 or 900 yards.

This monster affair burst with a charge of less than 20 pounds of powder after a few rounds firing.

Among the largest mortars on record are those of the island of Malta. "The rocks here are not only scarped into fortifications, but likewise into fire-engines or artillery to defend those fortifications; being hollowed out in many places into the form of immense mortars. These mortars they fill with cantars of cannon-balls, shells, stones, and other deadly materials; and if an enemy's ship should approach with a design to land, they fire the whole into the air. The effect of this tremendous invention must be very great, as it will produce a shower for 200 or 300 yards around, and would make great havoc among a debarkation of boats. A cantar is about 100 pounds weight; and as the mouths of some of these mortars are 6 feet wide, they will throw, according to calculation, 100 cantars each." — *From an account written just before the submission of the island to General Buonaparte,* 1798.

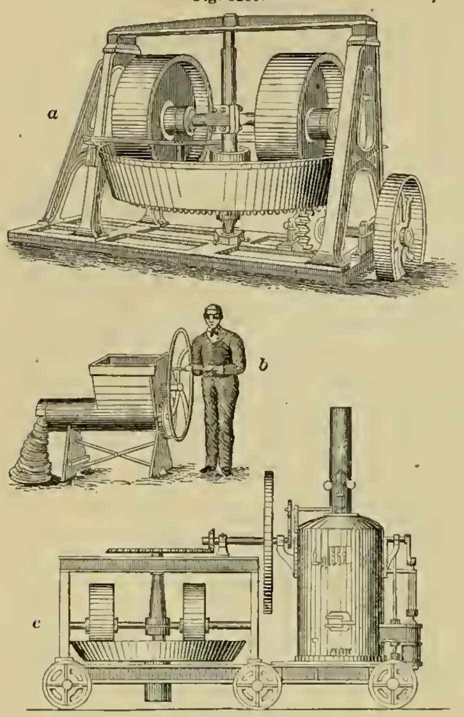
4. A short, thick candle.

Mor'tar-bed. The frame on which a mortar rests for firing.

Mor'tar-en'gine. A machine for grinding and combining materials into mortar. See MORTAR-MILL.

Mor'tar-mill. In the mortar-mill the sand, lime, and mortar are compounded together by rakes attached to the arms of a revolving wheel that moves round in a circular bed.

Fig. 3230.



Mortar-Mill.

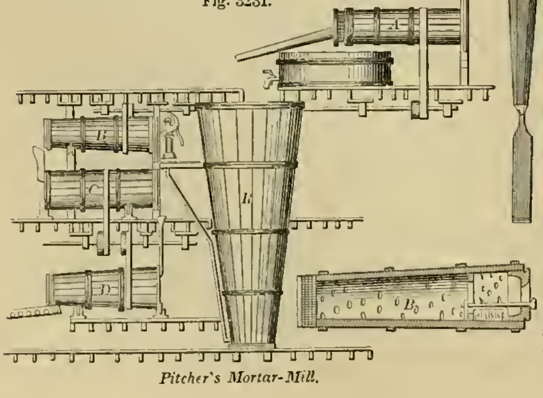
In the examples given, —

a is a large loam and mortar mill on the Chilian principle.

b is a mortar-tempering machine turned by hand-crank.

c is a mortar-mill on the same truck with the steam-engine which rotates the edge-stones in the bed.

Fig. 3231.



Pitcher's Mortar-Mill.

Fig. 3231 shows a mortar-mill on a large scale, occupying several floors of a building. The lime is slaked in a revolving barrel *A*, and discharged into a settling-vat. From this the "paste" passes to the curing-vat *R*, and is pumped thence into the upper one of three mixing-cylinders *B C D*. These revolving cylinders are slightly tapering, and have teeth on their inner surfaces, which mix the materials and gradually forward the mortar to the discharge end. It passes from one cylinder to another in the series, and from the lower cylinder *D* into the discharge-chute. The machine occupies three floors in a building.

Mor'tar-ves'sel. (*Vessel.*) A small vessel having a relatively wide beam for carrying a heavy mortar amidships. Formerly the vessel used was a *ketch*; hence, *bomb-ketch*.

Mor'tar-wag'on. A vehicle to transport a mortar and its bed.

Mor'tise. A cavity (*a b c d*, Fig. 3232) bored and cut into timber or other material to receive a *tenon*. It is the usual mode of joining the timbers of a frame, whether of a house or a machine.

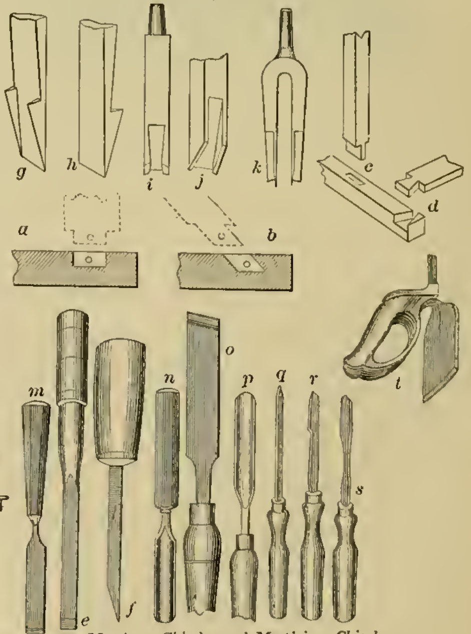
A lock made to slip in a mortise made in the edge of a door is a *mortise-lock*.

A wheel made with holes in its periphery to receive wooden cogs is a *mortise-wheel*.

Mortises in a hub are said to be *dodging* when they *dodge* in and out alternately, in order to spread the bases of the spokes and thus stiffen the wheel. The spokes are then said to be *staggered*, and the wheel is a *staggered* wheel.

Mor'tise-bolt. One let *into* a mortise in a door, instead of being placed *thereon*.

Fig. 3232.



Mortises, Chisels, and Mortising-Chisels.

Mor'tise-chis'el. A stout chisel (*e f*) driven by a mallet, and used to make mortises in framing. The smaller varieties have tangs, and the larger, sockets. The *firmer* and *turning* chisels, *m* to *s*, are introduced to show the difference. *t* is a hand-adze used in dressing tenons. *g h* are two views of the chisel of the mortising-machine, having side-wings which cut the sides of the mortise a little in advance of the chisel edge. It is the invention of Brunel or Maudslay, being applied in the mortising-machine invented by the former and constructed by the latter in Portsmouth Dock-Yard, England, in 1802–8. (See Fig. 3240.) *i j* are mortising-machine chisels whose lips are so formed that the chisel, on being withdrawn, clears the mortise of the core or chips.

The chisel *k* is a double one, each limb having two lips, adapting the tool to cut a double mortise.

Mor′tise-gage. A scribing-gage with two sharp, adjustable points, which may be set to the distance for the mortise or tenon from the working-edge, and also the width of the mortise and size of tenon.

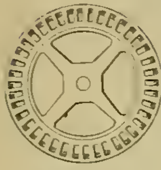
Mor′tise-joint. A joint made by a mortise and tenon.

Mor′tise-lock. (*Locksmithing.*) A lock adapted to be inserted into a mortise in the edge of the door, so as only to expose the *selvage* or edge-plate.

Mor′tise-lock Chis′el. A joiner's chisel for making the holes in door-stiles to hide the locks. It has a peculiar shape, in order to pull out the wood.

Mor′tise-wheel. A wheel having holes to receive wooden teeth, either on the edge or face, as the case may be. Such a tooth is specifically known as a *cog*.

Fig. 3233.



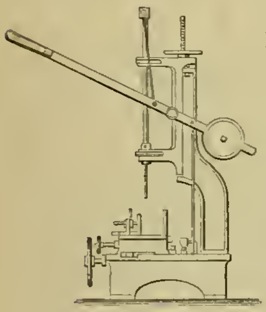
Mortise-Wheel.

Mor′tis-ing-ma-chine′. The self-acting mortising-machine was invented by General Bentham, and described in his specification of 1793. He made them for the British Admiralty previous to 1800.

His description includes the operation by means of a hole previously bored and then elongated by a vertically reciprocating chisel; and also the making of a mortise by a rotary cutter during the traveling of the work. One form included a pivoted table. He also invented double or forked mortise-chisels.

Fig. 3234 is a hand mortising-machine, having a vertically sliding bar carrying the cutter and moved by a counterbalanced lever. The work is clamped in the sliding table beneath, and is advanced by a hand-feed.

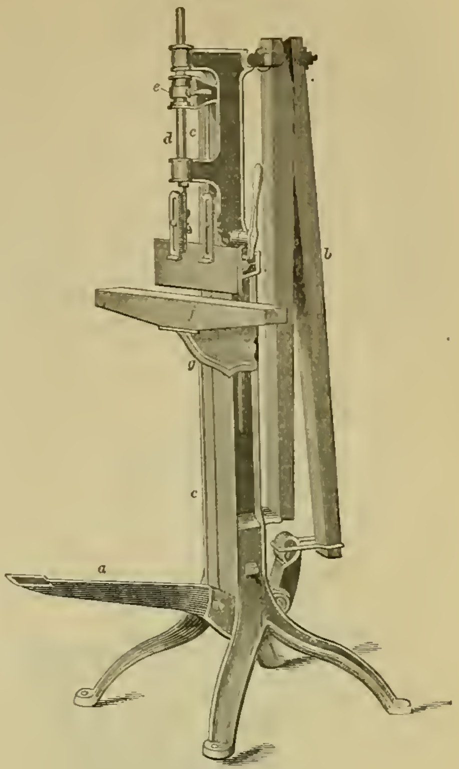
Fig. 3234.



Hand Mortising-Machine.

Fig. 3235 is a foot mortising-machine, in which the treadle *a* works on a pin in the cross-brace, being connected to the wooden spring *b* by an iron strap at the back, and with the spindle *d* by the rod *c* in front; the chisel is held in a socket at the bottom end of the spindle, with which it is reversed by the handle *e* on the slide; the wooden rest *f* is screwed to an iron one *g*, which slides on the frame perpendicularly, and is secured to it by a bolt; the guide-plate is moved back and forward to adjust for the thickness of the stuff, and has stops to prevent the work from rising with the chisel.

Fig. 3235.

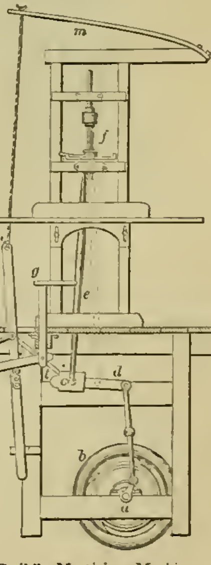


Foot-Mortiser.

In operating, the foot is pressed upon the treadle, which carries the chisel into the stuff to the required depth; when the pressure is relieved by raising the foot, it is withdrawn by the spring, and being lipped brings the chip out; after cutting far enough one way, reverse the chisel and finish the mortise to the required length.

Fig. 3236 is an example of a form of mortising-machine in which, while the operative shaft runs constantly, the chisel is brought into operation when needed, and to the extent required, and instantly becomes quiescent when the means employed to bring it into work is removed.

Fig. 3236.

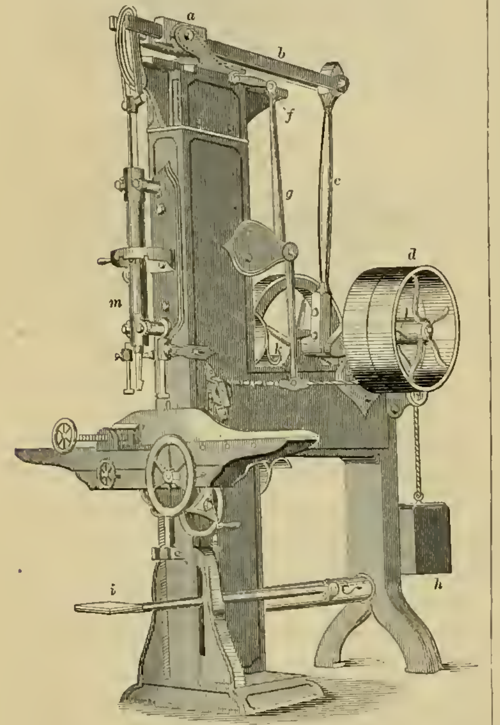


Guild's Mortising-Machine.

In the example, Guild's machine, 1852, *a* is the shaft, having a fly-wheel *b*; when the sliding wrist *c* is over the axis of oscillation of the arm *d*, no motion is transmitted to the pitman *c*, which operates the chisel-stock *f*. When the treadle *g* is depressed, the sliding wrist *c* is driven out on the arm and partakes of its motion, the chisel being thereby reciprocated to a degree proportionate to the depression of the treadle, and the consequent distance of the wrist from its axis of oscillation. The spring *m* restores the wrist to its position of quiescence.

In Fig. 3237, the working parts are supported upon a strong iron frame, at the top or upper end of which are guides *a*, upon which is a slide having pivoted in it a collar through which is passed the lever *b* that operates the chisel-stock *m*. This lever is itself operated by a pitman *c* from a transverse crank-shaft at the rear end of the frame, and rotated by pulleys *d*. The slide is connected by a link *f* with the upper end of a vertical lever *g*, the lower extremity of which is attached to a horizontal chain *k* passing over two supporting pulleys. The rear end of this chain has a weight *h* secured to it, and the forward end being passed downward is connected to a treadle *i* in such manner that by depressing the treadle the vertical lever will be caused to move the slide, and consequently the fulcrum of the chisel-operating lever, farther back, of course increasing the length of the forward arm of such lever, and consequently the stroke of the chisel-stock and its chisel. On releasing the treadle, the weight reverses the movement of the vertical lever, and throws the slide forward so that the stroke of the chisel-stock is reduced to almost nothing. By thus changing at will the fulcrum of the chisel-operating lever, the chisel may at any time be made to cut to any required depth, and when desired may be thrown out of operation, by the agency of the weight, without stopping the motion of the crank-shaft or interfering with the belt that drives the machine.

Fig. 3237.

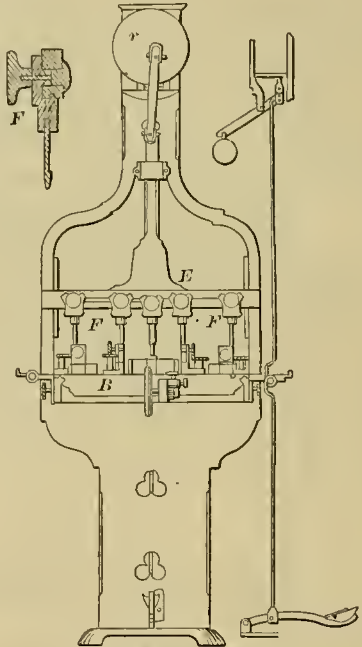


Bartlett's Power Mortising-Machine.

The table at the front of the machine for holding the stuff under the chisel is made compound, so that the stuff may either be moved along by hand or be held firmly upon the table and fed along as required by the hand-wheel operating the carriage or upper portion of the latter. The table is made adjustable vertically by means of a screw, and is pivoted and attached to its immediate supporting parts in such a way that it may be tilted, with one end or the other depressed to any desired angle, and there retained; the object of this being to enable the ends of the mortise to be cut at any required bevel or angle to suit the exigencies of various kinds of work.

Fig. 3238 is a gang mortising-machine. It has a set of chisel-holders *F F*, adjustable as to relative distance on a horizontal bar *E*, which is reciprocated by the wrist-wheel *r*. The work is clamped on the bed *B*, which has the requisite feed-motions. The chisel-holders are provided with projections that fit in a slot in the cross-head, and also with tongues fitting into grooves on the lower side of the same. They are held in place by a bolt passing through the chisel-holders and the slot in the cross-head, which is secured by a thumb-screw.

Fig. 3238.

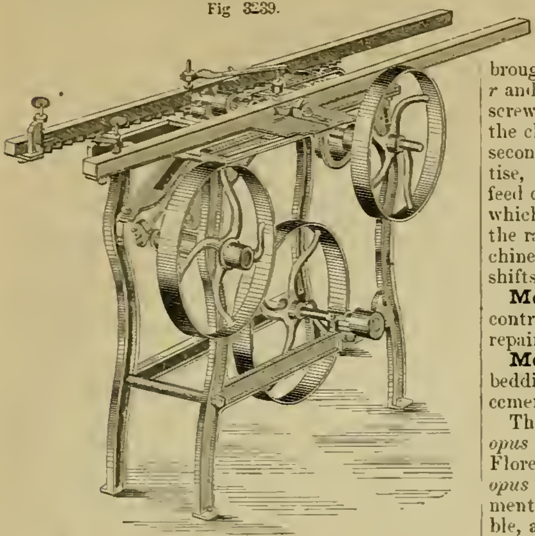


Gang Mortising-Machine.

The mode of clamping the chisel-holders to the bar is shown in the smaller detached figure.

Buck's machine for boring and mortising the stiles of blinds is automatic in its operation, and either bores the round holes for the reception of the pivots of turning slats or mortises the recesses for the reception of the ends of those slats designed to be permanently fixed at a certain angle. The latter are made on this machine by means similar to those used in boring a simple round hole, the tool being a reciprocatory or traversing burr or bit, which can be used on knotty pine and other obstinate descriptions of wood where ordinary machine-chisels fail. The machine is self-operating in all its parts. The workman puts in the stiles and sets the machine in motion, when it does its work, and, having done it, stops.

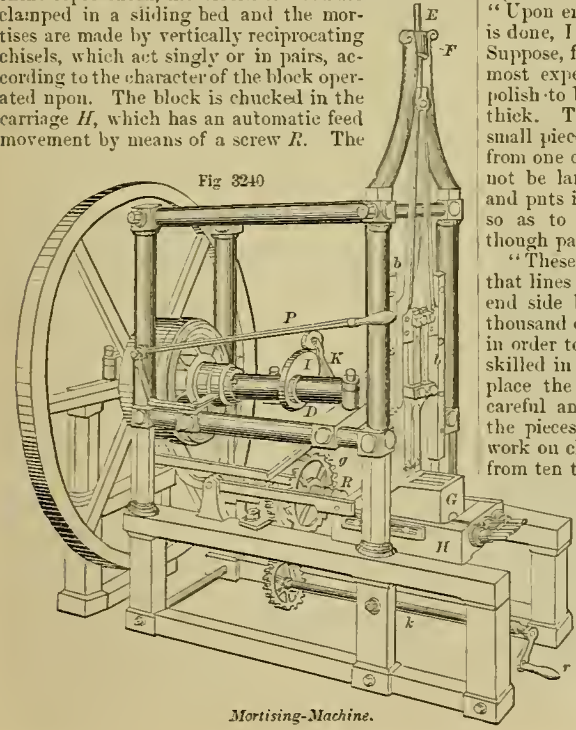
Fig 3239.



Machine for boring and mortising Stiles of Blinds.

Fig. 3240 shows Brunel's mortising-machine made by Maudslay for the British Admiralty, about 1804, for mortising the shells of ships' blocks. The series of machines for making blocks is described under BLOCK-MAKING MACHINE. In the mortising-machine represented, the blocks of wood are clamped in a sliding bed and the mortises are made by vertically reciprocating chisels, which act singly or in pairs, according to the character of the block operated upon. The block is chucked in the carriage *H*, which has an automatic feed movement by means of a screw *R*. The chisels are attached to a slider *E*, which reciprocates vertically in guides *b* and a socket *F* on the summit of the frame. The slider *E* is moved by a crank-arm which is connected thereto, and attached to the axis *D*, on which are the driving and fly wheels. In starting, the block is brought to the right position by turning the handle *r* and shaft *k*, which act upon the cog-wheel *g* and screw *R* to slide the carriage *H*. The first stroke of the chisel is into the hole previously bored, and the second takes a shaving in the direction of the mortise, the feed having commenced. The automatic feed consists of an eccentric *I* acting upon an arm *K* which turns the ratchet-wheel on the screw-shaft *R*; the ratchet is turned one tooth at a time. The machine is thrown into action by the lever *P*, which shifts the band from the loose to the fast pulley.

Fig 3240



Mortising-Machine.

Mor'ton's Slip. (*Hydraulic Engineering.*) A contrivance for hauling ships out of the water for repair. Patented in England, 1819. See SLIP.

Mo-sa'ic. 1. Ornamental work produced by imbedding different colored stones, glass, or gems in a cement.

The simplest form is the dice-shaped pavement, or *opus musivum*, of the Romans. The *pietra dura*, or Florentine work, is an amplification of the idea. The *opus tesselatum* was a tesselated geometrical pavement. The *opus sectile* was formed of slices of marble, as its name implies. The *opus vermiculatum* is an artistic rendering of the forms, lights, shades, and colors of pictures by the selection, shaping, and apposition of pieces of stone or gems of the right color.

A traveler in Italy relates that he saw a Florentine mosaic table valued at two hundred thousand dollars. It was less than six feet in diameter, but had required the work of a large number of men for fifteen years. It was ornamented with mosaic work composed of stones of different colors and shades matched together so as to form pictures. The traveler says: "Upon entering the hall where this kind of work is done, I could not doubt these enormous figures. Suppose, for instance, a thousand of the hardest and most expensive stones which will take on a high polish to be cut into pieces three eighths of an inch thick. These pieces are cut the other way into small pieces like shoe-pegs, and where the shading from one color to another is sudden, these pegs must not be larger than a needle. Now the artist cuts and puts in these, selected according to their color, so as to give the coloring wanted as distinct as though painted.

"These pieces or pegs must be fitted so closely that lines of separation will not show, and set upon end side by side like types. They claim that ten thousand different shades of color are necessary; and in order to do this kind of work a man must be as skilled in colors and shades as a painter, in order to place the colors properly, and then be the most careful and accurate of mechanics, in order to fit the pieces; and he must have patience enough to work on cheap pictures one year and on a fine one from ten to twenty years."

Some wonderful specimens of mosaic are to be seen at the Imperial works, St. Petersburg, Russia.

Roman mosaic consists of pieces of artificial enamel, in place of natural stone. The enamel is drawn out into rods of various sizes, cut into lengths, and arranged in cases something after the manner of printing type, the boxes containing each a different shade or color.

Glass mosaic is made of rods, shreds, or *hairs* of glass enamels of various colors arranged side by side, so that their ends show the pattern. The bundle of glass rods, being cemented by heat, may be cut across, and each section show the pattern. *Filigree glass* and millefiore are of this character. Some of the ancient Egyptian beads were thus made.

The Tunbridge *wood-mosaic* of England is made of colored parallelopipeds of wood glued together so as to show a pattern at their ends or sections.

Mosaic rug-work is made by a careful selection of colored wools, which are stretched in a frame, so that a cross-section at any point will show the design. About 800,000 threads are thus held in a cast-iron box with a movable bottom. The top surface, formed by the ends of the threads, is treated with a solution of caoutchouc, and a backing of canvas similarly treated is laid upon it. The bundle of threads is then pushed up in the box by screwing up the false bottom $\frac{3}{16}$ of an inch. A section of the threads at this depth is then made by a horizontally revolving knife, and the sections of thread come off on the backing, to which they adhere, forming a nap thereon.

2. A pyrotechnic device consisting of a surface with diamond-shaped compartments, formed by two series of parallel lines crossing each other. The effect is produced by placing at each intersection four jets of fire which run into the adjoining ones. The intervals between the jets must be associated with the discharge of others, so as to keep up a succession of fires in the spaces.

Mo-sa′ic Floor. One laid in colored woods, tiles, or marbles, systematically arranged, either symmetrically or pictorially.

Mo-sa′ic Glass. Mosaic glass is formed by the association of various colored opaque or transparent rods of glass, so arranged that the ends may form patterns.

Sections being removed, the pieces are arranged for the production of a recurring pattern, or a general combination is formed by the association of a variety of separate ornaments.

A section imbedded in a bulb of transparent glass forms the *millefiore* paper-weight.

The *aggry-beads* of Ashantee are of this class, and show that at some former time the country was visited by, or had communication with, a land where glass-making was artistically practiced.

Another form of glass mosaic consists in the putting together of pieces of glass enamel of varying colors, and sawing them into rectangular prisms. See Glass Mosaic.

The art of glass-making, instead of being comparatively modern in the time of Pliny, had long been practiced in Egypt. The manner in which the mosaic glass was made is thus described by Dr. Abbott, referring to specimens in his collection now in the Museum of the Historical Society, New York City.

"678. Three fragments of colored glass on a card.

"No. 1 represents a star, No. 2 a lotus. These pieces are particularly interesting as examples of a curious manufacture. No. 3 more especially deserves attention, inasmuch as it explains the ingenious manner by which the ancients accomplished the work. Long sticks of glass of the desired color and form were welded together, side by side. This mass, being well united, was then sawn through transversely at regular intervals, thus producing a supply of perfectly similar patterns. The pieces thus obtained were afterward polished and inserted, like mosaic work, to decorate various utensils. Thus, for example, were produced a series of stars of exactly similar dimensions and form as No. 1, which were inserted side by side in a cavity to represent the heavens; or the ornament No. 2, representing the lotus, was thus reproduced with an exactness which no other contrivance could guarantee. The piece No. 3 has evidently been sawn from such a stick of glass as above described and broken off. They were found at Sakkarah."

Mo-sa′ic Gold. A brass used for making cheap jewelry.

Hamilton and Parker's: copper, 32; zinc, 33. Or, copper, 4; zinc, 1.

Hermstadt's: copper, 7; zinc, 1; platinum, 16. Resembles gold in color and weight. See Alloy; Mock Gold.

Mo-sa′ic Pave′ment. One laid in colored tiles or slabs arranged in systematic order.

Mo-sa′ic Tile. A tile molded with different colored clays, arranged in patterns in imitation of the associated pieces of colored stones in a true mosaic.

Mo-sa′ic Wool. A form of rug or mat made from colored wool, arranged so that the ends of the wool present a definite pattern.

Threads of wool of equal length are placed horizontally in a frame, close together, to form a compact mass They are of different colors, and the colors are arranged in conformity with a pattern. The threads, being held firmly in the frame, are then cut across to form cubical masses, all the threads in each cube being kept rigidly in their places. The cube is then placed in a frame with the threads vertical, and a clean cut made across the top. The smooth surface is then wetted with a solution of rubber, and a piece of canvas firmly attached. When dry, a machine cuts off a slice of such thickness as is desired for the length of the pile. A rug or mat of a velvety finish is thus produced. Other slices can be cut off in the same way until the wool is exhausted.

Mo′ses-seam. A sailmaker's seam, as the selvages of the canvas lap past each other. See Monk-seam.

Mos′lings. The thin shreds or scrapings of leather shaved off by the currier in dressing skins.

They are used in wiping off metals while grinding and polishing. Cotton waste is used in a similar manner when plentiful.

Moth′er-gate. A lateral passage where a shaft intersects a seam of coal.

Moth′er-lye. The liquid remaining after all the salts that will regularly crystallize have been extracted from a solution.

Moth′er-of-pearl Mi-crom′e-ter. The micrometer of Cavallo. A thin semi-transparent slip of mother-of-pearl, $\frac{1}{20}$ of an inch wide, is ruled with fine graduations, and mounted within the tube at the focus of the eye-lens of the telescope, where the image of the object is formed. The divided edge is brought into convenient proximity to the image.

Moth′er-of-pearl Work′ing. Mother-of-pearl is the inner coat or layer of some sea-shells, the beautiful tints of which depend upon the lamellar structure of the surface, which decomposes and reflects the light.

The structure of the pearl shell admits of its being split into laminæ, which may be used for the handles of knives, for inlaying, the manufacture of buttons, etc.; but in practice, the different parts of the shell are selected of a thickness to suit the special purposes, and the pieces are adapted by saws, filing, or by the grindstone. Square or angular pieces are cut with the circular saw or the back saw; in the former case, the shell is fed up as the saw divides it, and in the other the shell is held in a vise and the saw operated by hand. Circular pieces are cut with an annular or crown saw, which is fixed upon a mandrel. In sawing and grinding, water is plentifully supplied to the instrument.

After the pieces of pearl shell are cut, ground, or turned to the proper form, they are finished with pumice-stone and water, while the work is held fast in a form of clamp as it is revolved in a lathe. This process may be followed by an application of ground pumice-stone applied with a piece of cork or a cloth moistened with water. The polishing is with rotten-stone, powdered chalk, or Spanish whiting, moistened with dilute sulphuric acid, which may be applied upon a piece of cork or a bit of soft wood. The acid tends to develop finely the striated structure of the shell. In some turned works fine emery-paper may be used, and followed with rotten-stone moistened with the acid, or some limpid oil instead.

The grinding or polishing material may be applied to the surface of wheels covered with cloth and moistened with water, the pumice-stone, and the rotten-stone. Sometimes dry powdered chalk or Spanish whiting is used in the place of the rotten-stone.

Pearl may be engraved in relief, by the aid of corrosive acids and the etching-point. The designs or patterns are drawn upon the shell with asphaltum varnish; strong nitric acid is then brushed over the plates repeatedly, until the parts undefended by the varnish are sufficiently eaten away by the acid. The varnish being washed off with turpentine, the device, which the acid has not touched, is found in relief.

Moth-trap. An attachment to a beehive to catch the moth, — *miller*, as it is familiarly called, — whose larva builds its web in the hive, and destroys the colony.

Some traps have slats, with intervals which are adapted for the passage of the moth, but too small for the bees. The moth runs in here for concealment, and hence their eggs are taken and destroyed Other traps are on the principle of the *cul-de-sac*, and are removable for the destruction of the tenants. Others have a liquid in which the moth or larvæ are drowned.

Mo'tion. 1. The train of wheels in a watch immediately concerned in the moving of the hands. See MOVEMENT.

2. (*Steam-engine.*) *a.* The cross-head in a locomotive.

b. The slide, slide-rod, and link of a locomotive-engine.

Mo'tion-bars. (*Steam-engine.*) Guide bars or rods.

Mo'tor. Properly speaking, — a source of motion, such as heat derived from the combustion of coal used in expanding a substance such as water or air; falling water; air in motion; dynamic electricity produced by chemical reactions or otherwise; animal strength, etc.

Technically, — a prime mover in the sense of a steam, air, or electro-magnetic machine; a water-wheel, horse-power, etc. See under those heads.

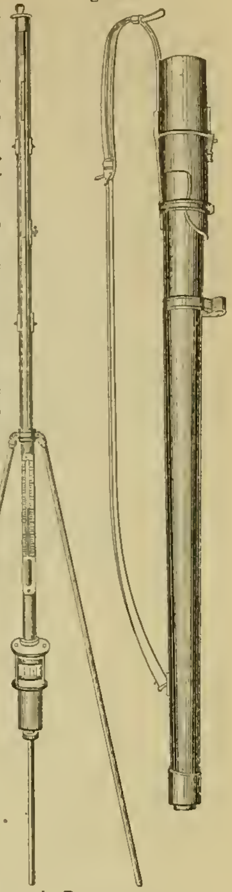
Moulde'baert. The Flemish earth-scraper. A large shovel drawn by a horse and guided by a man. A *grading-scraper*.

Mou'line; Mou'li-net. The rope-winding drum of a hoisting-machine.

Mound. (*Civil Engineering.*) A lump of original ground left at intervals to show the depth of ground excavated.

Moun'tain-ba-rom'e-ter. A portable barometer designed for measuring vertical hights above the sea. It is, consequently, more carefully made and accurately adjusted than the common barometer. That of Troughton, which is most generally known and probably the most convenient, is, for transportation, inclosed in the tripod which forms its support when an observation is to be made, as shown in Fig. 3241. The cistern has a flexible leathern bottom resting upon the flat upper extremity of a screw, by which it may be raised or lowered until the level of the mercury in the cistern corresponds with the zero of the scale. The tube is inclosed in a brass case, the upper part of which is partially open, so as to expose to view the mercurial column, the lower part containing a thermometer. The graduations commence at 15 inches, are carried up to 33 inches, above the zero point, and are subdivided so as to read to thousandths of an inch by means of a vernier.

Fig. 3241.



Mountain-Barometer.

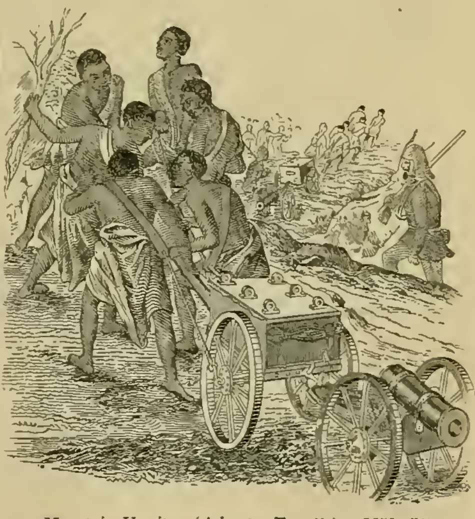
Moun'tain-blue. Carbonate of copper. Malachite.

Moun'tain-cork. A spongy, elastic variety of asbestus; light enough to float in water.

Moun'tain-green. A carbonate of copper combined with a white earth.

Moun'tain-how'it-zer. A light field-piece, of large caliber in proportion to its weight. It is mounted on a light carriage which may be drawn by one horse.

Fig. 3242.



Mountain-Howitzer (*Ashantee Expedition*, 1873-74).

The howitzer and its carriage may each be packed on the back of a horse or mule.

The piece shown in the cut is a gun of the howitzer battery made for the negro contingent in the Ashantee war, just concluded. Sir Garnet Wolseley's dash on Coomassie is something of which to be proud.

Moun'tain-leath'er. A variety of leather with interlacing fibers producing a texture resembling leather.

Moun'tain-lime'stone. A series of marine limestone strata, below the coal measures and above the old red sandstones.

Mount'ing. 1. The setting of a gem.

2. The frame of a picture.

3. The back stiffening or support of a print or map.

4. The harness tackle of a loom.

5. The carriage and tackle of a piece of ordnance.

6. The ornamentation of the stock of a fowling-piece.

7. The fastening of a piece to be turned on the mandrel of a lathe.

8. (*Saddlery.*) In the plural, — a general term given to the metallic trimmings of harness. In England called harness furniture.

Mouse. 1. (*Nautical.*) *a.* A ball, knob, or puddening worked on a rope.

b. A turn or two of spun-yarn uniting the point of a hook to the shank to prevent its unhooking.

2. (*Blasting.*) A match used in firing guns or mines.

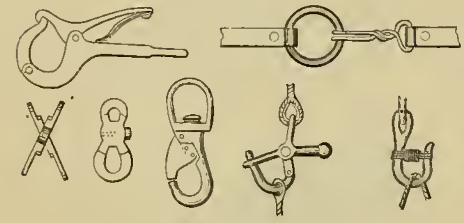
Mouse-trap. A small trap for catching mice. (See ANIMAL TRAP.) Pepys in his Diary, 1661, mentions purchasing two mouse-traps on his way home.

Mous'ing. 1. (*Loom.*) A ratchet movement in a loom.

2. (*Nautical.*) A lashing or latch connecting the bill with the shank of a hook.

Mous'ing-hook. A hook secured by a mousing passing around its two branches and closing its mouth, in order to prevent it from straightening out when supporting a heavy weight or to obviate the danger of unshipping.

Fig. 3243.



Mousing-Hook.

Fig. 3243 shows several forms: —

One has a mousing of cord, by which the bill of the hook is secured to the shank.

Next to it is one with a retaining and releasing hook.

Above is a pair of hooks engaging in different directions, one forming a mousing for the other. *Sister-hooks.* A snap-hook.

On the left, below, are views of a watch-chain or brequet hook, having portions which open on a swivel.

Also a hook having a mousing-block of caoutchouc.

Above is a gravitating mousing-link which throws off from the point when the load on the hook is suddenly lightened, as in the case of the hooks of davit-fall blocks.

Mousse-line'. French muslin.

Mouth. 1. An opening by which a vessel is filled or emptied; if it have a turned-over edge, such is called a *lip.*

2. The muzzle of a fire-arm.

3. The opening of a vice between its *chops, chaps, cheeks,* or *jaws,* as they are indifferently termed.

4. (*Metallurgy.*) *a.* The charging opening of a furnace.

b. The hole in a furnace out of which melted metal flows.

5. The cross-bar of a bridle-bit; uniting the branches or the rings, as the case may be.

The *mouth* gives character to the bit as the *straight* mouth-piece, or *arched, severe, jointed, wired, clothed,* or *with rollers,* as the case may be.

6. (*Music.*) *a.* The opening in an organ pipe whence the wind emerges. Being directed against the *lip* or *wind-cutter,* it acquires a vibration which is imparted to the column of air in the pipe, producing a musical sound. The principle of the flageolet is similar.

b. In a flute, — the edge of the opening against which the air from the mouth of the performer is cut, the vibration thereby imparted being communicated to the column of air in the tube. The *pitch* depends upon the length of the tube beyond the mouth, and the holes allow the length to be varied so as to produce varying notes. See PIPE.

7. (*Fortification.*) *a.* The outer or widest part of an embrasure. The narrow part is the *neck.*

b. The part of a trench most remote from the besieged place.

8. (*Joinery.*) The slot in a plane to receive the bit.

Mouth-gage. (*Saddlery.*) A device for measuring a horse's mouth, consisting of a gage which answers as the mouth-piece, a stationary cheek-piece on one end, and a sliding cheek on the other, with a set screw to hold it in any desired position. On the lower arm of the sliding cheek there is another slide held to its place by a set screw. The first slide is used to obtain the exact width of the horse's mouth; the slide on the lower arm of the sliding cheek is used to measure the hight of the bar of the mouth, each of the bars being gaged in inches and fractions.

Mouth-glass. (*Dentistry.*) A dentist's small mirror for inspecting the teeth and gums.

Mouth-piece. (*Music.*) 1. The part of a wind-instrument applied to the lips.

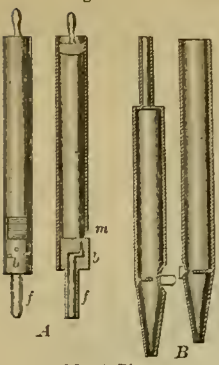
2. (*Saddlery.*) That part of the bit which is placed in the horse's mouth.

Mouth-pipe. (*Music.*) *a.* The part of a musical wind-instrument to which the mouth is applied.

b. An organ pipe having a lip to cut the wind escaping through an aperture in a diaphragm. See FLUTE-ORGAN.

The *mouth-pipe* is similar to the *flageolet.* In the *wooden* mouth-pipe *A* of the organ it is a cylinder or a parallelogram; in the latter case, the inside sectional dimensions are as 4 to 5, the interior surface being smoothed by an application of size. The pitch of the note depends upon the length of the pipe above the mouth. The upper end may be open, or stopped by a *tampion,* which fits air-tight. The lower end is closed by a block on which three of the walls of the pipe are glued. The front wall terminates in a sharply beveled edge at the lower end, just above the block *b,* the space forming the mouth *m,* and the edge itself the *lip* or *wind-cutter.* The wind-pipe *f* from the bellows is attached to the block *b.* A block is fastened to the walls of the pipe, leaving an intervening space between which the wind passes

Fig. 3244.



Mouth-Pipes.

to the mouth. The aperture is called the *plate of wind*, and the sheet of air issuing therefrom is cut by the sharp edge or lip at the lower end of the front wall, the vibrations caused thereby being communicated to the column of air in the tube and producing a musical note. See Pipe.

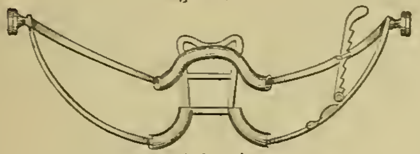
The *metallic* mouth-pipe *B* differs from the wooden one, not alone in the material, but in the construction. The lower end is diminished so as to meet the size of the pipe which conducts the wind from the bellows, and at a point opposite the *mouth*, or slit in the front of the tube, a *languette*, or plate, is placed, nearly closing the interior area of the pipe. Between the *languette* and the under lip a *plate of wind* is formed, the stream of air from which impinges upon the upper lip, and the vibration thus imparted is communicated to the column of air in the pipe.

At each end of the slit or mouth is a soft-metal lug which is called an ear, and is bent more or less over the mouth to modify and qualify the tone.

One of the figures shows a pipe at whose upper end is a smaller, open pipe; this is termed the *chimney-top*, and the partial opening thus afforded has the effect of *sharping* the note. The same effect in kind, if not in degree, is attained by making a hole in the *tompion*.

Mouth-spec'u-lum. (*Surgical.*) *a.* An instrument for depressing the tongue and raising the soft palate to expose the posterior fauces.

Fig. 3245.



Mouth-Speculum.

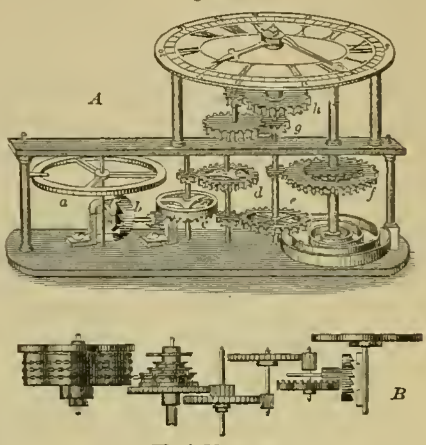
b. A frame to keep the jaws apart while operating in the mouth.

Mov'a-ble Lad'der. A form of *man-engine* for ascending and descending shafts. See Man-engine.

Move'ment. (*Horology.*) The going mechanism of a watch or clock. The motor, train, regulator, and indicator of time.

In Fig. 3246, *A* is a view of a watch-movement with vertical escapement, the barrel containing the mainspring and the fusee being removed. *B* is an elevation of a movement, barrel and fusee in place. In the lower right-hand corner (upper figure) is the mainspring, one end of which is fast to a pillar and the other to the winding-stem, which carries a ratchet-wheel provided with a click, and also the spur-wheel *f*. When the watch is wound up, the spring is condensed, and through the medium of the click operates to rotate the winding-stem, the wheel *f* on which turns a pinion and through it the wheel *e*, which gears with a pinion, causing the movement of the wheel *d*, rotating a pinion on the shaft of the crown-wheel *c*, which turns the pinion of the scape-wheel *b*. The teeth of this are alternately engaged by and released from two pallets on the axis or *verge* of the balance-wheel *a*, causing it to oscillate back and forth to an amount determined by a stop, so as to perform a uniform number of oscillations in a given time, thus regulating the movement of the works. The shaft of the wheel *e* is prolonged upwardly, and, passing through the hollow shaft of the wheel *h*, carries the minute-hand at its upper end. It also carries a pinion *g*, which engages a wheel on an upright shaft, turning a pinion which gears with the wheel *h* on the hollow shaft that carries the hour-hand. The number of teeth in the various wheels and pinions bear such relations to each other, that when the balance-wheel and escapement are in adjustment, the minute-hand shall be carried around the dial in exactly one hour, while the hollow shaft of the wheel *h* rotates but $\frac{1}{12}$ as fast, carrying the hour-hand round but once in 12 hours.

Fig. 3246.



Watch-Movement.

Mow. (*Husbandry.*) A bay or large compartment of a barn in which hay or sheaves of grain are stored ready for thrashing.

Mow'er. (*Husbandry.*) A machine for cutting grain or clover. A great many devices were used before a satisfactory conclusion was reached. Plate XXX. shows a large number of distinct inventions, involving reciprocating and circular movements of single knives and knives working in apposition. The illustrations and group headings will be readily understood, and the dates will add interest to the list, showing the length of time that man has been hammering at the problem. The harvester used in the plains of Rhætia, in the time of Pliny, had no proper motion, but was simply a comb whose teeth had sharp edges which cut and tore the head of the grain from the stalk and allowed it to be brushed into the box of the machine. See Reaper; Clover-harvester.

Mowing was a familiar duty in Palestine, and the Scripture references to it show that the ardent sun cured the grass in a short time, as with us. The sudden wilting and quick drying which form the basis of so many beautiful comparisons in the Bible are more descriptive of the Syrian or American hay harvest than that of England, where persistent spreadings and turnings are the order of the day.

Moses and David use the similitude: —

"In the morning it flourisheth and groweth up; in the evening it is cut down and withereth."

"For we are *consumed* by thine anger."

"My heart is *smitten*, and withereth like grass."

The uses of hay in Palestine are nearly forgotten. The *tibn* of the Arabs, the ordinary fodder for cattle and horses, consists of straw. It is sometimes cut and mixed with barley. Chaff, or the husks of grain, is also used.

The most ordinary classification of mowers is the apparent one, *two-wheeled* or *one-wheeled.* The former of these is shown in Figs. 5, 8, 9, 11, 14, 16, of Plates XXXI., XXXII.

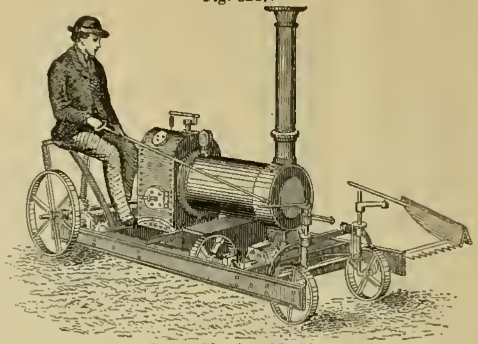
A one-wheeled mower is shown at Fig. 1, Plate XXXI.

Another distinction is the mode of attaching the finger-bar to the frame, *rigidly* or by a *hinge.* The former of these is shown in Figs. 1, 2, 3, 4, Plate XXXI., the different figures having distinguishing features. Figs. 5 to 12 inclusive show various adaptations of the hinged finger-bar.

Another distinction common among those who use the machine is the position of the cutter-bar in point of degree of advancement relatively to the driving-wheels. These positions are known as *front-cut, center-cut, rear-cut ;* that is, before the driving-wheel, even with the axle, rearward of the driving-wheel. The first is shown in Figs. 2, 5, 9, 10, 11, 15, 16, 21, of Plates XXXI., XXXII., XXXIII.; the second in Figs. 1 and 7, Plate XXXI.; the last in Figs. 4, 6, 8, 13, 19, of Plates XXXI., XXXII.

Several modes of draft also furnish peculiarities worthy of notice. The *center-draft,* as in Wilber's patent, in which the cutter-bar stretches across the width of the driving-gear. The *side-draft,* in which the cutter-bar projects laterally, so that the horses walk in the swath previously cut, not tramping in the standing grass. This feature is shown in most of the figures in the Plates. One other mode of draft is to be noticed, and that is the *propeller,* in which the cutting apparatus is ahead of the horses, which push the implement before them. This is the original form, it may be presumed, and was used in Gaul eighteen centuries since (see figure under the subject REAPER). The form still survives in the CLOVER-HEADER (which see). Reapers have other features, such as *reels, rakes, droppers,* etc., and are considered under REAPER.

Fig. 3247.

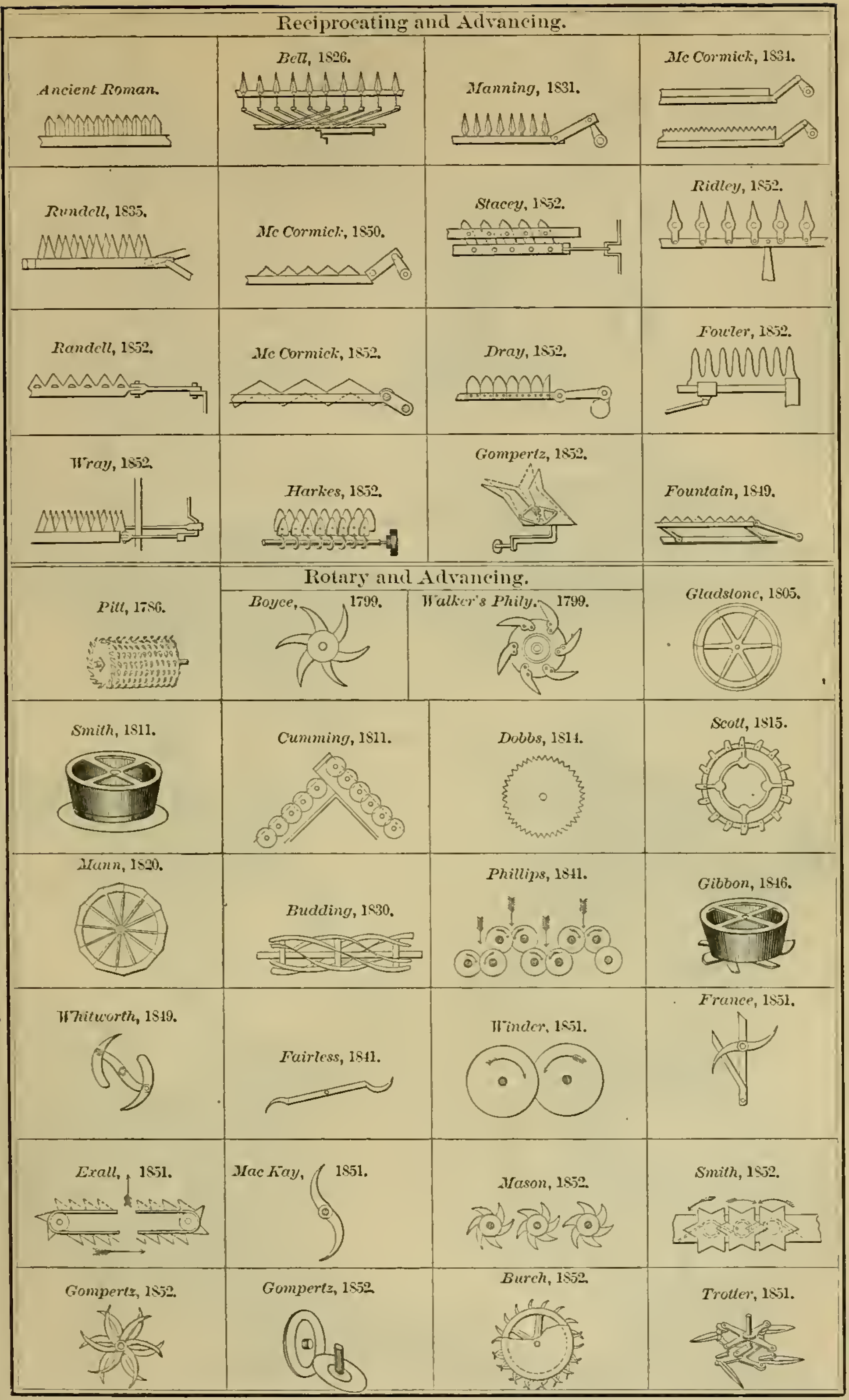


Steam Mowing-Machine.

Classification of Mowers by Structural Features.

The numbers refer to corresponding numbers in Plates XXXI., XXXII., XXXIII.

Mowers.	Connection of cutting apparatus with frame	*Finger-bar rigidly connected*		To main frame	1
				To hinged coupling-frame	2
				To vertically sliding frame	3
				To flexible coupling-arms	4
		Finger-bar hinged		To arms rigid with main frame	5
				To two arms; one rigid, the other jointed	6
				To two arms, both jointed	7
				To a single swiveled bar	8
				To a coupling-frame jointed to main frame	9
				To coupling-frame jointed to secondary hinged frame	10
				To coupling-frame vibrating on main axle	11
				To sliding arms	12
	Mode of driving cutters			By simple gearing	13
				By friction gearing	14
				By planetary gearing	15
				By gyrating gearing	16
				By screw gearing	17
				By changeable-speed gearing	18
				By cams	19
				By belts	20
				By piston moved by compressed air	21
	Style of cutters	*Reciprocating*	*Rectilinear*	Single blade	22
				Transversely divided blade	23
				Double blades	24
			Curvilinear	Blade hung upon hinged arms	25
				Series of pivoted knives	26
		Rotary		Cutters upon single vertical shaft	27
				Cutters upon single horizontal shaft	28
				Cutters upon series of vertical shafts	29
				Cutters upon endless chain or belt	30
	Dividers	*Rigid,* 31.			
		Adjustable		Vertically	32
				Horizontally	33
	Track-clearers.	*Hinged*		To move vertically	34
				To move horizontally	35
				To move axially	36
	Draft	*Rigid with cutter-frame.*		Upon main axle.	
		Jointed		Upon cutter-frame in rear of axle { Above. Below.	
		Independent of tongue.		Upon cutter-frame in front of axle.	



Reciprocating and Advancing.

Ancient Roman.
Bell, 1826.
Manning, 1831.
Mc Cormick, 1834.
Rundell, 1835.
Mc Cormick, 1850.
Stacey, 1852.
Ridley, 1852.
Randell, 1852.
Mc Cormick, 1852.
Dray, 1852.
Fowler, 1852.
Wray, 1852.
Harkes, 1852.
Gompertz, 1852.
Fountain, 1849.

Rotary and Advancing.

Pitt, 1786.
Boyce, 1799.
Walker's Phily. 1799.
Gladstone, 1805.
Smith, 1811.
Cumming, 1811.
Dobbs, 1814.
Scott, 1815.
Mann, 1820.
Budding, 1830.
Phillips, 1841.
Gibbon, 1846.
Whitworth, 1849.
Fairless, 1841.
Winder, 1851.
France, 1851.
Exall, 1851.
Mac Kay, 1851.
Mason, 1852.
Smith, 1852.
Gompertz, 1852.
Gompertz, 1852.
Burch, 1852.
Trotter, 1851.

PLATE XXX. CUTTING APPARATUS OF HARVESTERS.

Principles of Action.

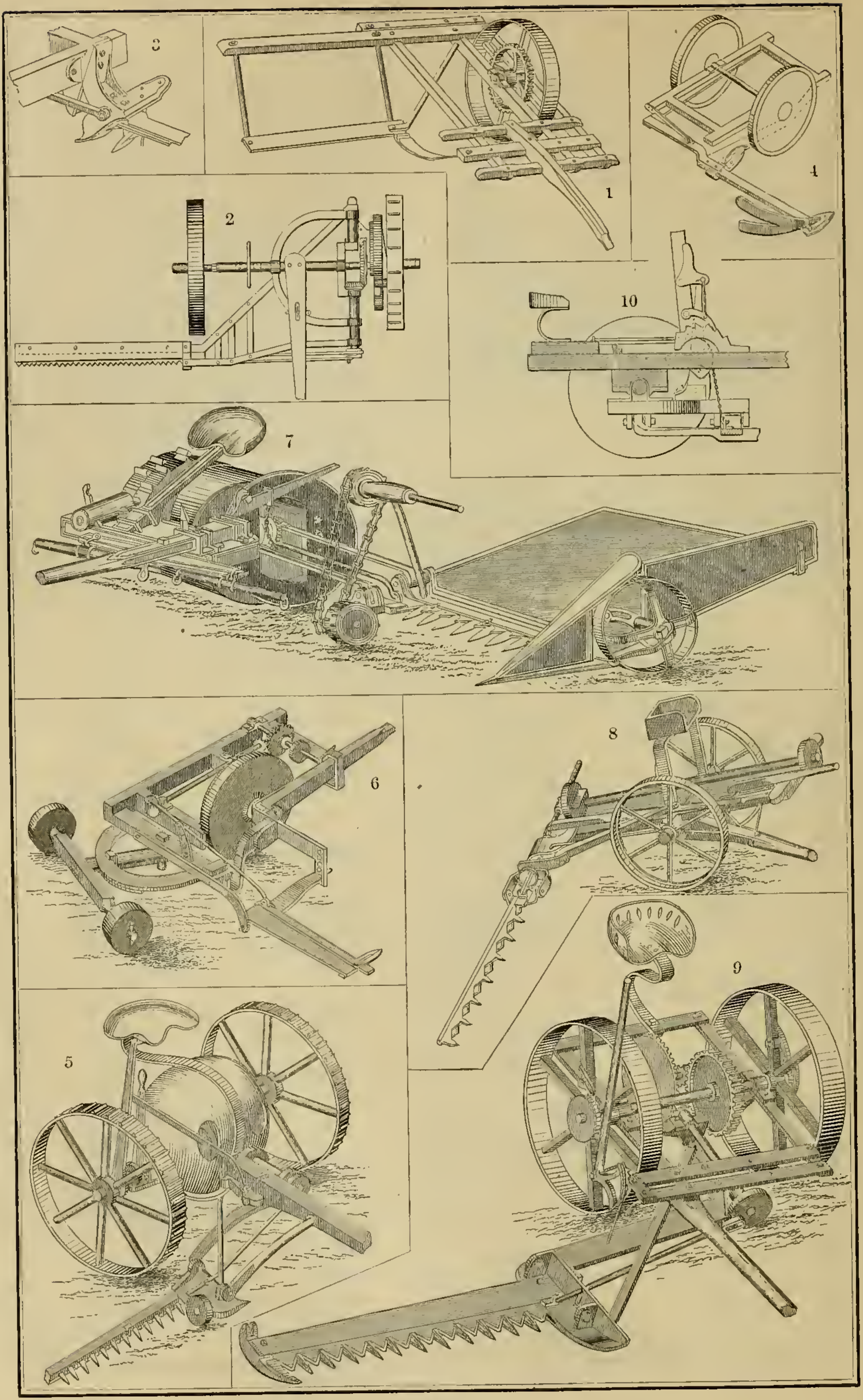


PLATE XXXI. MOWERS.

Showing Modes of connecting the Cutting Apparatus with the Frame.

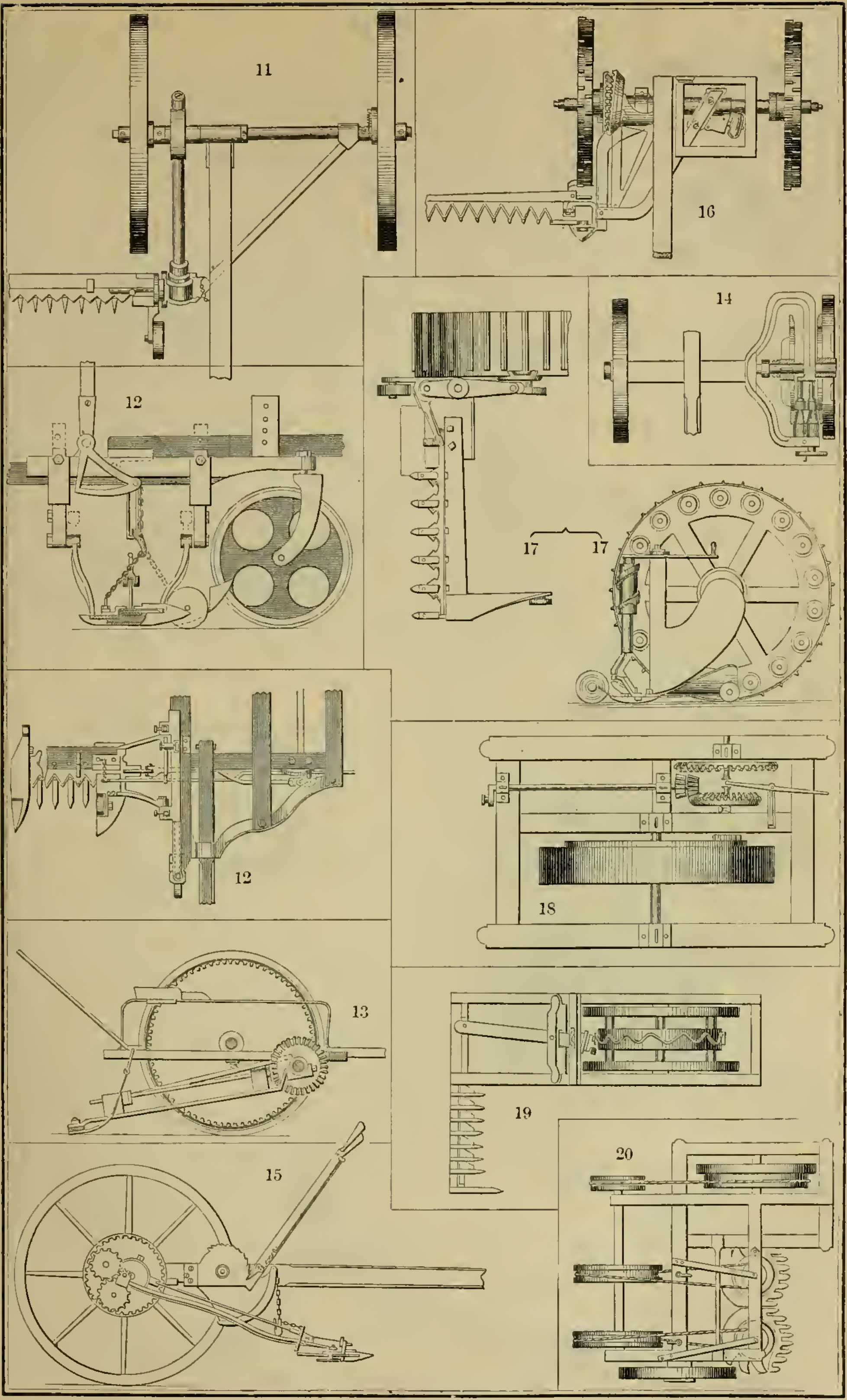


Plate XXXII. MOWERS.

Showing (11, 12) *Modes of Connection of the Cutting Apparatus with the Frame;* (13–20) *Modes of driving Cutters.*

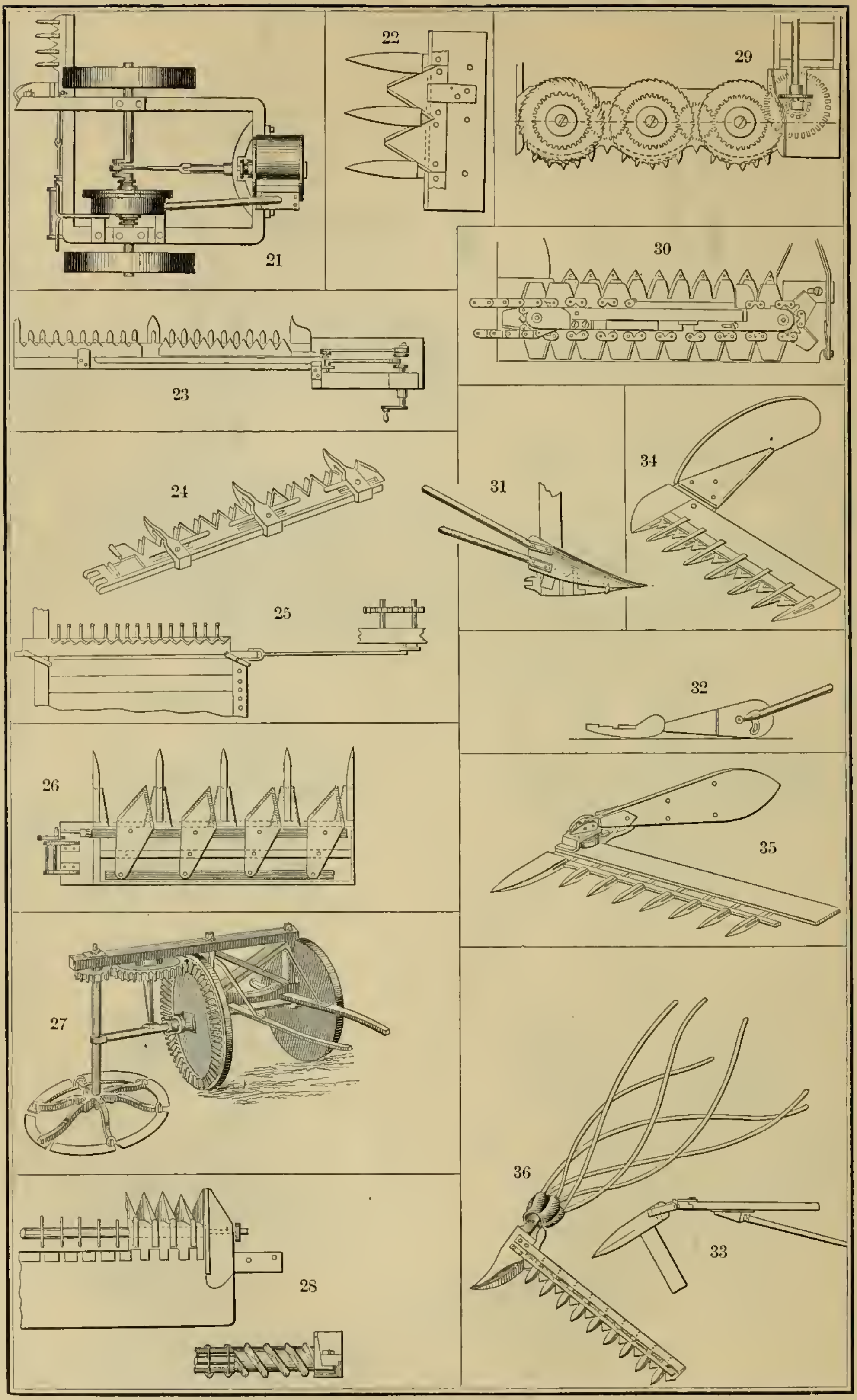


Plate XXXIII. MOWERS.

Showing (21) *Mode of driving Cutter;* (22–30) *Styles of Cutters;* (31–36) *Track-Clearers.*

In Fig. 3247 a steam-engine is shown as adapted to operating the implement.

In some parts of Solano County, California, where the grain and grass are very short, an apron is fitted under the sickle of the mower, which catches all the grass, and when full dumps it in piles. Grass and grain not over three inches in hight are thus secured, in some cases at the rate of a ton to an acre.

The smallest description of mower is that for mowing lawns, which is pushed by the gardener so as to cut the grass before it is tramped.

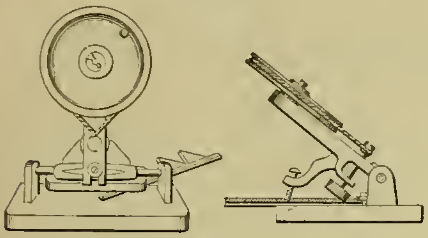
It weighs about 30 pounds and cuts a swath of 10 inches. The cylinder has spiral knives, and is rotated by gear connection to the wheels of the machine. These spiral blades cut against the rectilinear edge of a stationary knife, which is set at a tangent to the cylinder. The grass is nipped between the blades and swept into a trough in the rear, which carries it until sufficient has accumulated to render it advisable to empty. The grass is kept short by frequent cuttings. See LAWN-MOWER.

The classification just given concerns many parts common to *mowers* and to *reapers*, which are included under the generic title *harvesters;* the latter also embraces many other machines for cutting crops, such as beans, corn, cotton, hemp, etc. For a list, see HARVESTER.

The features appertaining to grain-harvesters proper, such as rakes, reels, droppers, binders, etc., are classified and considered under REAPER (which see).

Mow'ing-ma-chine' Cut'ter Grind'er. A grindstone or emery-wheel arranged and adapted for grinding the knives of mowing-machines. The example is a portable implement to be placed on a bench or stool. The cutter-bar is clamped to the base-plate, being guided to position by the angular projection on the adjustable bed-piece, and the emery-stone acts upon the teeth as they are consecutively brought into position beneath it. The emery-stone frame has oscillation in a vertical plane, to bring it down to or away from its work, and has also a longitudinal movement, to pass along the edge of the cutter.

Fig. 3248.



Mowing-Knife Grinder.

Mox'a. (*Surgical.*) A substance burnt on the skin to form an ulcer. The soft, woolly leaves of the artemisia are used. Dr. Brown-Sequard repeatedly applied moxas to the back of our late Senator Sumner. He regarded the treatment as the most severe he had ever applied to any living creature, — not excepting his guinea-pigs, which, in various states of dilapidation and destitution of limbs and nerves, were all eaten by the Parisians during the siege.

Mo'zam-bique'. (*Fabric.*) An open dress-goods having a chain in which the cotton threads are associated in pairs, and the woolen filling is soft and fleecy. It is dyed in the wool, self-colored, or striped in the warp.

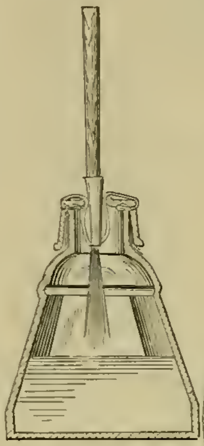
Moz'ing. Gigging of cloth.

M-roof. (*Carpentry.*) A double roof consisting of two ordinary gable-roofs and a valley between them.

M-teeth. (*Saw.*) Teeth in groups of two, like the letter _M_M_.

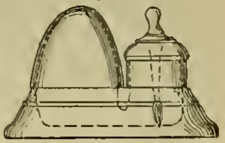
Mu'ci-lage-bot'tle. One for containing mucilage, a solution of gums tragacanth and acacia. In the example (Fig. 3249), an elastic band is applied to the stem of the brush and the cover of a mucilage, marking, or other bottle, for the purpose of always keeping the brush elevated above the contents of the bottle, except when forced down for the purpose of taking up some of the fluid for use.

Fig. 3249.



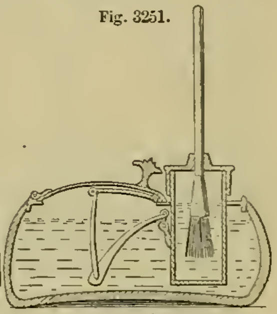
Mucilage-Bottle.

Fig. 3250.



Fountain Mucilage-Cup.

Fig. 3251.



Mucilage-Cup.

Fig. 3250 has a supply fountain.

In Fig. 3251, a water-tank forms a receptacle for the brush. The lid is attached to a rod which swings back with it and forms a wiper for the brush.

Muck-bar. Bar-iron which has passed once through the rolls. It is usually cut into lengths, piled, and rerolled.

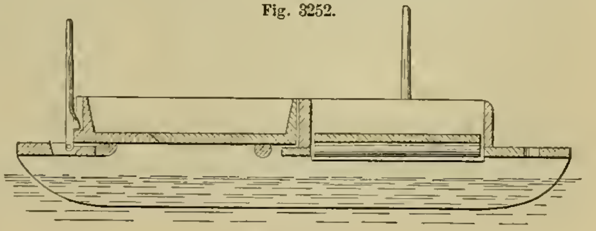
Muck-fork. (*Agriculture.*) A manure-fork.

Muck-rake. (*Agriculture.*) A drag or rake for removing or unloading manure.

Muck-roll. The *roughing* or first roll of a rolling-mill train.

Mud-boat. One for carrying off mud dredged from a river-channel or bar, and having convenient provision for discharge. In the example, the mud-boat has several vats resting on two boats which are placed parallel and connected by timbers. The floors of the vats have sectional drops for discharge, and

Fig. 3252.



Mud-Boat.

lever-catches which control their discharging functions.

Mud-drag. A machine for raking up the mud of a river, in order that it may be carried off by the current. A *hedge-hog*.

Mud-hole. A covered opening in the bottom of a boiler for discharging the dirt and sediment.

Mud-pat′tens. Broad wooden sole-boards for traveling on mud-lands.

Mud-plug. (*Steam-engine.*) A tapered stopper, removed from a boiler to allow the mud to escape.

Mud-sill. The lowest sill of a structure, which may be in the mud or on the surface of the earth.

Mud-valve. (*Steam.*) A valve by which mud is discharged from a steam-boiler.

Mud-wall. One of earth or clay.

One of materials laid in clay as a substitute for mortar.

Muff. 1. (*Glass.*) A roller or cylinder of glass for flattening out into a glass plate.

2. (*Wear.*) A fur pocket for the hands held in front of the person.

"This day I did first wear a muffle, being my wife's last year's muffle, but now I have bought her a new one." — Pepys's *Diary*, November 30, 1662.

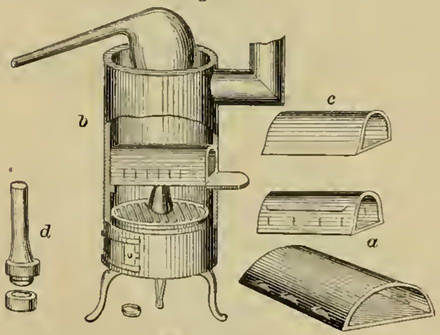
3. A joining tube driven into the ends of two adjoining pipes.

Muf′fle. 1. (*Metallurgy.*) An oven-shaped vessel (*a*) of baked fire-clay, used in assaying for containing the cupels or cups in which the alloy under investigation is fused. It is open at one end and closed at the other, and has slits in the sides to permit a draft of air through it. Its use is to protect the cupels from impurities of fuel while permitting access of air. It forms a chamber in the midst of the incandescent coals of the furnace *b*. See Muffle-furnace; Assaying-cupel.

2. A pulley-block containing several sheaves.

Muf′fle-fur′nace. (*Metallurgy.*) A furnace with a chamber which is surrounded by incandescent fuel, and in which cupellation or fusion of metals is performed; the former especially. (See Cupellation.) The holes in the sides of the muffle are important, as through them a draft is established which oxidizes the lead and some other associated metals.

Fig. 3253.



Muffle-Furnace.

a, muffle.
b, muffle-furnace.
c, closed muffle.
d, cupel-mold.

In the process of assaying, the *muffle* contains the cupel in which the metal is placed.

Arsenic is sublimed from arsenical pyrites in a muffle whose eduction-channel leads to a condensing chamber where the arsenious acid is deposited. See Arsenic-furnace; Cupellation.

Muf′fler. 1. (*Music.*) A soft cushion employed to terminate or soften a note.

2. A knit wrapper for the head or throat.

Mule. A spinning-machine in which the rovings are delivered from a series of sets of drawing rollers to spindles placed on a carriage, which travels away from the rollers while the thread is being twisted, and returns toward the rollers while the thread is being wound.

It was invented by Samuel Crompton, and perfected in 1779, so far as to make it an excellent working machine. Subsequent improvements by Roberts, Mason, and others have brought it to its present state, in which it is automatic, and is known in some parts of England as the "iron man," in allusion to its singularly deft and delicate action.

The combination which gave rise to the term *mule* was the junction of the *drawing-rollers* of Arkwright with the *jenny* of Hargreaves. The hybrid scarcely came within the definition of a *mule*, which is declared by Senator Nesmith of Oregon to be "a being without pride of ancestry or hope of posterity." The object of the machine is to deliver the roving with the required degree of attenuation and twist it as delivered. For this purpose, the spindles, instead of being stationary, are placed on a movable carriage, which is wheeled out to twist the threads and wheeled in again to wind on the spindles.

Mr. Kennedy, the friend and biographer of Crompton, states: —

"The great and important invention of Crompton was his spindle-carriage and the principle of the thread having no strain upon it till it was completed. The carriage with the spindles could, by the movement of the hand and knee, recede just as the rollers delivered out the elongated thread in a soft state, so that it would allow of a considerable stretch before the thread had to encounter the stress of winding on the spindle. This was the corner-stone of the merits of his invention."

Crompton's mule was also termed the *muslin machine*, from its producing yarn finer and softer than was obtained from any other machine then known, more nearly to the standard of the India muslins, which are yet the admiration of the cotton-trade.

Crompton gave up his invention to the public in 1780. Thirty-two years afterward he received £5,000 from government as a compensation for his services. This was unfortunately frittered away in starting his sons in business, and the father was again in poverty. A subscription was raised for him which supported him during the last two years of his life. He died in 1827.

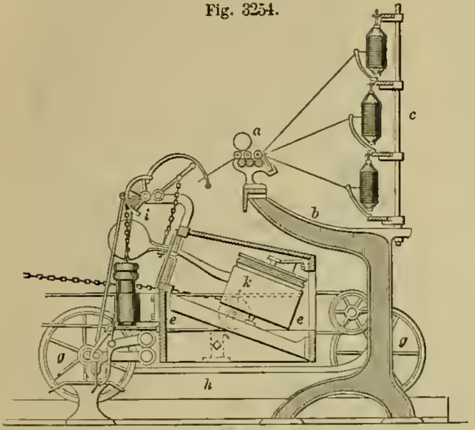
Crompton obtained no patent, and his poverty was not rendered additionally miserable by vexatious litigations and hopes deferred. There seems to have been no conscience among manufacturers as to the right of property in patents during the period marked by the inventions of Hargreaves, Arkwright, and Watt. The latter two, by indomitable energy and the possession of partners of skill, capital, and business tact, survived the attack of the Ishmaelites, and left honored names and good estates. (See Spinning.) Crompton's first machine contained only 20 or 30 spindles, and was built to supply his own loom with good yarn. The traverse of the mule-carriage was only 5 feet. The distance traveled is now much greater, and the carriage sometimes carries 1,000 spindles.

Previous to the invention of the mule few spinners could make yarn of 200 hanks to the pound, the hank being always 840 yards. The natives of India were at the same time making yarns of numbers ranging from 300 to 400. Houldsworth of Manchester, England, has lately succeeded in making No. 700, which was woven in France.

Mr. Roberts invented the self-acting mule in 1825. By this, the carriage, after the thread is spun, is automatically returned to the rollers, requiring no attendance, except for the purpose of joining threads which may be accidentally broken. This is performed by children.

In Fig. 3254, *a* is the triple set of drawing rolls, working in heads fixed on the roller-beam *b*. *c* is the creel for holding the bobbins in three rows. *e e* is the carriage, resting on wheels *g g*, which run on the railway *h*. Spindles *i* are set in a nearly upright position. *k* is one of a series of drum-cylinders with grooves around the upper end for the driving band.

Fig. 3254.



Mule.

This machine is not self-acting, but illustrates the principle of action.

The drawing and stretching action of the *mule-spinner* makes the yarn finer and of a more uniform tenuity than the mere drawing and twisting action of the *throstle*. As delivered by the rollers, the thread is thicker in some parts than in others; these thicker parts, not being so effectually twisted as the smaller parts, are softer and yield more readily to the stretching power of the mule; by this means the twist becomes more equable throughout the yarn. Throstle-spinning is seldom employed for numbers higher than 40 or 50 hanks to the pound, because smaller yarn would not have strength to bear the drag of the bobbin, but in mule-spinning the yarn is built upon the spindles without subjecting it to appreciable strain.

The mule-carriage carrying the spindles recedes from the rollers with a velocity somewhat greater than the rate of delivery of the reduced roving, the rapid revolution of the spindles giving a twist to the yarn, which stretches it farther. When the rollers cease giving out the rovings, the mule-spinner still continues to recede, its spindles still revolving, and thus the stretching is effected.

The distance to which the spindles recede from the rollers while both are in action is called a *stretch*. This is usually about 54 to 56 inches.

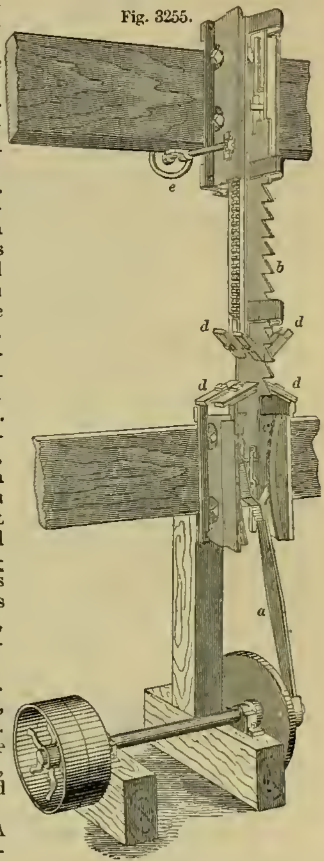
The space over which the carriage moves in excess of the paying out of the rollers is called the *gaining* of the carriage.

The space traversed by the carriage after the paying-out action of the rollers is stopped is called the *second stretch;* during this latter the spindles are revolved very rapidly, to save time.

When the *drawing*, *stretching*, and *twisting* of the yarn are thus accomplished, the mule disengages itself from the parts of the machine by which it has been driven, and the carriage is returned to the rollers, the thread being wound in a *cop* upon the spindle as the carriage returns.

The specific difference between the action of the throstle and the mule is, that the former has a continuous action upon the roving, *drawing*, *twisting*, and *winding* it upon the spindle; while the mule *draws* and *twists* at one operation as the carriage runs out, and then *winds* all the lengths upon the spindles as the carriage runs in.

Fig. 3255.



Muley-Saw.

Mu'let; Mu'lette. A Portuguese vessel with three lateen sails.

Mu'ley-head. The sliding carriage to which the muley-saw is attached, and which moves in guides on the frame of the mill. The saw is attached to a *muley-head* at each end.

Mu'ley-saw. A mill-saw (German, *mühlsäge*, mill-saw) which is not strained in a *gate* or *sash*, but has a more rapid reciprocating motion, and has guide-carriages above and below, called *muley-heads*.

Mull. (Fr. *molle.*) A thin, soft, cotton goods. Varieties are known as Swiss, India, starched mull, etc.

Mul'lar. A stamp with an intaglio ornament, for giving a salient impression to metal upon which it is struck.

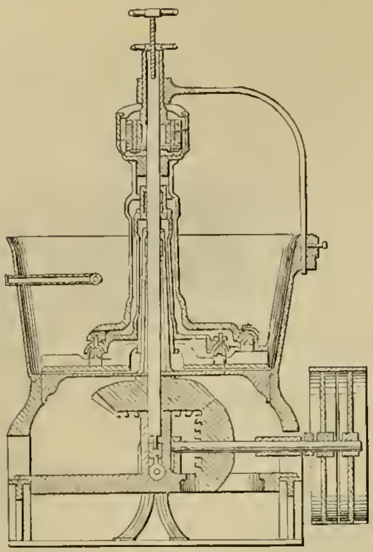
Mul'ler. A grinding apparatus consisting of a stone or slab with a flat surface, which is moved upon a stone table or slab to grind and mix pigments, etc. The action is sometimes called porphyrization.

A painter's stone and muller, much like the modern, were disinterred from an Egyptian tomb, and are now in the Abbott collection.

The mulling action is shown in the mill (Fig. 3256). This is a form of amalgamating pan in which the mullers are attached to two sets of arms, and rotate in the pan in different directions by means of gear-wheels and an axial shaft, which passes down through the bottom of the pan, and is put in motion by gearing. See list of allied devices under Mortar; Mill; Ore-mill.

Mul'lion. 1. A vertical bar separating the compartments of a window, especially used in the Gothic and double-casement windows. The horizontal bars are *transoms*. *Munnion, monycale, monial.*

Fig. 3256.



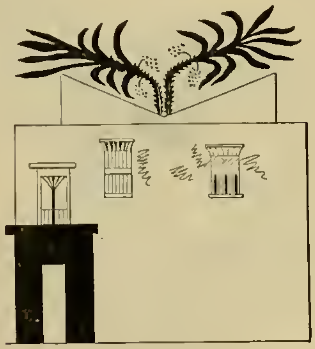
Muller.

2. A style or upright division in wainscoting.

Mull-mus′lin. (*Fabric.*) A thin, soft, transparent muslin. Finest quality.

Mul′quf. Perhaps the most ancient device for ventilating, specially constructed for that purpose, is the *mulquf*, which has been in use in Egypt for at least 3,000 years, and is still to be seen attached to the modern houses of Cairo and other towns. The name is Arabic, and means *wind-conductor*. It is open in the direction of the prevailing wind, which is conducted down the descending chute and thence disseminated through the house. The illustration is from an ancient drawing in a tomb at Thebes. Wilkinson states that it consists of a strong wooden framework to which planks are nailed, according to the length and breadth desired. If cheaper materials be required, the framework is covered with reeds or mats, plastered. The illustration shows two, presented respectively, it may be assumed, up and down the river. They are common features in Cairene architecture, where their presentation is usually N. W., being toward the prevailing wind.

Fig. 3257.



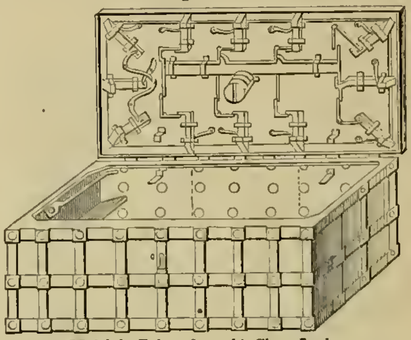
Mulquf.

Mul′ti-flue-boil′er. A steam-boiler having a large number of moderate-sized or small flues, as that of a locomotive.

Mul′ti-ple Bolt. An arrangement by which a number of bolts are simultaneously moved. It was a common feature on the strong-boxes of other days, and has been revived upon safe-doors.

The engraving represents an old French lock, with four corner bolts, six others on the sides, and two on the ends. Each bolt has a spring, and is acted upon by a lever, operated by the central and subsidiary bolts. The keyhole in front of the box is merely a deception, the real keyhole being in the middle of the lid, concealed by a secret door opened by a spring.

Fig. 3258.



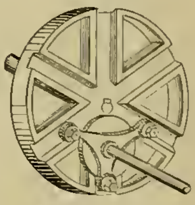
Multiple Bolts of an old Chest-Lock.

Mul′ti-ple Wheel. The rollers on the arms of the smaller wheel traverse in the diametric grooves on the face of the larger wheel, and impart motion to the latter.

One revolution of the smaller wheel gives half a revolution to the larger. If the *larger* wheel be the *driver*, two revolutions of the smaller wheel are obtained for one of the driver.

It is substantially the same as the *slosh-wheel*, which has two diametric grooves and two slides. The relation of speed is the same in each. See SLOSH-WHEEL; TRAMMEL.

Fig. 3259.

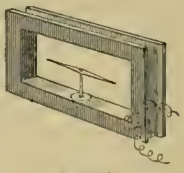


Multiple Gearing.

Mul′ti-pli-er. 1. (*Telegraphy.*) A frame with a number of repetitive windings of the same wire, in order to obtain their cumulative effect in deflecting a magnetized needle, when the wire is traversed by a current. An invention of Schweiger.

Unless the current is sensibly diminished by the resistance of the wire, each convolution exerts an equal force on the needle, thus multiplying the deflective force as many times as there are turns in the wire. Owing to the resistance, however, it frequently occurs in practice that a few turns of stout wire exert a greater influence on the needle than numerous convolutions of much finer wire.

Fig. 3260.

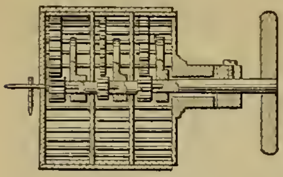


Multiplier.

2. An arithmometer for performing calculations in multiplication. See ARITHMOMETER.

Mul′ti-ply-ing-gear′ing. An arrangement of cog-wheels by which motion is imparted from wheels of relatively larger diameter to those of smaller, so as to increase the rate of rotation. This is used in many kinds of machinery. The example shows a nest of gearing for increasing the rate of motion from the driving-shaft of a harvester to the rate required by the cutter-bar. The motive shaft has arms which carry spur-wheels engaging the inner gear of the drum, and a pinion which is fast to the second shaft, having similar arms and spur-wheels engaging a pinion on the third shaft. This may be extended as far as desired; the proportion between the planet-wheels and their pinions regulates the increase of speed gained.

Fig. 3261.



Multiplying-Gearing.

Multiplying-gearing is also used with some forms of propeller-engines.

Mul′ti-ply-ing-glass. One with a number of facets repeating the object. A toy.

Mul′ti-ply-ing-lens. A plano-convex lens whose curved surface is divided up into a number of plane facets which give separate images.

The facets of a multiplying-lens or a cut diamond resemble those of the compound eye of some insects. Each little facet of the cornea gathers a certain set of pencils of light, and the main necessity for the motion of the eyeball is avoided. The facets in the compound eyes of the insects following are cited as,

The butterfly	17,335
The dragon-fly	12,544
The house-fly	7,000

The eye of a flea has been so mounted with the assistance of a microscope as to exhibit a flame or other object as a grand miniature illumination or assemblage.

Mul′ti-ply-ing-ma-chine′. One form of calculating-machine. See Fig. 328, ARITHMOMETER. See also CALCULATING-MACHINE.

Mul′ti-ply-ing-wheel. One which increases the number of movements in machinery. See MULTIPLYING-GEARING.

Mul′ti-tu′bu-lar Boil′er. One having numerous tubes in which water circulates.

Mun′go. (*Fabric.*) A woolen cloth made of second-hand material. Old cloth and woolen goods are torn to pieces by cylindrical machines, and, being mixed with various proportions of pure wool, are re-spun and woven. Druggets and low-priced goods of but little strength are the result. *Shoddy.*

Mun′nion. 1. (*Ship.*) A piece which divides the lights in a window of a stern or quarter gallery.

2. A bar separating the compartments of a Gothic or casement window. A *mullion.*

Mun′tin. (*Carpentry.*) A vertical piece between the panels of a double-panel door. The name is probably derived from *munnion,* and that from *mullion,* a pier between the divisions of a Gothic window. Mullion is from *molding* (Fr. *moulure*), signifying the form.

Muntz's Met′al. An alloy for plates for sheathing the bottom of ships. Patented in England in 1832. It resembles several previously patented alloys, all of which were designed to be rolled while red-hot, and to be used for the purpose stated.

See the following; also table on page 61.

	Kier, 1779.	Collins, 1800.	Muntz, 1832.
Copper	54	55.5	50, 60, 63
Zinc	40	44.4	50, 40, 37
Iron	5.4		

Mu′ral Cir′cle. An astronomical instrument consisting of a graduated circle, furnished with a telescope and firmly affixed to a wall, in the plane of the meridian. It is used for determining with great accuracy altitudes and zenith distances, from which may be found declinations and polar distances, and has a graduated circle secured at right angles to its horizontal axis. See TRANSIT.

The old Hindoo instrument for obtaining by observation the sun's altitude and zenith distance is described in the Sanscrit treatise "Sûrya Siddhânta." It was a wheel suspended by a string, graduated to degrees, having its lowest point and the extremities of its horizontal diameter distinctly marked, and with a projecting peg at the center. When used, its edge is turned toward the sun, so that the shadow of the peg falls upon the graduated periphery, and the distances of the point where it meets the latter from the horizontal and lowest points of the wheel respectively are the required altitude and zenith distance of the sun.

Among celebrated instruments may be mentioned the mural circle made by Graham, for Halley, at Greenwich, and those made by Ramsden in 1788, for Piazzi, at Palermo, and one for Dublin. See GRADUATING-INSTRUMENTS.

The *mural circle* is so called because it is supported by means of a long axis passing into a wall.

The mural circle of the National Observatory in Washington was made by Mr. William Simms of London. It is 5 feet in diameter, made of brass, and cast in a single piece. It is divided into spaces of 5′ each, upon a band of gold inlaid on the rim and perpendicular to the plane of the circle. Placed at equal distances round the circle are six micrometer microscopes, with an acute cross of wires at their foci for reading angles less than 5′. Five revolutions of the micrometer are designed to measure 5′ upon the circle. The micrometer heads being divided into 60 equal parts, each division represents 1″ of arc. The object-glass of the telescope has a clear aperture of 4 inches and a focal length of 5 feet. At its focus is a fixed diaphragm containing seven vertical wires and one horizontal wire. There is also another diaphragm, movable by a micrometer screw, and furnished with five horizontal and equidistant wires, by which the distance of any star from the fixed horizontal wire is measured as it passes through the field. The magnifying power usually employed is 125. The cost of the mural circle was $3,550.

The mural circle is placed in the meridian, and is used for determining the polar or zenith distances of celestial objects.

Mural quadrants and *mural sectors* are instruments of lesser arcs, similarly mounted.

Mu′ral Quad′rant. Differs from the preceding in the merely quadrantal character of the graduated arc.

The mural quadrant of Tycho Brahe at Uranibourg had a radius of five cubits. The collection of astronomical instruments at this observatory was by far the finest that had ever existed.

Mu-rom′e-ter. An instrument for measuring small spaces. — WEALE.

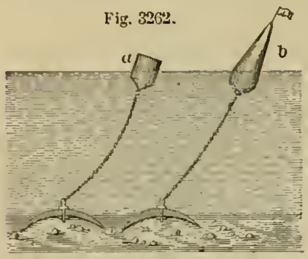
The term may refer to a mural attachment, as in the case of the mural circle, for measuring arcs of the meridian. The instrument is permanently attached to a perpendicular wall.

Mu-sette′. (*Music.*) A name by which the bagpipes are known among some of the European continental nations. Named from a mountebank performer.

Mush'room-an'chor. An anchor with a central shank and a head like a mushroom, so that it can grasp the soil however it may happen to fall. Invented by Hemman of Chatham, England, 1809. See Anchor.

That used by the United States Lighthouse Board for anchoring buoys is shaped like an inverted saucer, having a shackle and chain attached to the center of its convex side. The chain is just long enough to give the buoy sufficient prominence above the surface and allow for the rise and fall of tides.

Fig. 3262.



Mushroom-Anchor.

It imbeds itself in the ground, offering a strong resistance to an upward pull and not a little to a lateral one.

a, *can*-buoy with anchor.
b, *nun*-buoy with anchor.

Mu'si-cal Box. (*Music.*) A small musical instrument having a toothed barrel operating vibrating tongues.

Mu'si-cal Clock. One which plays tunes at the hours. It may consist of a musical-box attachment set in motion by the clock-work at the expiration of the hours.

One of late construction is cited as having a large bell on which the hours are struck, a chime of eight bells for the quarters, and a four-bell chime for "Cambridge quarters." It will also play seventy different tunes upon sixteen bells, the tune being selected by turning a hand on a dial; and by means of pushing a small stud the same tune may be repeated any number of times. There are ten barrels, each adapted for seven tunes, and readily substituted one for another. Other musical clocks are also provided with mechanical movements, dancing figures, soldiers marching past to the tunes played on the bells, all automatic. See also Clock, pp. 568–71.

Mu'si-cal Com'pass. (*Music.*) The range of notes of the voice or of a musical instrument.

Ptolemy first described the diatonic scale now in use. It appears that the ancients had no notation for time, and no music in parts; even their melodies were formed on different principles from the modern. Pope Gregory the Great (A. D. 590) denoted the scale by seven Roman letters, which represented in different octaves replicates of the same sound. Previous to this the sounds in the double octave had been denoted by fifteen letters. The letters of Gregory were placed over the syllables to which they were to be sung. Afterward, a little higher or lower than a median line, as an assistance in reading the notes. At a later period, on seven lines, in imitation of the strings of a lyre. Guido of Arezzo, a Tuscan monk (about 1022), reduced the number of lines to five, and placed the points of notes on lines and spaces. He also introduced solmization, or singing by syllables, as in the *do*, *re*, *mi*, *fa*, yet used, though not exactly so called. Bars were first used in the beginning of the seventeenth century.

Fig. 3263.

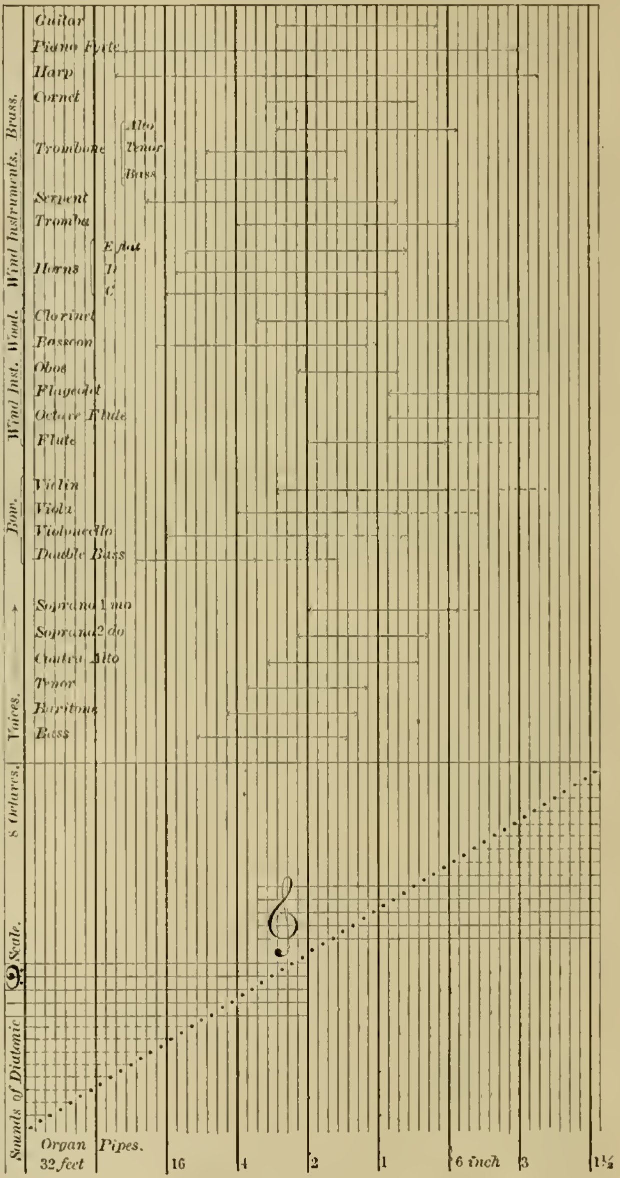


Table of the Compass of Voices and Instruments, showing the Place each occupies in the Scale.

The original compass of the piano-forte was 5 octaves. This was gradually extended to 6½ and 7 octaves, the latter being the usual range on grand-pianos. See Piano-forte.

Piano-fortes were exhibited in London, 1851, with 7½ and 8 octaves.

Mu'si-cal Glass'es. (*Music.*) A musical instrument consisting of a number of goblets, tuned by filling them more or less with water, and played by touching their rims with the dampened finger. The size of the glasses being equal, the smaller quantity of water produces the lower note in the scale.

The instrument was revived and improved by Benjamin Franklin in 1760. See Harmonium.

Mu'si-cal In'stru-ments. Devices designed to create a succession of harmonious sounds are to be found at the earliest historic periods, including under that term the times when men wrote by pictures, long before phonetic signs and syllables were invented.

We find them among those races which stand low down in the scale of humanity, and ancient monuments show that at a very distant period they had advanced to a considerable degree of perfection.

> "The birds instructed man,
> And taught him songs before his art began.
> And while soft evening gales blew o'er the plains,
> And shook the sounding reeds, they taught the swains;
> And thus the pipe was framed, and tuneful reed."
>
> Lucretius, *De Rerum Naturæ*, B. V.

The musical instruments of a rude people are themselves rude. Those of the Feejees are the conch-shell, nose-flute, pipes, a jew's-harp made of a strip of bamboo, and drums.

The Maories have three or four varieties of flutes, a lyre with three or four strings, and conch-shells.

The Society-Islanders have wooden drums with shark-skin heads; shell trumpets having holes in the small ends into which are fitted bamboo canes about three feet long; bamboo flutes blown through the nose.

A greater variety and improved construction indicates a more advanced civilization.

In the sculptures and paintings of Karnak are representations of musical instruments carried in processions. They consist of harps, maces, sistrums, lutes, flutes, and drums.

We suppose musical science and art to have originated in Egypt, — the land where, over all others, the husbandman could tell when he sowed his grain how much he was to reap in harvest; where the chances were reduced to the minimum; and where, first of all lands, a cultivated leisure was possible.

The musical instruments of Egypt utterly disprove the statements of Diodorus Siculus, that music was unknown in that country. A remarkable instance, which may stand as a complete refutation, is found in the harps discovered by Bruce depicted upon a tomb near the ruins of Thebes. These were so superior to the harps of 100 years since, that doubts were entertained of the fidelity of the representation; but Rosellini's "Monumenti dell' Egitto," and Wilkinson's "Ancient Egyptians," have removed all doubts. (See Harp.) The testimony of Herodotus, Plato, and others also enforces the statement, that music arose in Egypt and came thence to Greece.

When the Israelites left Egypt, they carried away with them some of the arts with which they had become acquainted in their at first voluntary and subsequently enforced stay.

According to Father Kircher, thirty-six kinds of instruments played by striking were employed by the Jews in the service of the Temple. Others reduce the number to twenty-two. Among these, the class termed *neghinoth* included stringed instruments of a long oval or rounded shape with perforated bottoms; the strings, three in number, were struck by a horse-hair bow. These were called *trichordon* in Greek, and *trifidium* in Latin.

Other instruments of the kind were the *psalter*, *nablium*, or *cithara*, denominated by the Hebrews *assur*, *nevel*, *kinnor*, *maghul*, *minnim*.

Of these no intelligible description remains. Some have supposed that the *psalter* was not in fact an instrument, but that the term was applied merely to harmony produced by the voice in conjunction with instruments. According to Josephus, however, it was an instrument with twelve strings played on by the fingers. The general opinion is that it was a species of harp.

The Hebrew drum, termed *thoph*, appears to have been covered at one end only. It was struck with a rod of wood or iron, and is said to have been of Egyptian origin. (See Drum.) The *gnesto berusim*, according to Rabbi Hannase, was a species of wooden mortar struck on the interior with a rounded stick.

The *maghul* is believed to have been a stringed instrument, but was, perhaps, a circle surrounded by little bells. A tambourine.

The *minghinim* has been confounded with the psalter and the cymbal, but Kircher states that it was a quadrangular plank, having a handle, to which small globes of wood and copper were attached by chains and cords, producing a clear jingling sound which could be heard at a considerable distance. Perhaps a kind of sistrum.

The *magraphe temid* was used to call the people to the Temple. Kircher supposes it to have been similar to a bell, but as no description remains this is a mere matter of inference.

The *mafra kitha*, according to Kircher, was composed of a series of reeds of different sizes inserted into a hollow piece of wood. It had holes opened and stopped by the fingers similarly to the flute.

The Hebrews employed at an early period the horns of animals as musical instruments, and also made flutes from the leg bones of birds, as the crane and stork.

According to Josephus, no less than 40,000 instruments were collected by Solomon for the service of the sanctuary, divided into different classes appropriate for each class of the services.

With regard to the form and use of many instruments employed by the ancients, no authentic account remains. In many instances conjecture has been substituted for fact.

They were generally used at festivals and religious ceremonies, are frequently mentioned by Ovid and other poets, and some are shown on ancient marbles.

Athenæus states that in the triumphal procession of Ptolemy Philadelphus there were 600 musicians in the chorus, 400 of whom played on the cithara or lyre.

Then, as now, musical instruments were ranged in three great classes, — wind, string, and percussion. In Numbers, chap. xix, the Hebrews are directed to sound trumpets on going into battle, and the walls of Jericho fell at the sound of the trumpet. This has been the warlike instrument of all nations from the earliest ages, except the Spartans, who employed pipes and soft instruments to temper rather than inflame their martial ardor.

Trumpets with two tubes were sometimes used by the ancients. At a later period the tube was recurved, as in the modern trumpet, of which the bugle is a variation. The trumpet used in Persia and the East is a very long tapering tube with flaring mouth. A similar instrument without a flaring mouth is used in Turkey and India.

The Chinese have trumpets of wood.

The Florida Indians, according to the history of Jacques Le Moyne, made a species of trumpet by winding the bark of trees spirally, forming a tube wider at one end than the other, to which oval plates of gold, silver, or other metal were attached by strings, intended apparently to jingle in accord with the instrument.

The Greeks ascribed the invention of the three-stringed lyre to Thoth, the Egyptian Mercury; and Terpander, the Greek, is credited with founding the Greek music, and with the invention of the seven-stringed lyre. He also contrived a method of representing musical sounds, writing music. Pythagoras added an eighth, completing the octave. The Greeks excelled in the use of the flute, using a variety of instruments of different pitch, but probably played in unison, not in harmony. It is apparently well settled that they did understand counterpoint.

The Romans seem to have added nothing to the art.

Toward the end of the fourth century, St. Ambrose composed a musical service for the church of Milan. Previous to this time, the Christian service was probably various in different parts of the Empire: in some it doubtless was Oriental and noisy; in lands where the Grecian civilization prevailed, it was copied from the dramatists, and consisted of airs, recitatives, and responses; in other regions again it probably followed the chants as performed at the pagan altars, and among the Christianized Jews it doubtless long followed the Hebrew models.

Two tubes, one sliding within the other, a form from which the trombone is derived, appear to have been early employed. See Plate V., Bonanni's "Istromenti Armonici," Roma, MDCCLXXVI.

From being at first straight, the tube was made curved, slightly, perhaps, at first, afterwards so as form a semicircle or more, and then so as to make one or more convolutions like the modern French horn.

Tyrrhenus, son of Hercules, it is said, first employed a sea-shell, perforated at the smaller end, as an instrument of music. The tritons attendant on Neptune are represented as blowing sea-shells.

The flute was originally sounded by a mouth-piece at the end, like the clarinet. In this form it is of great antiquity. The German flute is a comparatively modern invention. See FLUTE.

The ancient flute was frequently made double, the tubes diverging outwardly from the mouth. From an instrument of this kind to the compound or pandean pipes the transition is easy, and we accordingly find the latter in vogue at a very early period. The Chinese *tam-kin*, which is played by opening and closing the ends of a series of pipes filled by a single mouth-piece, is an analogous device. See Plate XLIII., Bonanni, *supra*.

The bagpipe is said to have come from Lydia, and is mentioned by Suetonius in his life of Nero. See BAGPIPE.

The organ is of great antiquity, but the word "organ" is applied in the Bible, according to St. Augustine, to a variety of instruments. The invention of the hydraulic organ is attributed to the Alexandrian Greeks. (See ORGAN.) The pneumatic organ, even in its most primitive form, does not appear to have been used prior to the seventh century.

The *cithara*, or an equivalent instrument, is the most ancient of the stringed class known, being mentioned in the fourth chapter of Genesis; Jubal having been the progenitor of such as handle the *harp* (or cithara) and *organ*. The connection between instruments of this kind, as the lyre, harp, and others on the same principle, is so close that we can hardly decide positively which is the primitive form. The monuments of Egypt illustrate a number of varieties. See HARP; LYRE; LUTE.

The *violin*, *guitar*, *mandolin*, and similar instruments are of later origin. The first were struck by a *plectrum*, or a small rod, or by the fingers. See GUITAR.

The *monochord* and *tromba marina*, or marine trumpet, are played with a bow. (See Plate LXIV., Bonanni.) The latter has merely a flat sounding-board, on which the single string is stretched.

The so-called German lyre is a *hurdy-gurdy*.

The Kaffirs have a species of *monochord*, consisting of a string stretched on a bow and twanged with an ornamented swan-quill, and a sort of violin formed by stretching a string over a kind of drum with a handle. This is played with a bow.

Instruments played by percussion seem to have been among the first known. Miriam is represented as playing on the *timbrel* after the passage of the Israelites across the Red Sea. (Exodus, chap. xv.) This appears to have been similar to the tambourine, and was also probably surrounded by little bells. See TAMBOURINE.

The *tam-tam*, formed by stretching a skin over the opening of a hollow hemisphere, cylinder, quadrangular box, or even a gourd, and beaten with a stick, has been found among all races and tribes of people. See DRUM.

The *maramba*, formed by thus preparing a number of gourds of different sizes so as to accord with one another, is in use alike among the inhabitants of Africa and Southern America. Bamboos similarly attuned and arranged are also employed by some African tribes.

Drums, *tam-tams*, and *gongs* are much in vogue among the Chinese and other imperfectly civilized or barbarous nations, with whom noise and music are synonymous terms. With nations having more appreciation of harmony, such instruments have been more sparingly employed, for the purpose of marking time or of reinforcing the sound of a combination of other instruments at proper intervals.

The *sistrum* and *crotalus*, or rattle, jingling devices caused to sound by shaking, were used in former times with this view; but at the present day, with the exception, perhaps, of the cymbals and triangle, instruments of the jingling and clashing kind are banished from the orchestra. See CASTANET; CYMBAL; TRIANGLE; GONG; BONES.

The arrangement of bells in a diatonic series, so as to play tunes, is of comparatively modern origin. See PAVILLON CHINOIS; CARILLON.

For a list of the more generally known instruments, see specific index, next page.

The following list and classification of musical instruments is given in Berlioz's "Treatise upon Modern Instrumentation and Orchestration": —

STRINGED INSTRUMENTS.	Vibration effected by the bow	Violin. Viola Viole d'amour. Violoncello. Double-bass.
	Played by the hand .	Harp. Cithern. Guitar. Banjo. Mandolin.
	With keys . . .	Piano-forte.

Wind Instruments.	With reeds	Hautboy. Corno inglesi. Bassoon. Basson de quinte. Double-bassoon. Clarinet. Corno di bassetto. Bass-clarinet. Saxophone.
	Without reeds	Flute. Octave-flute.
	With keys	Organ. Melodeon. Accordeon. Concertina.
	Brass instruments with mouth-piece	Horn. French-horn. Trumpet. Cornet. Bugle. Trombone. Ophicleide. Bombardon. Bass-tuba.
	Voices	Men, women, children, and artificial soprani.
Percussion Instruments.	Of definite sonorousness	Kettle-drum. Cymbals (ancient). Sets of bells. Glockenspiel. Dulcimer. Keyed harmonica. Bells.
	Variable sonorousness, and producing characteristic sounds	Drum. Long drum. Tambourine. Cymbal Triangle. Gong. Pavillon chinois.

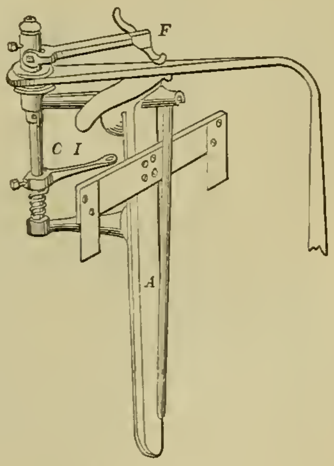
See under the following heads: —

Accordeon.
Æolian attachment.
Æolian harp.
Æolina.
Æolophon.
Angelot.
Apollouicon.
Atabel.
Autuphon.
Bagpipes.
Balalaika.
Bandore.
Banjo.
Baritone.
Barrel-organ.
Basset-horn.
Bassette.
Bass-horn.
Bassoon.
Bass-viol.
Bell.
Bird-call.
Bird organ.
Bombard.
Bones.
Bow-instrument.
Bugle.
Cabinet-organ.
Call.
Calliope.
Carillon.
Castanets.
Chanter.
Chime.
Chronometer.
Cithara.
Claribella.
Clarichord.
Clarion.
Clarinet.
Clavecin.
Clavichord.
Clavicitherium.
Clavicymbal.
Claviole.
Concertina.
Contra-bass.
Cornet.
Cornet-a-piston.
Cornopean
Coupler.
Cremona.
Cromorna.
Crotalo.
Crowle.
Crwth.
Cymbal.
Decachordon.
Double-bass.
Double-drum.
Drone.
Drum.
Dulcimer.
Echometer.
Eölian.
Fagotto.
Fiddle.
Fife.
Flageolet.
Flute.
Flute-organ.
French-horn.
Gender.
Gong.
Guitar.
Guitar-banjo.
Hand-organ.
Harmonica.
Harmoniphon.
Harmonium.
Harmonometer.
Harp.
Harpsichord.
Hautboy.
Hexachord.
Horn.
Horn-pipe.
Hunting-horn.
Hurdy-gurdy.
Hydraulicon.
Jew's-harp.
Kalidophone
Kallifthorgan.
Kemengeh.
Kent-bugle.
Key.
Key-bugle.
Kin.
Knee-swell.
Krum-horn.
Kussier.
Lapideon.
Lute.
Lyre.
Mandoline.
Mandore.
Manichord.
Manual.
Maramba.
Melodeon.
Metronome.
Monochord.
Mouth-organ.
Musette
Musical box.
Musical glasses.
Naker.
Oboe.
Octachord.
Octave-flute.
Ophicleide.
Orpheon
Organ.
Organ-harmonicon.
Orlo.
Pandean-pipes.
Pandore.
Pedal.
Percussion-stop.
Piano-forte.
Piccolo.
Pipe.
Pipe-organ.
Pitch-pipe.
Polychord.
Psaltery.
Reboe.
Recorder.
Reed.
Reed-organ.
Sackbut.
Sax-horn.
Saxophone.
Seraphine.
Serpent.
Side-drum.
Sistrum
Snare-drum.
Spinet.
Sticcato.
Stop.
Syrinx.
Tabor.
Tabret.
Tambourine.
Tam-tam.
Theorbo.
Timbrel.
Tom-tom.
Triangle.
Trombone.
Trumpet.
Tuning-fork.
Tympano.
Viola.
Viole d'amour.
Violin.
Violoncello.
Violone.
Virginal.
Wood-harmonicon.
Zithern.

Mu'sic-box. (*Music.*) An automatic playing instrument in which a row of vibrating tongues are tripped by pins on a barrel rotated by a spring. Boxes are made on a small scale for two tunes, and of many other sizes, some very large, expensive, and having a capacity for playing many tunes. The rapidity of the successive notes is such that it is impossible to make one tongue make the requisite number of notes in succession without striking upon the following pin; therefore, there are two, three, or four teeth of the comb having the same tone or pitch, and placed contiguous, which allows the rapid recurrence of the same note by placing the pins side by side, following, instead of behind each other. The regulator, or *fly*, is adjustable; the wings which impinge against the air are capable of limited extension and contraction, thus retarding or accelerating the rate of revolution of the cylinder.

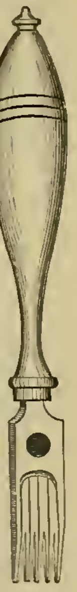
The tones of the tongues are regulated by their length and thickness; the shorter they are, the quicker the vibrations, and the higher in the scale is the pitch. To the long teeth, which are to vibrate slowly for the low notes of the scale, are attached masses of lead of sufficient weight to give the requisite tone. The tuning of these teeth is accomplished by altering their thickness by stoning, filing, or scraping, till the proper pitch is obtained. To prevent too long vibration of any of these teeth, a system of dampers is employed; on the under side of the longer tongues small pieces of steel spring are attached; to the middle teeth of the comb small bits of goose-quill are attached by cement, the short teeth, having a short vibration, requiring no dampers.

Fig. 3264.



Music Leaf Turner.

Fig. 3265.



Music-Pen.

Mu'sic-clamp. A temporary binder or file for holding sheet music in convenient form for use and preservation. See PAPER-CLAMP.

Mu'sic-leaf Turn'er. The arm *A* is

held to the music-stand by a clamping piece; the fingers are inserted between the pages and turned by the ratchet-plate *F*, which slides freely over the fingers when turned in one direction, but engages them one by one when it is moved in the opposite direction. It is fixed on the spindle *C*, which is partially rotated by the arm *I* connected by a cord with a treadle, and is restored to its former position by a spring.

Mu'sic-pa'per. Paper ruled with lines for writing music.

Mu'sic-pen. A pen made for ruling at once the five lines which, with the intervening spaces, form the staff of music. The instrument has a brass head and five parallel pens like ruling pens; that is, they consist of bent strips of brass which form spouts to conduct the ink from the reservoir to the paper.

Mu'sic-print'ing. Music was first printed by types on which the ledger lines were cast. The font displayed all possible variations of character and position. In 1720, music was engraved on plates.

Breitkopf's type, 1764, had the ledger lines on separate type. Reinhard printed the ledger lines from engraved plates, and the notes from type at a second pull.

Another and more modern plan is to put up the ledger lines in rules and cast the type so as to admit of the ledger line crossing them when necessary.

Music has been for a long time engraved by cutters and punches on soft metal plates and printed by the copperplate press.

The compositor, having the manuscript of the music before him, selects a thin sheet of soft metal of the proper size, and sinks, by the use of a machine constructed for the purpose, the staff-lines into the metal. He then proceeds to sink in the notes, rests, points, bars, slurs, etc., by the use of suitable punches, each musical character or element of a character having its appropriate punch.

The plates thus prepared have thus produced upon them the piece of music in sunken characters, which characters are next filled up nearly to the level of the plate with beeswax. The musical notation now appears as if printed in wax upon the plates, the surfaces of which are highly polished.

To print from these plates the ink is first distributed uniformly over the entire surface by a hand-roller. The surfaces are then wiped off with a cloth, which removes all the ink from the polished parts, while it still adheres to the wax in the punched depressions.

The pressman lays the paper upon the surface of the plates, and then passes them through the ordinary copperplate D-press. While the above is the usual plan adopted for preparing plates for the best music, a very large proportion of the music of the present day admits of being set up for the usual letterpress printing. The *sorts* of the case embrace all the various possible requirements of the music.

Mu'sic Re-cord'ing-in'stru-ment. A machine to record the notes played upon a keyed instrument.

The organ or piano is connected with the recording apparatus by a magnetic telegraph. Beneath each note of the three manuals and of the pedals, and connected with each stop of the organ, is a small brass spring, which is pressed down whenever the piece to which it is attached is brought into action. From each spring wires run to a galvanic battery, and to the recording apparatus, which may be situated at any convenient distance from the organ. When the spring is pressed down, connection between the battery and the recording apparatus is formed, and the electric current passes through. The recording apparatus is similar to that used in Morse's telegraph. Attached to clock-work, by which a uniform motion is produced, are two cylinders, between which is carried a strip of paper divided into about 250 longitudinal divisions, — one for each note and stop in the organ. Corresponding to each of these divisions is a magnet, whose armature carries a lever armed with a style, which indents the paper as long as the electric current is passing through. When any note or stop is brought into action, the spring connected with it is pressed down, the circuit is completed, the corresponding armature is attracted to its magnet, and the division of the paper belonging to the note struck is indented with a line proportionate in length to the time during which the note is held down. A staccato touch will be represented by a simple dot, while a longer tone will be recorded by a more prolonged indentation. The clock-work is so geared that the paper is carried forward on the rollers at the rate of about one half an inch per second, thus recording each note in the most rapid playing, at the rate of about ten notes per second by a line one twentieth of an inch in length, and longer notes by lines proportionally extended.

Mu'sic-stool. A stool with a pillar leg, and a revolving seat adjustable as to hight by means of its screw-stem.

Mu'sic-type. Movable types for setting up music to be printed by the ordinary printing-press.

The first plan was that of Cowper, who printed by two operations; the first printing the lines and the second the notes.

The second plan was that of Branston, who punched the notes and cut the lines deeply in a plate and from this obtained a stereotype, from which he printed in the usual manner.

The present plan of detached types was introduced by Hughes of London, about 1840. See pp. 310, 311, of Ringwalt's "Encyclopedia of Printing."

Mu'sic-wire. *a.* A steel wire employed for instruments of wire.

b. Wire drawn of various patterns and used in some kinds of music-printing.

Mu'sic-writ'er. Several contrivances were suggested or made during the last century for "writing extempore voluntaries or other pieces of music, as far as any master shall be able to play them upon the organ, harpsichord," etc. (*Phil. Tran.*, 1747.) Creed invented a machine for this purpose in England in 1747; Hennersdorf of Berlin, one in the following year. John Freke in England, Unger and Hohlfield in Prussia, worked at the idea. Unger formed a part of the harpsichord. The device of Hohlfield was attachable to any instrument. Descriptions were transmitted to the Academy of Berlin in 1752, and published in Brunswick in 1774.

Mus'ket. (*Fire-arms.*) The fire-arm of the infantry soldier. It superseded the arquebus, on which it was an improvement. Formerly, smooth-bore and muzzle-loading, modern progress has improved it into the rifled breech-loader of the present. See FIRE-ARMS.

Mus'ket-oon. A short musket used by cavalry and artillery previous to the introduction of breech-loaders.

Mus'lin. (*Fabric.*) A bleached or unbleached thin white cotton cloth, unprinted and undyed; finer than calico. Varieties are known as Swiss, buke, mull, jaconet, lawn, saccharilla, harness, leno, nainsook, seerhand, foundation, cambric, cord, check, figured, long-cloth, tamboured, muslinet, organdie.

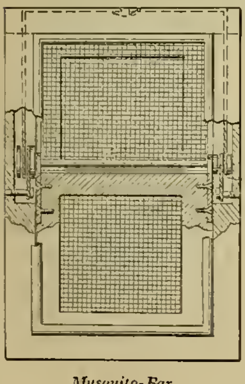
Muslins are so called from Moussol in India. First imported into England in 1670. Made in England, 1778-80. Other very different styles of fabric are now indifferently called muslins, and the term is used differently on the respective sides of the Atlantic.

At the London Exhibition in 1862, a few yards of English muslin were shown, woven from a thread .00216 of an inch in diameter, but the finest Dacca thread is only one quarter the size ; and there is this essential difference, that the finest European muslins have little or no durability, whereas the Dacca muslins, of far finer quality, are strong and lasting. This is in part explained by the fact that the thread of the India fabric, being made by hand, is more closely twisted and compressed, — the number of twists to an inch in the best English being 68.8 ; the Indian, 110.1.

One pound of the finest Dacca thread is 250 miles in length. The most delicate pieces are transported in bamboo reeds, and a tube eighteen inches long and one inch in diameter will hold twenty-two square yards. One of the best pieces which found its way to England was ten yards long by one yard wide, weighed only three ounces two pennyweights, and could be passed through a very small ring. A Persian ambassador to India, on his return to his native country, once presented the king with a cocoanut-shell containing a turban sash sixty cubits long. The warp threads, in the best qualities, number from 1,000 to 1,800 in a piece one yard wide. Four square yards of some specimens weigh only 566 grains. The Emperor Aurungzebe reproved his daughter because, on a certain court occasion, the outline of her form could be distinctly seen through her dress. Her defense was that her covering consisted of seven garments.

To the fine and delicate Indian muslins the names of "webs of woven air," "dew of night," "running waters," etc., are given by the natives. They use the spinning-wheel generally for the ordinary fabrics, but the spindle still holds its place in the hands of the Hindoo woman when employed in spinning thread for the finer muslins. For these the Hindoo woman first cards her cotton with the jawbone of the *boa'ec* fish ; she then separates the seeds by means of a small iron roller worked backwards and forwards upon a flat board. An equally small bow is used for bringing it to the state of a downy fleece, which is made up into small rolls to be held in the hand during the process of spinning. The apparatus required for this consists of a delicate iron spindle having a small ball of clay attached to it in order to give it sufficient weight in turning, and imbedded in a little clay there is a piece of hard shell, on which the spindle turns with the least degree of friction.

Fig. 3266.



Musquito-Bar.

Attention is paid to the temperature of the air during the process of spinning, and the spinners in the dry climate of the northwest of India work under ground to secure a moist and uniform atmosphere.

The Hindoo's loom has a yarn-beam, a cloth-beam, heddle, swinging lathe, shuttle with an eye, treddles, and temple.

Mus'lin-de-laine. (*Fabric.*) A cotton chain and woolen filling, or an all-wool ladies' dress-goods, printed like calicoes.

Mus'li-net. (*Fabric.*) A kind of muslin of which there are several varieties, as single-cord, fancy satin-stripes, and figured.

Mus-qui'to-bar. A net to ward off musquitoes, gnats, and other flying insects. It is usually a canopy which surrounds the bed, but is sometimes applied to the windows and doors to exclude outdoor insects from a room.

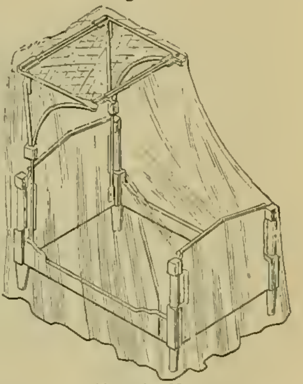
In the example, it is applied to a window. The cords are attached to screws fixed to the casing, and are passed once around the pulleys, so that the act of raising or lowering the sash revolves the roller and rolls up or unrolls the bar or netting.

Mus-qui'to-can'o-py. A netting acting as a protection against musquitoes.

The *conopeum*, or musquito-bar, is mentioned by Horace. It was of linen thread, of a gauze texture. Its name is literally rendered, *gnat-curtain*, and survives in our word *canopy*.

It is usually supported upon a tester or canopy, and depends all around the bedstead. In Fig. 3267 it is upheld by a frame laterally expansible, and its parts detachable so as to be attached to any bedstead, or packed in a trunk.

Fig. 3267.



Musquito-Net.

In Fig. 3268 the cot-bed is supported on springs, and the musquito-netting supported by attachment to a wall and a foot-rest.

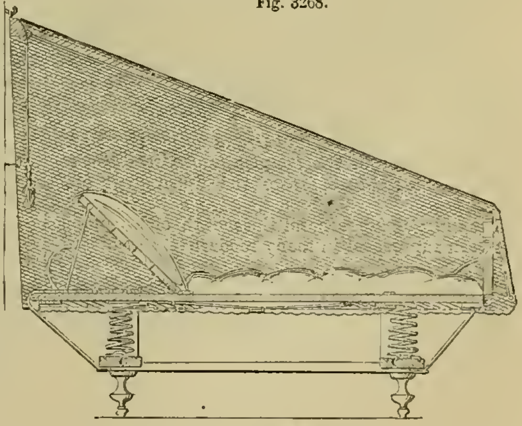
Fig. 3269 has a calash-top.

Mus'role. (*Menage.*) The nose-band of a bridle.

Mute. A device to deaden the sound of a musical instrument, wind or stringed.

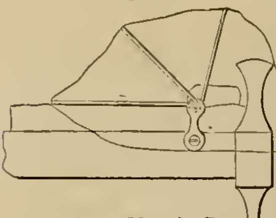
a. Fig. 3270 is an example of one applied to the pavilion of a horn. A plug is made to fit the bell of the instrument, and has a central tube, which allows only a part of the sound to issue. By this means the sound is

Fig. 3268.



Hospital Cot and Musquito-Bar.

Fig. 3269.



Calash-Top Musquito-Bar

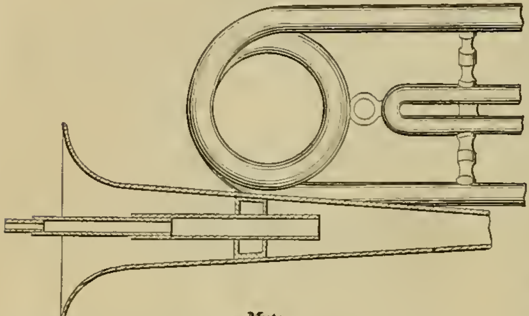
deadened, without throwing the instrument out of tune, and pupils are enabled to practice on the instrument without annoying their neighbors.

The mute is also used to produce echo effects.

b. A little implement placed on the bridge of a stringed instrument to deaden its sonorousness, and give it a mournful sound. A *sordine.*

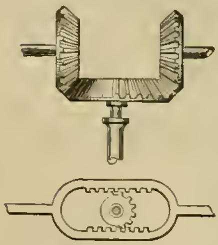
Mu'ti-la-ted Wheel. A wheel, from a part of the perimeter of which the cogs are removed. It is usually adapted to rotate constantly in one direction, and impart an intermittent motion to other cog-wheels or a reciprocating motion to a rack-bar, by alternate connections to one or the other of said wheels, or the respective racks of the bar.

Fig. 3270.



Mute.

Fig. 3271.



Mutilated Gear.

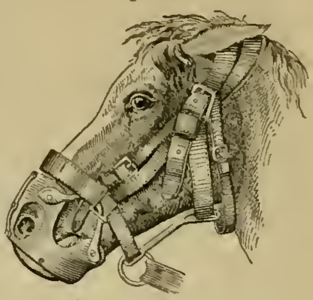
Mu'tule. (*Architecture.*) A projecting block worked under the corona of the Doric cornice, in the same situation as the modillions in the Corinthian and Composite orders; it is often made to slope downward toward the most prominent part, and has usually a number of small guttæ or drops worked on the under side.

Muz'zle. 1. (*Guns and Ordnance.*) The mouth of a gun, closed by the *tompion*, and, in ships, secured by *muzzle-lashings* to the upper part of a port.

The *muzzle-ring*, around the mouth of a cannon, has been suppressed in many modern styles of ordnance.

2. A gag or mask placed over the head of a dog or the muzzle of a calf or vicious horse. It may be made of heavy leather, galvanized wire, or block-tin covered with leather.

Fig. 3272.

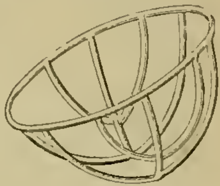


" *Cruiser* " *Muzzled.*

One of the heaviest descriptions of muzzles was used upon the untamed "Cruiser" before he was made tractable by Mr. Rarey. The illustration shows the muzzle and halter; the former was of iron and leather, a bar passing in front of the lips which compelled him to lick up his food.

Fig. 3273 is a muzzle to prevent biting the manger, but allow the horse to pick hay.

Fig. 3273.



Crib-Biter's Muzzle.

3. The piece at the forward end of the plow-beam by which the draft is attached. The *clevis.* Also called the *bridle*, or the *plow-head.*

Muz'zle-cap. (*Ordnance.*) The cover over the muzzle of a gun.

Muz'zle-sight. The *front-sight*, screwed into the swell of the muzzle of a gun or the muzzle-band of a howitzer. It is made of iron or steel, and is equal in hight to the *dispart* or difference between the semi-diameters of the base-ring and muzzle.

Muz'zle-stop'per. (*Ordnance.*) A *tompion*, to close the mouth of a gun.

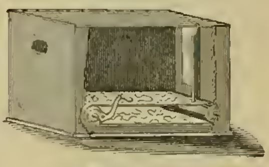
Muz'zle-strap. (*Menage.*) A broad strap, which is buckled around the horse's mouth to prevent his biting; used in place of a muzzle.

My'o-dyn'a-mom'e-ter. An instrument for measuring the strength of the muscles.

Myr'i-o-ra'ma. An exhibitional picture made of a number of separate sections which are capable of being associated in various ways so as to form distinct scenes.

Myr'i-o-scope'. This is a variation of the kaleidoscope, and, like the latter, depends upon the multiplication of images, which coalesce in such manner as to form a geometrical pattern.

Fig. 3274.



Myrioscope.

A square box has a sight-hole in front, and at the rear are two plane mirrors which are arranged at a suitable angle. On horizontal rollers is a piece of embroidered silk or other ornate fabric, which is caused to traverse by means of a crank-handle on one of the rollers. This causes a pretty display when the ornamental figures are multiplied and thrown into geometrical apposition.

The top of the box is of oiled muslin or other translucent material which admits sufficient light.

N.

Nab. 1. (*Fire-arm.*) The cock of a gun-lock.
2. (*Locksmithing.*) The keeper of a door-lock.

Nac'a-rat. (*Fabric.*) Fine linen or crape dyed of a pale red color.

Nail. 1. A sharp narrow piece of metal for attaching objects by driving it into or through them. It differs from a *spike* or a *tack* in being smaller than one and larger than the other; from a *screw* in that the latter is not driven but twisted into the wood; from a brad in having a head, while the *brad* has but a spur.

The *nail* used by Jael, the wife of Heber the Kenite, when she smote Sisera, was a tent-pin (*wated*). The hammer was the mallet used to drive in the tent-pin. The nail was probably of hard wood, and when "fastened in a sure place" was useful then as now. It is not all ground that will hold a tent-pin securely when a wind-storm comes on. Deborah's song is a magnificent pæan, but we must agree with Kitto that Jael's was "a treacherous and cruel act."

The nails of ancient Egypt were usually of bronze. Iron nails have mostly perished with rust.

The tools of the Tahitians, when first discovered, were made of stone, bone, shell, or wood. They had no idea of metal. When they first obtained nails, they mistook them for the young shoots of some very hard wood, and, hoping that life might not be quite extinct, planted a number of them carefully in their gardens. Eight years after the first voyage of Captain Cook, that distinguished navigator says iron had quite superseded stone and bone.

Until eighty years since nails were always forged. Before the introduction of machine-made nails, 60,000 persons were employed in forging nails in Birmingham, England.

One authority states that there are about 300 varieties of nails made in England, and 10 sizes of each variety. We have no such to present.

The English mode of numbering, 7 lb., 8 lb., etc., denotes that 1,000 of the respective varieties would have those weights.

This mode of enumeration is substantially similar to our own, but much variation has occurred.

The following are the names, lengths, and number to the pound of the several sizes of nails: —

Name.	Inches long	No. to the pound
2*d*. fine	1	880
3*d*. fine	1¼	665
3*d*. common	1¼	400
4*d*.	1½	280
5*d*.	1¾	195
6*d*. common	2	155
6*d*. fencing	2	80
7*d*. common	2¼	120
7*d*. fencing	2¼	65
8*d*. common	2½	90
8*d*. fencing	2½	50
9*d*. common	2¾	70
9*d*. fencing	2¾	40
10*d*. common	3	55
10*d*. fencing	3	30
12*d*.	3¼	45
16*d*.	3½	28
20*d*.	4	20
30*d*.	4½	16

Nails are cast for some purposes, but their quality is inferior. They may be improved by ANNEALING (which see).

Garden nails for driving into brick walls, and nails for shoe-soles, are cast.

In 1718 an English patent was granted to Clement Dawbeny for cutting iron into nail-rods; it was worked by water-power.

Clifford, 1790 (England), patented a process of making nails by swaging between rollers whose depressions agreed with the shape of the nail; half in each roller. The heads and tails joined so as to make them in a string, to be afterward separated by nippers. It was proposed to treat a sheet in this way, converting it into strings of nails.

Clifford's next machine was to cut the nails from a bar rolled thicker at the head-end. The nails were made at another operation, in a swage.

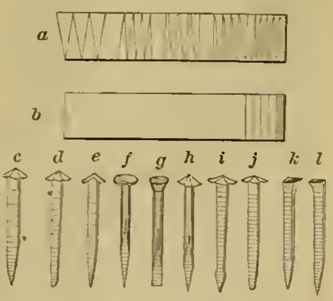
Thirty or forty patents in England followed these of Clifford's, but the American nail-cutter was the first to cut the nails and swage the heads at one operation. See NAIL-MAKING MACHINE.

The preliminary operations of smelting, puddling, squeezing, rolling, cutting, fagoting, re-heating, and re-rolling in the nail-plate train are described under their appropriate heads. The plate thus prepared is taken to the cutting-machine, which shears off pieces as long as the width of the plate, the strips having a width to suit the particular size of nail for which they are intended. This is a little longer than the destined nail, as a part of the slip cut from it is to be upset to form the head. The nail-strips are heated by being placed on their edges on red-hot coals, whence they are taken one by one by the pinchers of the boy who tends the nail-machine.

It will be understood that the plate as it comes from the nail-plate train has fibers running in the direction of its length. This is cut transversely into strips in which the fibers run across. A transverse cut on this strip gives a nail in which the fibers are lengthwise. See diagram *b*.

The cutting jaws of the nail-machine are presented somewhat obliquely to the line of direction of the nail-plate, so as to remove a taper piece, the wide end being swaged into a head and the sharper end remaining as a point, and the nail-plate being turned over after each cut.

Fig. 3275.



Nail-Plate and Nails.

Sparables, sprigs, brads without heads, and glazier's points are all of them of a triangular shape, and are merely cut from the strip. Brads with heads and headed nails are made by cutters of peculiar form, which leave projections upon the head-ends of each nail, as seen in the figure, which illustrates the various kinds mentioned.

Nails are assorted as to —

1. *Purpose*; as, *hurdle*, *pail*, *deck*, *scupper*, *sheathing*, *fencing*, *slating*.
2. *Form of the heads*; as, *rose*, *clasp*, *diamond*, *billed*, *clout*, *countersink*, *dog*, etc.
3. *Form of points*; as, *flat*, *sharp*, *spear*, *clinch*.
4. *Thickness*; as, *fine*, *bastard*, *strong*.

5. *Size;* from 1½ lb. to 40 lbs. That is, 1,000 nails of a given size will weigh so many pounds.

6. *Material;* as, *copper* nail, for sheathing of ships, metal covering of roofs. *Galvanized,* plated with zinc, etc.

7. *Mode of manufacture;* as, *wrought, cut, cast.*

The accompanying cut shows some of the peculiarities as to *heads, points,* and thickness.

c. Rose-nail; sharp point, a flat head showing facets, square shank.

d. Rose-nail; flat point, square shank.

e. Clasp-nail; bastard (medium) thickness, barbed head, square shank.

f. Clout-nail; fine point, flat circular head, and round shank.

g. Counterclout nail; countersunk head, flat point, round shank.

h. Dog-nail; faceted head, round shank, fine point.

i. Kent-hurdle nail: a broad, thin, rose head, flat shank, spear-point for clinching.

j. Rose-clinch nail; rose head, square point, either clinched or riveted down on a washer or *rove.*

k. Horseshoe-nail; countersunk head, square shank, fine point.

l. Brad; billed head, square shank, fine point.

To which may be added *spikes, tacks,* and other varieties.

Nichol's nail (1873) is a strong, light nail formed of sheet-metal with or without a head, and stiffened by longitudinal grooves, ridges, or corrugations.

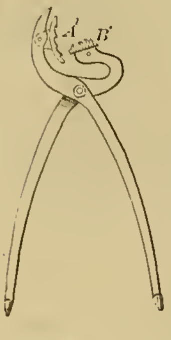
See under the following heads: —

Bastard-nail.
Brad.
Brob.
Bullen-nail.
Clamp-nail.
Clasp-nail.
Clinch-nail.
Clout-nail
Counterclast-nail.
Countersink-nail.
Cut-nail
Deck-nail
Diamond-nail.
Dog.
Door-nail
Doubling-nail.
Fencing-nail.
Fine nail.
Flat-head nail.
Flat nail.
Forge.
Frost-nail
Garden-nail.
Gate-nail.
Gimp-nail.
Glazier's point.
Hob-nail.
Horseshoe-nail.
Hurdle-nail.
Lead-nail.
Mop-nail.
Nail-clincher.
Nailer's forge.
Nail-hammer.
Nail-machine.
Nail-plate feeder.
Pail-nail
Picture-nail.
Pleashing-nail.
Ribbing-nail
Rose-nail
Screw.
Screw-nail.
Scupper-nail.
Sharp nail.
Sheathing-nail.
Sparable.
Spear-nail.
Spike.
Spike-extractor.
Spike-machine.
Sprig.
Tack.
Tack-claw.
Tack-driver.
Tack-hammer.
Tack-puller.
Tin-tack.
Tree-nail.
Trunk-nail.
Weight-nail.
Wheelwright's nail.
Wire-nail.

2. (*Blasting.*) A taper copper rod used in tamping to make a hole by which the fuse or train may reach the charge.

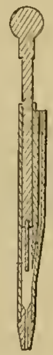
3. A stamping instrument.

Fig. 3276.



Nail-Clincher.

Fig. 3277.



Nail-Driver.

4. A measurer of length, 2¼ inches = $\frac{1}{16}$ of a yard.

Nail-ball. (*Ordnance.*) An iron ball with a tail-pin projecting from it, to keep it from turning in the bore of the piece.

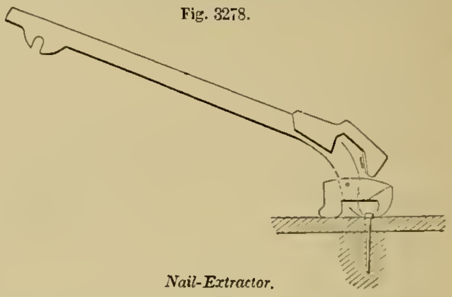
Nail-brush. A small brush for cleaning the finger-nails.

Nail-clinch′er. A blacksmith's tool for clinching the point end of a nail, — or what remains of it — against the hoof. In the example, the steel faces of the clincher are adjustable, being hinged to the jaws so as to conform to the various forms of hoofs, one face *B′* resting below the shoe and the other *A′* clinching the nail.

Nail-driv′er. In Fig. 3277, the point of the instrument is placed at the spot where the nail is to be driven, the plunger is raised, and a nail dropped through the feed-tube; the plunger being then allowed to fall drives the nail home.

Nail-ex-tract′or. An implement with nipping claws for grasping a nail and withdrawing it. In the example, one claw is upon the fulcrum-piece to which the other jaw is hinged.

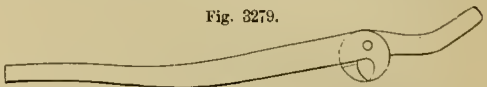
Fig. 3278.



Nail-Extractor.

In Fig. 3279 the lever and fulcrum are pivoted together, and their jaws are clamped together by the act of lifting.

Fig. 3279.



Nail-Extractor.

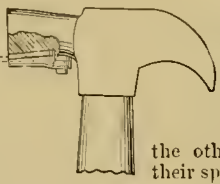
Nail-file. A small, flat, single-cut file for trimming the finger-nails. It is a part of the furniture of the dressing-case, or is cut on the blades of the nail-scissors, or on one small blade of a pocket-knife.

Nail-ham′mer. One for driving nails.

Notably, one which holds a nail for driving, as in the example.

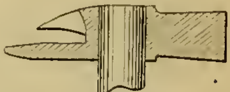
Between the *peen* and the claws is a recess in which a nail may be held to start it in the lumber; the other parts are effective for their specific duties.

Fig. 3280.



Nail-Hammer.

Fig. 3281.

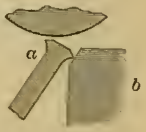


Nail-Hammer.

In Fig. 3280 the nail is gently held by the spring under the poll of the hammer till it is stuck into place ready for driving by a one-armed carpenter.

Nail-head Tool (*Iron-turning.*) A lathe-tool *a* having a circular expansion with a sharp edge, causing it to resemble, in a degree, a nail-head. One edge is supported on the rest *b,* and the other is applied to the work to be turned.

Fig 3282.



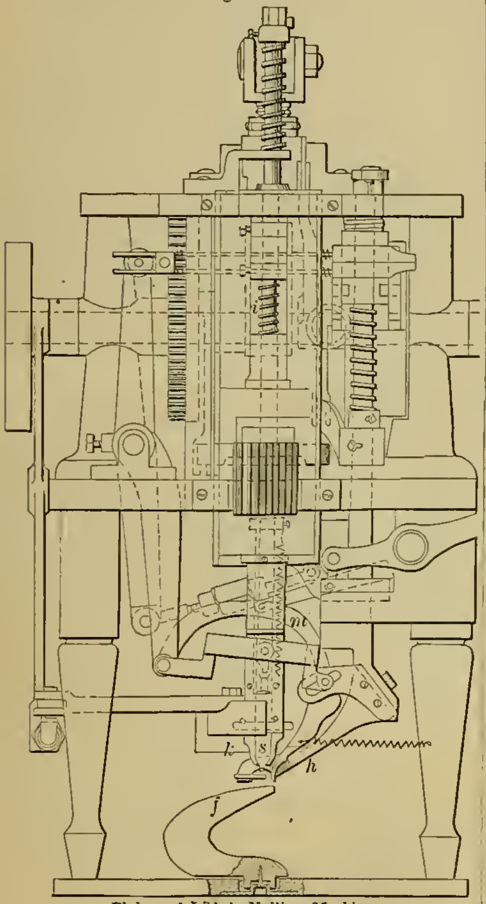
Nail-Head Tool.

Nail′ing-ma-chine′. 1. (*Carpentry.*) A machine in which, the parts of a box being placed in the proper relation, plungers advance and drive the nails which secure the sides of the box together, and the sides to the bottom.

Similar machines (see Rice's and Holmes's patents) are used for driving the legs of a wash-board against the sharpened edges of the corrugated zinc plate, sinking the zinc into the legs; an immediately succeeding motion forces the nails which secure the legs to the other portions. The nails are fed into grooves from hoppers, and the drivers advance along the grooves and complete the operation.

2. (*Shoemaking.*) A machine which acts automatically to drive the nails into shoe-soles. The nails are fed from a hopper, or are cut, one at a time as needed, from a coil of wire, and driven into the sole.

Fig. 3283.



Blake and Libby's Nailing-Machine.

In Fig. 3283, the work is held for nailing between the presser-foot *h* and horn *f*. At the lower part of the nail-tube *i* is suspended a pivoted guide *s*, which is vibrated so as to be in line with the tube for receiving a nail and to form an angle therewith when the nail is driven. The nail-tube is turned half round at the moment of driving, so that each nail is driven into the work inclined oppositely to the preceding one. The tube *i* and nail-driver are reciprocated by an eccentric on the driving-shaft, the other motions being derived from cams on the same shaft. The presser-foot arm is adjustable on the arc *m'* to regulate the feed of the work, and devices connected with the presser-foot are provided, by which the motion of the driver-bar is adjusted to varying thickness of the work.

The mechanism by which the nails are cut from the continuous coil of wire is adjustable, so that each nail may be allowed to project entirely through the inner sole and have its end clinched on the horn, or may only penetrate sufficiently to unite the work. The nailing mechanism and presser-foot may each be lifted away from the horn by means of a lever, when it is desired to remove the work.

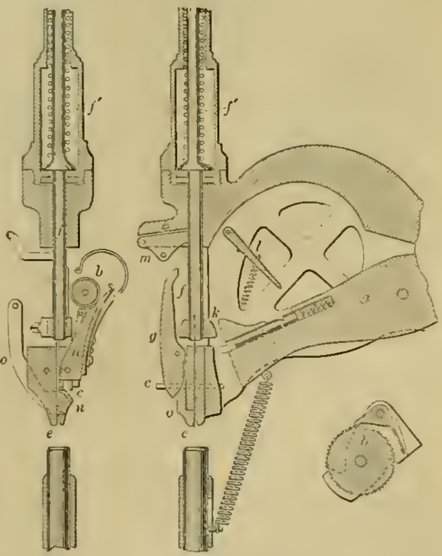
In Goddu's machine (Fig. 3284), for nailing shoe-soles with wire, the wire from a reel is fed downward through a tubular opening in the guide *a* by a feed-wheel *b* advanced by means of a ratchet and pawl. It is severed by a cutter *c* on the upright lever and a stationary cutter, and driven by a nail-driver *e* fixed in the lower part of the vertical shaft *f*.

The lever *g* is operated by depressing a treadle acting against the force of a spring which tends to keep that end in elevated position.

Its upward movement causes the spring-catch *i* to bear against the foot *k* of the nail-driver carrier *f*, and lift it until the arm *l* engages a notch in the spring-catch, retracting the catch and allowing the nail-driver carrier to be acted on by its spring *f'*. A pivoted clamp or binder *m* bears against the carrier, preventing its descent until an arm on the binder is struck by the lever *g* at the end of its upward movement, so that no feed will take place unless the lever is sufficiently raised, the feed-wheel ratchet and pawl being operated by the downward motion of the carrier *f*.

The wire from the feed-guide being severed by the fixed and stationary knives *c' n*, the nail cut off passes into a passage in the transferrer *o*; this is pivoted, and is moved by a stud entering a cam-groove on the lever *g*, so as to present the nail in vertical position at the proper moment to be acted on by the driver.

Fig. 3284.



Goddu's Nailing-Machine.

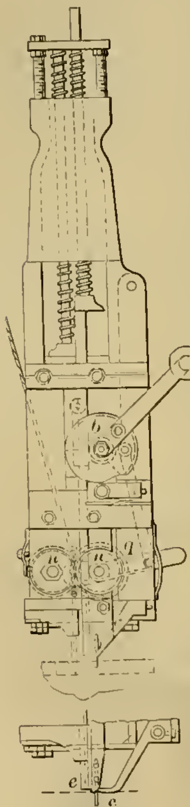
See also patent of Tyson, March 24, 1874, for screwing the uppers upon the soles and heels of boots.

The jack or work-supporting mechanism is mounted on a shaft in the tubular standard *p*, connected by a spring with the lever *q*, so as to be drawn up to the nose-piece *q* when a nail is to be driven.

In Caralli's machine two wires from separate reels are simultaneously fed through two tubes, by which they are conducted to a plate having dies through which they are passed, being at the same time rotated by bevel-gearing, by which screw-threads are cut upon them. As they are screwed into the work, held by mechanism on an arm projecting from the machine, they are severed by movable jaws acting against stationary cutters and operated by a foot-lever, by which the end next to be inserted is cut with a tapering point to facilitate its penetration.

In Prosser's machine, wire from a coil is drawn between a pair of serrated rollers which indent it and also press it into a hole previously punctured by an awl. It is then severed by a pair of shears. The rollers are intermittingly advanced by a ratchet and pawl actuated by a cam on a vertically reciprocating rod, which also operates a lever that depresses the awl and opens and closes the shears. One arm of the shears carries a pawl engaging a ratchet-wheel which turns a wheel by which the work is advanced beneath the nailing mechanism.

Fig. 3285.



Sargeant's Nailing-Machine.

In Fig. 3285, the cam-wheel *b*, through the medium of a rod and pivoted lever *q*, lifts the feed-foot *c*, which, being released, is swung forward by a spring, advancing the work the due interval between two nails. The cam-wheel *b* also raises the awl-driver, the shaft of which has a cam that lifts the driving-bar *e*, and also operates a pawl intermittingly turning a ratchet by which the two geared wire feed-wheels *n n* are rotated. The awl and peg-driver carriers are consecutively released at the proper moments and forced downward by springs on their respective shafts.

The wire drawn from a coil is severed into proper lengths by a cutter operated from the swing-bar *q* by means of a ratchet-wheel and pawl, with an adjusting device for varying the number of teeth advanced at one stroke of the pawl so as to cut different lengths of wire.

Nail-mak′ing Ma-chine′. Nails were formerly forged from the bar, which was reduced by hand to the proper size. In 1606, Sir Davis Bulmer obtained letters-patent for a machine for cutting nail-rods by water-power. The details of this invention are unknown, no records of English patents prior to 1617 existing.

In 1618, Clement Dawbeny patented an improvement on Bulmer's machine, its object being to remedy "the waste that comonly grewe and happened of the iron which was usually cutt into the said small rodd by reason of the often heating, vnapt instruments, and devises then vsed and practised for the cutting thereof." No farther description is given.

Neither of these appear to have been brought into practical use, and were probably soon forgotten.

Machinery for splitting rods for nail-making was first introduced in Sweden. The mode of construction and operation was ascertained by a man named Foley, of Stourbridge, England, who traveled to Sweden and fiddled his way into the affections of the workmen at the mills, where he took mental notes of the machinery and brought them to England, where he established a factory.

In July, 1790, Thomas Clifford patented in England a machine for making nails from the prepared rod by drawing it between rollers having cavities corresponding to the shape of the nail; and in December of the same year he patented a process for drawing bars or plates to a varying thickness and cutting the nails therefrom by a punch. Machines of this kind were in operation at French's factory, Wineburne, Staffordshire, England, in 1792.

Cut-nails were first made in this country.

About 1775, Jeremiah Wilkinson of Cumberland, R. I., cut tacks from plates of sheet-metal, and afterward made nails and spikes in a similar manner, forming the heads in a vise.

Ezekiel Reed of Bridgewater, Mass., in 1786, invented a machine for cutting nails from the plate, and in 1798 obtained a patent for cutting and heading them at one operation. Benjamin Cochran had also constructed a machine of this kind; and Josiah Person of New York, in 1794, patented a machine for cutting nails from the sheet.

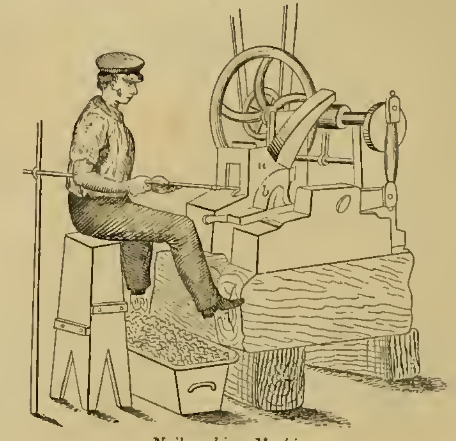
Perkins's machine, invented 1790 and patented in 1795, is said to have been capable of making 200,000 nails per day.

These, and Odiorne's, which embraced some improvements upon them, attracted great attention in England, where they soon came into extensive use.

At the close of the century, 23 patents had been granted for improvements in nail-machines.

In cutting nails from the plate, it is an object of primary importance to avoid waste of metal. This is effected either by rotating the plate 180°, or by changing the angle of the cutter at each stroke, cut-nails universally being made slightly tapering in one direction. For this purpose many varying forms of feeding-device have been invented, a few of which are illustrated.

Fig. 3286.

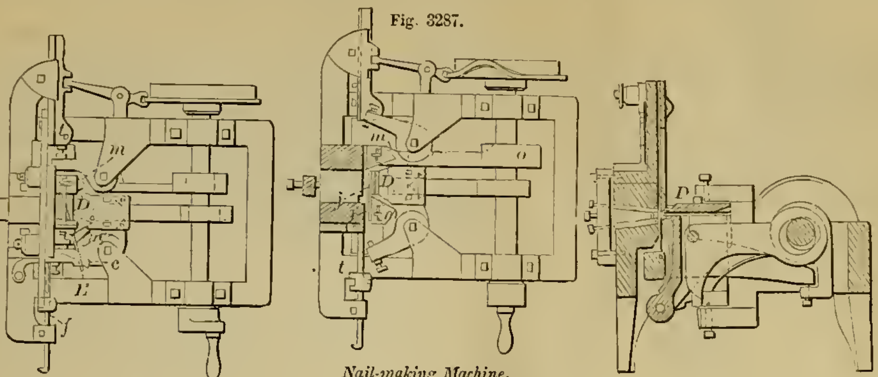


Nail-making Machine.

In Fig. 3286 the feeding is done by hand, the plate being turned by the operator. A lever operated by an eccentric on the shaft works the cutter inclosed in the box *a*, forming the nail-blank, which is then moved sideways and presented to the action of the lever *b*, by which the head is formed.

In the machine (Fig. 3287), two nails are cut from the sheet at once. On the forward movement of the punch *D* a projection is made to come in contact with an inclined block on the spring *E*, so as to force the latter against the blank while the punch is operating. The spring is held in position by a locking lever *c* until the punch is withdrawn, when a reciprocating stud *f* comes in contact with an arm on the locking lever and releases the spring. The fingers *j j'* which push the blanks between the grippers are held in reciprocating boxes *t* by springs, so as to slide if any undue resistance is met. The grippers *m m'* hold the cut blanks in position with the large ends projecting far enough for the headers to form the heads.

Fig. 3287.



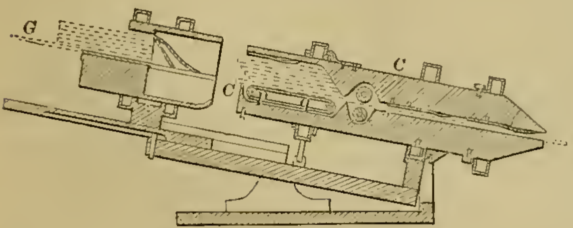
Nail-making Machine.

The illustration shows two plan views in different positions of the parts, and also a vertical longitudinal section.

In Fig. 3288, the nail-plates are placed in a box *G*, from which they are delivered to the hollow cylinder *C C*, and fed forward singly by the band-carrying rollers *p q* to the cutters. The cylinder is, by means of gears, moved half round after each cut, being withdrawn from the cutters by a cam movement.

In Fig. 3289, the nail-blanks, previously headed, are fed to the upper pair of rolls, which reduce the size of the body. The head is then seized by the second pair, arranged transversely to the first, by which it is still farther reduced, and so on successively, until the last pair, by which the nail is perfected, is reached. Each pair is grooved to correspond with the intended form of the nail, the grooves successively decreasing in size from first to last. The successive pairs of rollers act upon alternate faces, the rolls *a a*, etc., being at right angles to their alternates.

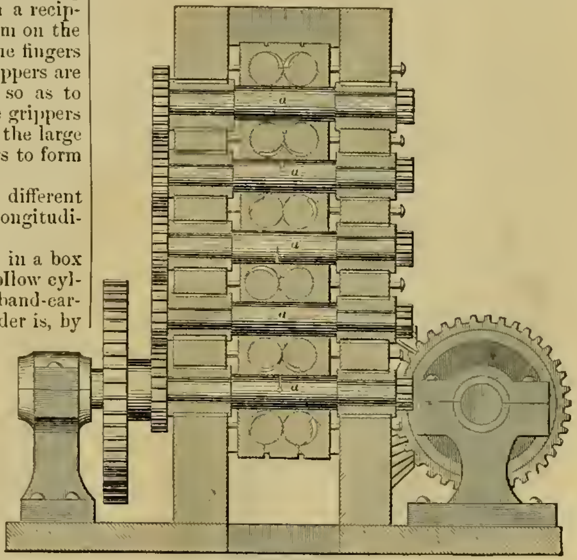
Fig. 3288.



Nail-Plate Feeder.

Wickersham's nail-machine produces a nail pointed like a chisel and tapered throughout its whole length. A sheet of metal from 20 to 25 inches wide presents its edge to a series of cutters arranged around the periphery of a cylinder which cut simultaneously a row of nails from the entire edge of the sheet. The nails are cut and headed at one operation.

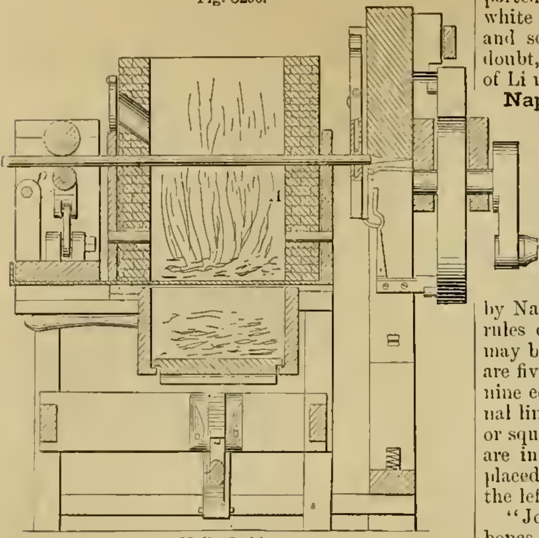
Fig. 3289.



Nail-Rolling Machine.

In Ward's machine (Fig. 3290), for making horseshoe or other wrought-iron nails, the rod *p* is automatically drawn by rollers through the furnace *A*, where it is brought to a forging heat, and is presented to the action of hammers while supported by an anvil. The hammers are operated by crank-arms and levers, which withdraw them from the iron, and at the proper moment permit springs to act upon them, forcing their acting faces, which

Fig. 3290.

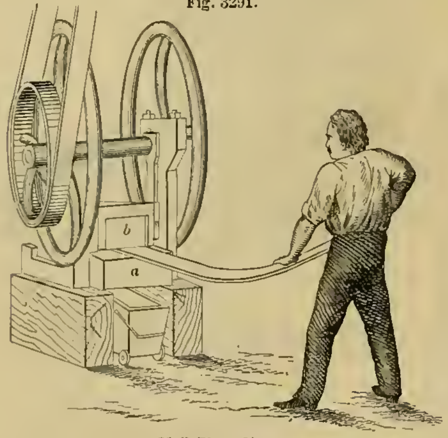


Nail-Machine.

are grooved to suit the shape of the nail, into contact with the red-hot rod, which is thus hammered on all four sides at once.

Nail-plate Shears. A machine for cutting nail-plates into suitable lengths to form nails. The plate is laid on the cutter-block *a*, and fed forward at each upward movement of the cutter *b* a distance equal to the length of the nail to be cut, from 2 *d.* to 60 *d.*

Fig. 3291.



Nail-Plate Shears.

The cutter is reciprocated in grooves in the standard by crank attachment to the fly-wheel, its downward movement taking off a slip from the end of the plate. The strip is received in a small car beneath.

Nail-scis'sors. Small scissors having files on the sides and used for trimming the finger-nails.

Nain-sook'. (*Fabric.*) A thick sort of jaconet muslin, plain or striped, formerly made in India. — Webster.

Na'ked Floor'ing. The parallel floor-joists, unboarded.

Na'ker. (*Music.*) A kind of kettle-drum.

Nan-keen'. Originally a fabric made from cotton of a yellow color (*gossypium religiosum*) and exported from Nankin, China. It is now made of white cotton, dyed by oak bark, arnotto, alum, etc., and sent from England to China. A part is, no doubt, reshipped in curious packages with the name of Li upon it.

Nap. 1. The pile of cloth.

2. The down of a hat.

3. *Naps.* The loops of velvet which are cut to make the pile.

Naph'tha-line. A substance formed during the destructive distillation of pit-coal.

Naph'tha-liz'ing. The enriching of poor gas, or carbureting of air, by passing either through naphtha or coal-oil.

Na'pier's Bones. Instruments invented by Napier for performing some of the fundamental rules of arithmetic by a mechanical process. They may be made of bone, ivory, horn, or wood. There are five of them, and the face of each is divided into nine equal parts, each being subdivided by a diagonal line into two triangles. In these compartments or squares the numbers of the multiplication-table are inserted, the units or right-hand figures being placed in the right-hand triangles, and the tens in the left.

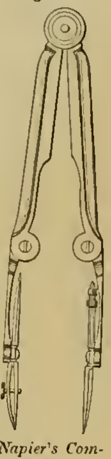
"Jonas Moore tells me the mighty use of Napier's bones, so that I will have a pair presently." — Pepys's *Diary*, 1667.

They were first described by the inventor, John, Lord Napier of Murcheston, in his "Rabdologiæ seu Numerationes per virgulas, Libri duo," ed. 1617.

> "A moon dial, with Napier's bones,
> And several constellation stones."
> Hudibras.

Na'pier's Com'pass. A draftsman's compass, to one leg of which is pivoted a plain point and pencil-holder, and to the other a plain point and pen. These fold in between the legs, so that the instrument may be carried in the pocket without inconvenience.

Fig. 3292.



Napier's Compass.

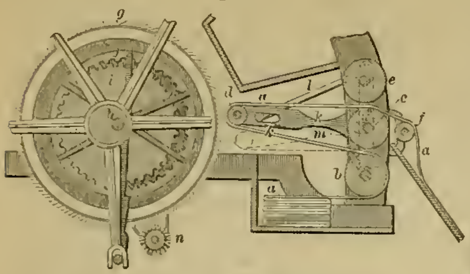
Nap'ping. (*Hat-making.*) A sheet of partially felted fur in a stage between the operation of the bow, which first distributes the fur in a light layer, and the *battery* at which it is united to the hat-body. It becomes the *nap* of the hat, which is raised by *carding* and shorn to a length.

Nap'ping-ma-chine'. A machine for raising the nap or pile on woolen and cotton fabrics.

Fig. 3293 illustrates an improved form. In this the cloth *a a a* is drawn between the rollers *b c*, passing around the roller *d*, then between the rollers *c c*, and over the small roller *f* to a receptacle. These rollers, as well as the napping-cylinder *g*, are driven by the shaft *h*, which carries two eccentrics running loose upon it. The inner one of these is attached to the gear-wheel *i* on the napping-cylinder, which meshes with the internal gear *j*, causing an intermittent rotary motion. This movement causes a reciprocating motion of the arm *k* slotted at *k''*, the latter of these slots receiving the pivoted rod *l*, which is adjustably attached to a lever *m* (indicated by dotted lines) provided with a spring-pawl that engages with teeth on the central roller *c*.

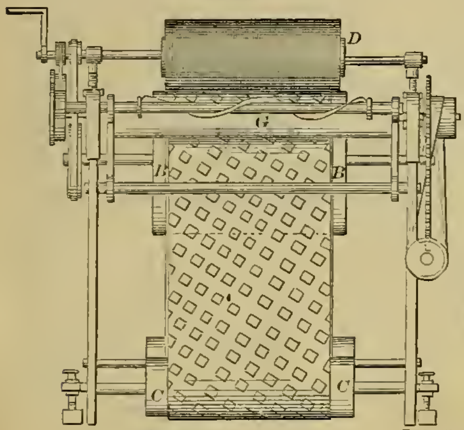
In the operation of the machine, at each revolution of the driving-shaft the napping-cylinder is moved slightly forward, remaining momentarily stationary while the roller *d*, which presents the cloth to the napping-cards or teasels on the periphery *g*, is moved eccentrically back and forth toward and from them, the ratchet device causing at the same time a partial revolution of the roller *c*, and presenting to the action of the cards a width of cloth equal to that which is at the same moment withdrawn therefrom by the rollers *c c*.

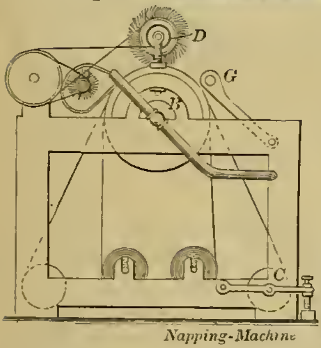
Fig. 3293.



Napping-Machine.

Fig 3294.





Napping-Machine.

The roller *d* admits of delicate adjustment to regulate the depth of nap raised.

n is a revolving clearer for removing fibers from the napping-cards.

Four series of the rollers are actuated at the same time by the movement of the shaft, so that four pieces of cloth are napped simultaneously.

In Fig. 3294, the rolls *C B* carry an endless band of thin sheet-metal stenciled with figures of any desired pattern. The fabric, which passes between the roller *B* and the endless band, is only exposed to the action of the napping-cards or teasels on the surface of the cylinder *D* at those points where the metal has been removed from the band; consequently, those parts only are napped, the rest of its surface remaining plain.

A shearing-device *G* of the ordinary kind may also be attached to the machine.

Nap-warp. (*Weaving.*) *Pile-warp.* In fustian weaving, the upper warp covering the main warp or nap.

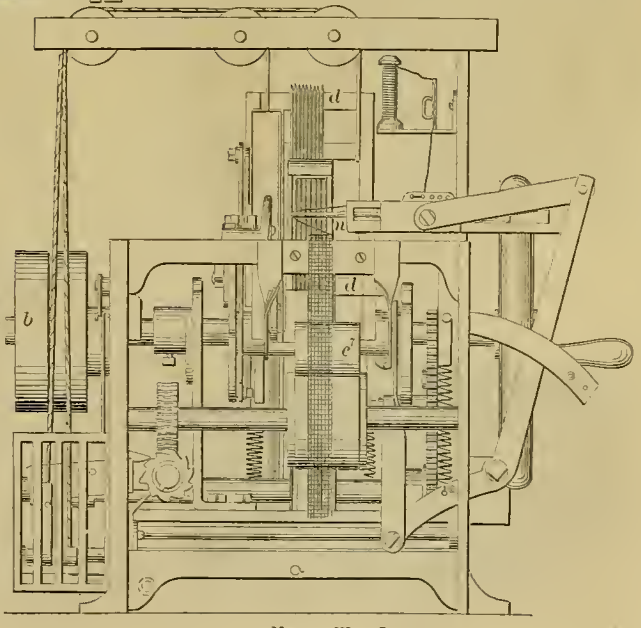
Nar-cot′ic-spray Ap′pa-ra′tus. A device for producing local anæsthesia. It consists of a bottle stopped by a perforated cork, through which passes a double tube, one of whose extremities reaches to the bottom of the bottle. Above the cork, a tube connected with a hollow sphere of india-rubber acting as a bellows penetrates the double tube and communicates through an aperture in the cork with the interior of the vessel. See page 93.

The operation of the bellows causes a current of air to descend through the aperture in the cork last mentioned, forcing the ether or other anæsthetic, with which the bottle is partially filled, to ascend through the inner branch of the tube, at the same time causing a current to pass through the outer tube, driving the ascending fluid before it, and depositing it in the form of spray upon the part under treatment. See ATOMIZER.

Nar′row Cloth. Woolen cloth under 52 inches width.

Nar′row-fab′ric Loom. Or, *narrow-ware* loom. One adapted specifically for weaving ribbons, tapes, bindings, etc. They are sometimes shuttle-looms, but usually have an eye-pointed needle which traverses the shed and back again between each movement of the harness. In the example, the filling-thread is carried double across the shed by a recip-

Fig. 3295.



Narrow-Ware Loom.

rocating eye-pointed thread-carrier, and then locked at the opposite selvage by passing a shuttle and its thread through a loop of such filling-thread. The loop is spread by the movement of the thread-carrier across the web.

n is the needle, receiving its weft-thread from the bobbin above. *d d* are the frames of the harness, operated by the cams shown at the lower left-hand corner of the figure. The picker motion is shown at the right, and consists of a bell-crank lever with connections to a cam-wheel and the needle-bar at its respective ends. c^7 and the rollers below it are the take-up. *b* is the band-wheel, through which motion is communicated by a belt from a prime motor. See also Needle-loom.

Nar′row Gage. (*Railroad-engineering.*) One less than 4 feet 8½ inches in width between the rails, which is the usual distance between the wheels of locomotives and railroad-cars, as well as those of ordinary vehicles.

Railways of this description have been in operation in the Pennsylvania coal-region for more than thirty years, and have attracted great attention within the past few years, their advocates claiming for them much greater cheapness of construction, both of road and rolling stock, and greater economy of running expenses than can be attained on roads of the ordinary gage. Less excavation and embankment is necessary, a lighter rail is employed, and the cars are made much lighter in proportion to the weight they are capable of transporting. The narrow gages actually in use vary from 3 feet 6 inches to 2 feet.

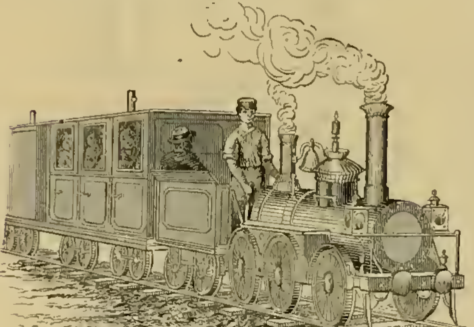
The Mauch Chunk road has a gage of 3 feet; this, the Nesquehoning, and the Carbondale roads, all narrow gage, were among the first of such gage constructed in this country.

Three feet six inches appears to be a favorite gage, those of Queensland, Australia, India, and Norway being all constructed of this width, the rails weighing from 35 to 40 pounds per yard.

Many engineers advocate a 3-feet gage or one even narrower for some purposes or localities. The narrowest in actual operation, so far as we are aware, only two feet, is the Portmadoc and Festiniog Railway in North Wales, through a very difficult country. This was originally designed as a tramway for the transportation of slate, stone, and other minerals from the hills of Merionethshire to the sea, but has since been used for passengers and general freight.

Fig. 3296 represents an engine, called the "Little Wonder," employed on this road. It weighs 19½ tons, and was first tested by a train 854 feet in length, consisting of 90 slate and 7 passenger cars, weighing 75 tons, constituting in all a load of 94½ tons, which it drew at a speed varying from 14½ to 26¼ miles an hour. Some of the curves on this road have a radius of but 1¾ chains. It is stated that an engine and tender weighing together only 10 tons is also used. The passenger-cars weigh 30 hundred-weight each, and carry 12 passengers.

Fig. 3296



"*Little Wonder*" (*Portmadoc and Festiniog Railway, South Wales*).

This is an extreme example. Most of those of more recent date in this country are 3-feet gage. The locomotives and cars are similar in general construction to those employed on wide-gage roads, but much lighter and of greater capacity in proportion to their weight; a four-wheeled house-car on some Western roads weighing 4,000 and carrying 8,000 pounds, and costing $185 to $200. The passenger-cars seat 30 passengers, cost $1,000 and upward, according to style and finish. The locomotives weigh from 8,000 to 12,000 pounds, and cost $4,500 to $7,000. The rail weighs 32 pounds to the yard.

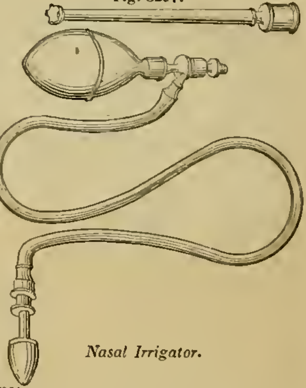
It seems to be conceded that for short roads and those required to accommodate but a moderate amount of traffic, the narrow gage possesses a decided advantage in point of economy, but for long roads transporting a large amount of freight and passengers and requiring high speed, 4 feet 8½ inches is by no means too wide a gage.

Nar′row-ing. (*Knitting.*) Contracting the fabric by throwing two stitches into one.

Nar′thex. (*Architecture.*) The first section in the Roman basilicas, set apart for monks and women, and devoted to certain religious ceremonies.

Na′sal Ir′ri-ga′tor. A syringe for nasal douches. In the illustration, the induction stem is shown detached, and the ejection end has a conoidal nozzle to fit the nostril.

Fig. 3297.



Nasal Irrigator.

Na′sal Spec′u-lum. (*Surgical.*) An instrument for distending the nostrils to expose the mucous membrane of the nose, and enable explorations and operations in cases of polypus, etc. See Speculum.

Nas-cale′. (*Surgical.*) A pessary of wool or cotton impregnated with a medicament for introduction into the vagina.

Nat′u-ral Steel. A steel obtained directly from the richer and purer kinds of ore by reducing them with charcoal and refining the cast-iron thus produced, so as to deprive it of a part of its carbon.

It is principally used for making files and other tools.

It is frequently termed German steel, being largely produced in Germany.

Na′ture-print′ing. A process in which impressions which may be printed from are obtained from objects, such as leaves, fibers, lace, etc.

In one method the object, such as a fern frond, is placed between a steel plate and one of heated lead and subjected to a strong pressure, forming an exact intaglio copy in the lead from which impressions are taken. This process was introduced by Auer of Vienna.

A process allied to the above consists in the application of successive layers of gutta-percha, — to fossil fishes, for instance, — and a mold obtained, which, being submitted to the action of a voltaic battery, is coated with copper, forming a plate on which all the markings of the fish are obtained in relief, the plate being used to obtain impressions by the ordinary typographic printing process.

By a third method the grain or markings of wood are transferred directly from the wood itself to paper, cotton cloth, etc. The wood is wetted with dilute acid and laid on the material; pressure transfers the markings of the wood to it, and it is then moderately heated, bringing out the colors.

One wetting suffices for twenty or thirty impressions.

Nau-ro-pom'e-ter. (*Nautical.*) An instrument for measuring the amount of a ship's heel or inclination at sea.

Nau'ti-cal A-larm'. See FOG-ALARM; BILGE-WATER ALARM; ICEBERG-ALARM; SHOAL-ALARM.

Nau'ti-cal Ap-pli'an-ces. See —

Accommodation ladder.
After-sail.
Alarm.
Anchor.
Anchor-ball.
Anchor. Drag
Anchor. Drift
Anchor. Mushroom
Anchor-tripper.
Apostles.
Apparel.
Arming.
Back-rope.
Back-stay.
Bag-reef.
Bails.
Balance-reef.
Ballast-shovel.
Balloon-jib.
Bangles.
Barking.
Beacon.
Bear.
Bearing-binnacle.
Becket.
Bee-block.
Bees.
Belaying-pin.
Bell-buoy.
Belly-band.
Bend.
Berth.
Bibbs.
Bight.
Bilge-water discharger.
Billet-head.
Binnacle.
Bird's-nest.
Bitter-end.
Bitts.
Bitt-stopper.
Blare.
Blast-engine.
Blind.
Block.
Block and tackle.
Blubber-guy.
Blubber-spade.
Boarding-nettings.
Boat.
Boat-detaching apparatus.
Boat-hook
Boat-lowering apparatus.
Bob-stay.
Body-hoops.
Bollard.
Bolster.
Bolt-rope.
Bonaventure-mizzen.
Bon-grace.
Bonnet.
Booby-hatch.
Boom.
Boom-iron.
Boom-jigger.
Boomkin.
Boot-topping.
Bower.
Bow-fast.
Bow-grace.
Bowline
Bowline-bridle.
Bowsprit.
Brace.
Brace-pendent.
Brail.
Breast-rail.
Breaming.
Breast-fast.
Bridle.
Bridle-port.
Broadside.
Bucklers.
Built-up.
Bull's-eye.
Bumkin.
Bunker.
Buntlines.
Buoy.
Buoy-rope.
Burgee
Burr-pump.
Burton.
Cable.
Cable-gripper.
Cable-hook.
Cable-nipper.
Cable-shackle.
Cable-stopper.
Caburns.
Cant-block.
Cantick-quoin.
Canvas.
Cap.
Capstan.
Card.
Careening.
Cargo-jack.
Cargo-port.
Carrick-bend.
Carrick-bitt.
Cat.
Cat-block.
Cat-fall.
Cat-harping.
Cathead.
Cat-hook.
Cat's-paw.
Center-board.
Chafing-gear.
Chain-cable.
Chain-hook.
Chain-lifter.
Chain-pump.
Chain-stopper.
Cheeks
Chess-tree.
Chest-rope.
Chinse.
Chinsing-iron.
Cleat.
Clew.
Clew-garnet.
Clew-line.
Clinch.
Clinching.
Clove-hitch.
Coat.
Collar
Commander.
Compass
Compressor.
Concluding-line.
Controller.
Cork-jacket.
Counter.
Counter-brace.
Courses.
Crane.
Creeper.
Cringle.
Cross-chocks.
Cross-jack yard.
Cross-tree.
Crotch.
Crow-foot.
Crow's-nest.
Crupper-chain.
Cuddy.
Cup.
Davit.
Dead-eye.
Dead-head.
Dead-light.
Dead-sheave.
Deck.
Deep.
Deep-sea line.
Dog-stopper.
Dolphin.
Dolphin-striker.
Downhaul.
Drabler.
Drag.
Drag-anchor.
Drift-anchor.
Drift-sail.
Driver.
Drog
Drum-head
Dunnage.
Earing
Electric buoy.
Electric log.
Euphroe.
Eye.
Eye-splice.
Fair-leader.
Fake.
Fall.
Fall and tackle.
Fancy-line.
Fang.
Fast.
Fender
Fid.
Fid-hammer.
Fife-rail.
Filling.
Fish-davit.
Fish-fall.
Flake.
Fleet
Flemish eye.
Flemish horse.
Floating-anchor.
Flying-jib.
Flying-jib boom.
Fog-alarm.
Foot.
Foot-rope.
Fore-and-aft sail.
Fore-ganger.
Forerunner.
Fothering.
Fox.
Frapping.
Furling.
Gaff.
Gallows-bitt.
Gammoning.
Gang-board.
Gang-cask.
Gangway.
Garland.
Garnet.
Gasket.
Girtline.
Gooseneck.
Goose-wings.
Gore.
Grafting.
Grapnel.
Grappling-irons.
Graving.
Gripes.
Grommet.
Ground-tackle.
Guest-rope.
Gutter-ledge.
Guy.
Halser.
Halyard.
Hammock.
Hand-lead.
Hank.
Harness-cask.
Harping.
Hawse.
Hawse-block.
Hawser.
Hawser-clamp.
Head
Head-fast.
Head-rope.
Head-sail.
Heart.
Heel-chain.
Heel-rope.
Hitch.
Hog-frame.
Holystone.
Hood.
Hoop.
Horse.
Horseshoe-rack.
Horsing-iron.
Hounding.
Hounds.
Housing.
House-line.
Ice-anchor.
Ice-beam.
Inhaul.
Jack-block.
Jack-cross-tree.
Jack-ladder.
Jack-staff.
Jack-stay.
Jaw.
Jeer.
Jewel-block.
Jew's-harp.
Jib.
Jib-boom.
Jigger.
Jury-mast.
Keckling.
Kedge.
Kennet.
Kentledge.
Kevel.
Kite.
Knights.
Knittle.
Knot.
Lacing.
Ladder.
Ladder-way.
Lanyard.
Larboard.
Lashing.
Lasket.
Latching.
Lateen-sail.
Lazy-jack.
Lead.
Leading-part.
Leak-indicator.
Leak-signal.
Lee-board.
Leech.
Leech-line
Leech-rope.
Lee-fang.
Lee-fannce.
Leeway-indicator.
Life-buoy.
Life-car.
Life-line.
Life-preserver.
Lift.
Link-worming.
Lizard.

Log
Log-board.
Log-book.
Log-chip.
Loggerhead.
Log-glass.
Log-line.
Log-reel
Loom.
Lubber's hole.
Luff.
Luff-tackle
Luff upon luff.
Lug-sail.
Made-mast.
Main.
Making-iron.
Mallet.
Man-rope.
Marks and deeps.
Marline.
Marline-spike.
Martinet.
Martingale.
Mast.
Mast-hoop.
Mast-scraper.
Mat
Messenger.
Mizzen.
Monkey-rail.
Moon-sail.
Mooring-swivel.
Mouse.
Nautical signals.
Necklace.
Nipper.
Nock-oar.
Norman.
Nun-buoy.
Oar-lock.
Outhaul.
Outrigger.
Oyster-dredge.
Oyster-rake.
Oyster-tongs.
Painter.
Pala.
Palm.
Parceling.
Parceling-machine.
Parclose.
Parral.
Parral-rope.
Partner.
Paunch.
Pawl-bitt.
Pawl-rim.
Paying.
Peak.
Pennant.
Pin-rack.
Plummet.
Point.
Pole-mast.
Port.
Port-tackle.
Poy.
Preventer.
Prow.
Puddening.
Puoy.
Purchase.
Puttock-shrouds.
Pyx.
Quant.
Quarter.
Quarter-block.
Rack.
Raddle.
Rafting and booming logs.
Raising-iron.
Ratline.
Rare-hook.
Reef.
Reef-band.
Reef-point.
Reef-tackle.
Reeming.
Reeming-beetle.
Relieving-tackle.
Rhodings.
Rhumb.
Ridge-rope.
Riding-bitts.
Rig.
Rigging.
Ring-bolt.
Ring-sail.
Ring-tail.
Ripping-iron.
Roach.
Roband.
Rolling-tackle.
Rope.
Rope-yarn.
Rough-tree.
Rounding.
Rowl.
Rowlock.
Rowport.
Royal.
Rubber.
Rubbing-paunch.
Rudder.
Rudder-chains.
Rudder-pendant.
Runner.
Running-rigging.
Saddle.
Sail.
Sail-clutch.
Sail-hook
Sail-hoop.
Saucer.
Save-all.
Score.
Scotsman.
Scraper
Screw-mooring.
Screw-steering apparatus.
Scull.
Scupper.
Scupper-hose.
Scupper-leather.
Scupper-shoot.
Seam.
Seaway-measurer.
Seizing.
Selvage.
Selvagee.
Sennit.
Serving
Serving-mallet.
Settee-sail
Setting-pole.
Shackle.
Shackle-crow.
Shears.
Sheep-shank.
Sheer-batter.
Sheer lashing.
Sheer-mast.
Sheet.
Sheet-anchor.
Ship's pendulum.
Shoal-indicator.
Shot-plug.
Shoulder-of-mutton sail.
Shroud-hawser-laid rope.
Shrouds.
Shroud-plate.
Shroud-truck.
Skeet.
Skipsail.
Skysail.
Sky-scraper.
Slab-line.
Slice.
Sliding-gunter.
Slings.
Slip-hook.
Slip-shackle.
Slip-stopper.
Smiting-line.
Smoke-sail.
Snaking.
Snotter.
Sounding.
Sounding-apparatus.
Sounding-line.
Sounding-rod.
Span.
Span-block.
Spanish burton.
Spanish windlass.
Spanker.
Spar.
Speck-block.
Speed-indicator.
Spencer.
Spider.
Spike-tackle.
Spilling-line.
Splice.
Splicing-fid.
Splicing-shackle.
Spring.
Sprit.
Sprit-sail.
Sprit-sail yard.
Spun-yarn.
Spurling-line.
Square-sail.
Standing-rigging.
Starboard.
Stay.
Stay-sail.
Stay-tackle.
Steam-steering apparatus.
Steering-apparatus.
Steering-wheel.
Steeve.
Stern.
Stern-fast.
Stern-sheets.
Stirrup.
Stop.
Stopper. Cable
Stopper. Rigging
Storm-sail.
Strand.
Strap.
Stray-line.
Stream-anchor.
Stream-cable.
Streamer.
Stretcher.
Studding-sail.
Stump-mast.
Submarine thermometer.
Supporter.
Surge.
Swab.
Sweep.
Swinging-boom.
Tabling.
Tack.
Tackle.
Tack-tackle.
Tail-tackle.
Tell-tale.
Thimble.
Thimble-eye.
Thole.
Throat.
Thrum.
Thumb-cleat.
Thwart.
Tie.
Tier.
Tiller.
Tiller-rope.
Tilt.
Toggle.
Top.
Top-chain.
Top-gallant.
Top-hamper.
Top-mast.
Topping-lift.
Towing-bridle.
Train-tackle.
Trap-net.
Traverse-board.
Traverse-table.
Trawl.
Tree-nail.
Trestle-tree.
Tricing-line.
Triatic stay.
Trigger.
Tripping-line.
Truck.
Trundle-head.
Truss.
Try-sail.
Tuck.
Tumbler.
Turk's head.
Tye.
Undocking.
Uphroe.
Vang.
Velocimeter.
Vessel.
Voyol.
Waft.
Wall-knot.
Wapp.
Warp.
Watch-tackle.
Water-anchor.
Water-line.
Waterman's knot.
Water-sail.
Wheel.
Wheel-rope.
Whelp.
Whip.
Whip-on-whip.
Whisker.
Winch.
Windlass.
Wind-sail.
Wire-rope.
Wooden-wing.
Wood-lock.
Worming.
Yard.
Yard-tackle.
Yoke.

Nau′ti-cal In′di-ca-tor. An instrument invented and thus named by Hunter.

It consists of a stand supporting a circular plate of polished brass, about 14 inches in diameter, representing the horizon, and marked and numbered accordingly with the proper divisions. The horizon is surmounted by a semicircular plate, as a meridian, set at right angles to the plane of the horizontal plate, properly divided and furnished with an index attached to a nonius indicating minutes. This meridian plate is cut out at the center, to allow room for a pivot or hinge for other parts of the indicator. On one side of the meridian are placed two quadrants, and at the other side one, similarly divided as the meridian and furnished with a similar index and nonius. The quadrants are movable on a pivot or hinge, rising perpendicularly from the center of the horizontal plate, or agreeing to this center; they are singly movable on the pivot, but capable of being attached at any relative distance, and retained in that position by a screw, binding together tails attached for that purpose. To the east and west points of the horizontal plate is attached a horary circle divided into hours, etc. This horary circle represents the path of the sun, and it may be furnished with a nonius, as the other parts are. This circle is so attached to the horizontal plate that it can be moved parallel to it, to suit the sun's declination. This is effected by the circle being attached to two tangent plates, which, by grooves, slide on the projections from the horizontal plate by means of screws passing through and working in these projections, and carrying the tangent plates, and with them the horary circle, to the degree of the sun's declination. This degree is indicated on a scale of tangent divisions on the tangent plates; and as such tangents are of various lengths, an expanding vernier is used to adjust them.

Nau'ti-cal Sig'nals. Signals for affording communication between vessels at sea or between vessels and the shore, consist of a system of flags of various colors for use by day or of lanterns at night, each separate combination and arrangement of which indicates some phrase or sentence that is or may be required in directing the evolutions of a fleet, the movements of a single vessel, making known the wants of the ship which displays it, or in replying to signals made by other parties. A more limited number of signals, sufficing for making known the most pressing necessities and for guiding a vessel into port when unprovided with a pilot, are made by the use of a single flag, attached to a staff, which is waved to the right or left, held vertically, or reversed, to express different meanings.

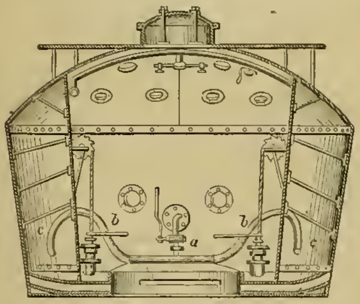
These combinations are depicted in books and numbered, so that, on seeing a particular signal hoisted, a party in possession of a similar book can, by reference thereto, ascertain the number of the signal and its meaning.

Those used by war-vessels differ with each nation, and the books containing them are covered with canvas lined with sheet-lead, so that in case of capture by an enemy they may be thrown overboard and sunk. The code of signals adopted by the British Admiralty requires the use of fifty flags.

For the merchant service the number of combinations required is much less. The code introduced by the late Captain Marryatt, R. N., was in general use until 1857, but is now superseded by that adopted by the British Board of Trade. This requires the use of only eighteen flags, by which 20,000 signals may be made, and numbers up to 70,000 represented. These numbers are printed in a book, and to each a word or sentence is attached.

Nau'ti-lus. A European form of diving-bell. It requires no suspension. Water admitted through the cock *a* into the pipes *b b* flows into the exterior chambers *c c*, causing the apparatus to sink. The workmen enter through an aperture at the top, closed by an air-tight cover, and can in still water move the machine in any required direction by stepping on the ground and pushing. Air is condensed in a reservoir at the surface to a degree somewhat greater than the condensation due to the depth, and passes through a pipe into the chambers *c c*, rendering the machine specifically lighter than water and enabling it to lift stones or other objects below. A gage indicates the amount of lifting power attained as the air is admitted, so that the supply may be cut off when the requisite power is attained.

Fig. 3298.



Nautilus.

Nau'ti-lus-pro-pel'ler. A device for propelling ships, so named by Mr. Ruthven. A large iron chamber containing water is placed in a suitable part of the ship. This contains a horizontal turbine-wheel rotated by a vertical shaft from the engine. The rotation of the wheel impels the water through two pipes outwardly to each side of the ship, where it escapes through two nozzles which may be directed either toward the stern or bow of the vessel, causing her either to go ahead or back, as the case may be. This motion of the nozzle is rapidly effected by means of a handle on deck. The two nozzles may be pointed in different directions, so as to cause the ship to turn on her center. The motion of the turbine does not require to be reversed, the backward or forward motion of the vessel being entirely controlled from the deck.

The apparatus has been tried by the British Board of Admiralty on the "Water Witch," a vessel of 800 tons. The result was a success so far as a reasonable speed was concerned, but the device was not regarded as equal to the paddle or propeller as a means of propulsion.

The idea is very old, has been tried a number of times, and proposed much more often. See Hydraulic Propeller.

Nave. 1. (*Vehicle.*) The central portion of a wheel from which the spokes radiate. See Hub.

2. (*Architecture.*) The main body of a church.

Na'vel. (*Ordnance.*) A perforated lug on the under side of a carronade which is engaged by a through bolt and thereby secured to the carriage.

Na'vel-hood. (*Shipwrighting.*) A hood wrought above the exterior opening of a hawse-hole.

Neb'ule-mold'ing. (*Architecture.*) An ornament of the zigzag form, but without angles; it is chiefly found in the remains of Saxon architecture, in the archivolts of doors and windows.

Neck. 1. A narrowed portion of an object relatively near to the end; as of a bottle, an axle.

2. (*Chemistry.*) The beak or rostrum of a retort.

3. (*Ordnance.*) *a.* The part joining the knob of the cascabel to the base of the breech; called the *neck of the cascabel.*

b. The small part of a gun where the chase meets the swell of the muzzle.

4. (*Music.*) The finger-board between the head and the body of a violin, guitar, banjo. Upon the *neck* the strings are pressed by the fingers in playing. Some *necks* have *frets;* the guitar, for instance.

5. (*Architecture.*) The narrow part between the astragal of the column and the annulet of the capital.

6. The jib of a crane.

7. A tubular projection to receive a collar, as that on a stove which receives a pipe.

8. A short shaft.

A diminished portion of a shaft where it rests in the bearing.

9. An intervening and connecting portion; as, the *neck* of a bayonet connecting the *blade* and *socket.*

10. A *goose-neck;* a flexible joint between a hose or pipe and a nozzle.

11. (*Nautical.*) A portion connecting the collar on the yard-arm and the iron of the studding-sail boom.

12. The narrower part of an embrasure. The *mouth* is the outer or *wider* part.

13. (*Metallurgy.*) The contracted portion of a furnace between the heating or melting chamber and the *stack*, passing over the *bridge*.

Neck'lace. (*Nautical.*) *a.* A strap round a mast carrying leading-blocks.

b. A chain to which the lower ends of the futtock-shrouds are secured.

Neck-mold. (*Architecture.*) A small convex molding surrounding a column at the junction of the shaft and capital.

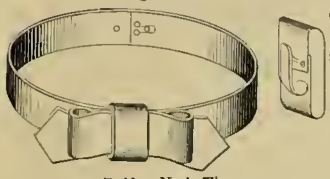
Neck-strap. (*Harness.*) *a.* A strap round the neck of a draft horse; a temporary expedient.

b. A halter strap around the neck. A part of a martingale.

Neck-tie Re-tain'er. A clasp to attach the tie to the neck or to the button of the neck-band of the shirt.

Neck-ties are usually of ribbon or some fabric, but sometimes of vulcanite, as in Fig. 3299.

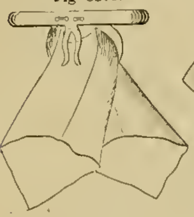
Fig. 3299.



Rubber Neck-Tie.

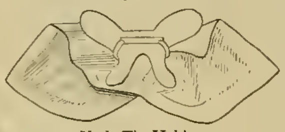
In Fig. 3300, the tie is sewn to an elastic plate, which passes beneath the collar and has a pair of elastic jaws projecting downward from its lower edge to embrace the button.

Fig 3300.



Neck-Tie Supporter.

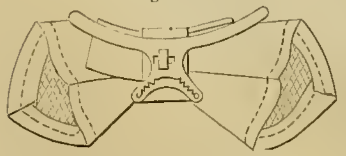
Fig. 3301.



Neck-Tie Holder.

In Fig. 3301, the forks straddle the button attachment, and the wings slip under the lappel of the collar.

Fig. 3302.

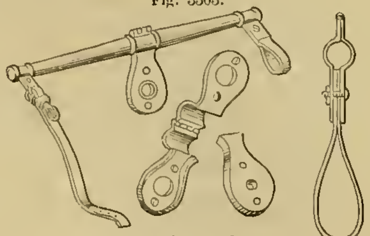


Neck-Tie.

In Fig. 3302, the slotted retainer is secured to the shirt collar or button, and the pin attached to the bow or scarf is caused to interlock therewith.

Neck-twines. (*Weaving.*) In fancy weaving, small strings by which the *mails* are connected with the *compass-board*.

Fig. 3303.



Neck Yoke and Straps.

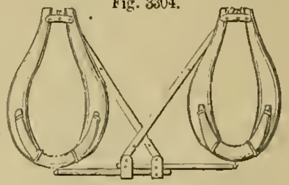
Neck-yoke. A bar, usually of wood, by which the end of the tongue of a wagon or carriage is supported. The *breast-straps* or *chains* pass through the rings on the hames, or, in the case of carriages, the straps pass around the lower part of the collar.

Animals in ancient Egypt were universally attached to their work by yokes. This was the case with horses, asses, or oxen, to wagons, chariots, or farming implements.

In a modified form, hinged plates are clasped around the neck-yoke, and the central clasp has plates perforated to receive the end of the tongue. Leather is inclosed between the two plates. The end straps are secured to the neck-yoke by metallic straps.

The cut shows the several parts.

Fig. 3304.



Draft Neck-Yoke.

Fig. 3304 shows a draft neck-yoke in which the collars are braced together and to a rod which is secured to the tongue, so that the draft is by the latter, dispensing with traces.

Nee'dle. 1. A pointed instrument for carrying a thread through a fabric, leather, or paper. It usually passes through the fabric and drags the thread after it, but it is otherwise with eye-pointed needles, such as packing-needles, and those in sewing-machines. The last-mentioned are really awls.

Needles of bone are found in the caves occupied by the ancient inhabitants of France during the stone period, and the same material is in use among uncivilized tribes at the present day.

The needles of ancient Egypt, as described by Wilkinson, are of bronze, and no eye is apparent in his illustration of them. It would rather seem that the thread is attached to a circular depression near the blunt end. It would be hardly reasonable to doubt that they had needles with eyes. We know from Scripture and secular history and from the tapestry that has survived thirty centuries that they were skillful and painstaking seamstresses.

> "A woman must not go out on the sabbath
> With a needle that has an eye."
> MISHNA.

The Phrygians and Hebrews held fine needlework in high estimation. Needles of bronze were used by the Greeks and Romans, are described by Pliny, and have been found in Herculaneum.

The history of art progress during the Middle Ages is a blank, but we find that needles were manufactured at Nuremberg in 1370. The history of their manufacture in England is involved in doubt, but it is said to have been introduced about 1543-45, either by a Spanish negro or a native of India, who died without disclosing the secret of his process. It was recovered during the reign of Elizabeth, by Growse, a German.

In 1650, Christopher Greening and a Mr. Damer established needle-factories at Long Crendon, near Redditch, and were soon followed by other needle-makers from London.

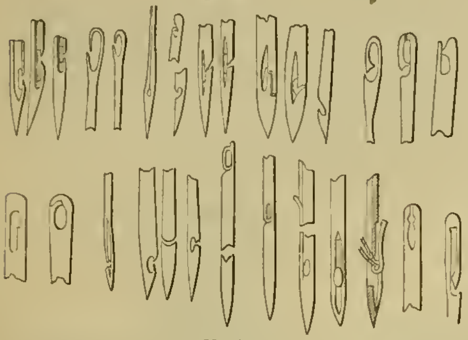
Redditch is yet the great center of the English needle manufacture.

The earliest needles were "square-eyed," that shape being most readily produced. "Drill-eyed" needles, after many unsuccessful attempts, were first brought out in 1826. The burnishing machine, in which the needles are strung on a steel wire to which rapid revolution is imparted, was introduced two years later. By this, a beautiful finish is imparted to the eye. The process of hardening them in oil was introduced in 1840, water having been previously used for this purpose, which caused a large proportion of them to become crooked, requiring the services of a large number of workmen to straighten them. These being thrown out of employment by the new process made a riot and drove its introducer out of town, but it was finally generally adopted. A similar disturbance had taken place in 1830, on the introduction of the stamping-machine. The machine for pointing is of still more recent introduction.

A needle with a point at each end and an eye at the middle of its length was patented in England in the year 1755, for hand-sewing or embroidering, the patentee describing it as used by holding it with the fingers at the middle of its length, so that it will not require turning. In 1829 it was successfully introduced into an embroidering-machine, which is still in extensive use. As many as one hundred and thirty such needles, worked by pincers on opposite sides of the fabric to be embroidered, are used in a single machine. In 1842 a sewing-machine inventor adopted the same kind of needle, and some others have made sewing-machines with such needles, but no such machines have ever been successful.

The accompanying cut shows a number of patented needles, some with eyes near their points, some having means of slipping the thread into the eye without reeving.

Fig. 3305.



Needles.

Needles are known as *sharps*, *betweens*, *blunts*, according to the relative fineness of their points.

The so-called *golden-eyed* needles are tinted by dipping in an ethereal solution of gold.

The *silver-eyed* needles are not really silvered, but the silvery hue is given by a peculiar polish.

The *blue-pointing* is a dark polish effected by applying the needles to a revolving stone of a bluish color.

The *drilled-eyed* needles have the eyes finished by a countersink drill, the eye end being previously softened.

Bell's *needles*, English patent, are made of steel, *cast* in sand molds.

The mode is particularly intended for bodkins, fish-hooks, knitting, netting, packing, and sail needles.

2. (*Surgical.*) The *acupuncture*-needle is a gold or silver needle, four inches long, with a handle. See ACUPUNCTURATOR.

The *cataract*-needle is a steel, inflexible needle, 15 to 24 lines long, and is employed to depress or tear the opaque crystalline lens. The extremity may be as in Scarpa's and Langenbeck's, pointed, prismatic, triangular, and curved. In Duputren's and Walther's, flat, curved, and sharp-edged. In Hey's, flat, with a sharp end. In Beer's, Siebold's, Schmidt's, Himly's, Von Gräfe's, straight and spear-pointed. A mark is placed on the handle to indicate the side corresponding to the crystalline when the instrument is in the eye.

The *counter-opening* needle, or *acus invaginata*, is a long, narrow steel needle with a point sharpened on both sides. The heel has an aperture to receive a thread or tape. It has a sheath to cover the point in passing critical places.

The *fistula*-needle is a flat, flexible silver instrument, with a point at one end and an eye at the other to lead in a seton. Its side is grooved to form a leader for a bistouri. Also a steel instrument like a trocar.

The *hare-lip* needle is a small silver canula with a spear-point.

The *ligature*-needle has a point and eye, and was formerly used to pass a ligature around the artery and a portion of the integuments to suspend circulation prior to amputation. Or a steel curved needle with a lance-point and long eye to pass a ligature around a vessel. See LIGATURE-CARRIER.

The *seton*-needle, a long, narrow steel blade with a point and eye.

A *suture*-needle. For a twisted suture the hare-lip needle; a straight needle for stitching up after dissection; or a curved needle, flat on one side and with a sharp ridge on the other.

See also ACUS.

3. (*Nautical.*) *a.* The seaman's and sailmaker's needles are *seaming*, *bolt-rope*, and *roping* needles; they are three-sided.

b. The polarized steel of a mariner's compass.

4. (*Sewing-machine.*) The eye-pointed instrument for carrying thread through the cloth.

5. (*Weaving.*) A horizontal piece of wire with an eye to receive the lifting-wire in a Jacquard loom. See JACQUARD; PATTERN-CARD.

6. (*Hydraulic.*) One of a set of vertical square bars of wood in a timber frame in a weir. These *needles* stand close together, and close the opening which forms a sluice-way. They are capable of being removed separately to open a way for the water.

7. (*Hoisting.*) A beam projecting from a building, with a pulley at its outer end, the *fall* worked by a crab placed inside the building.

8. A tool for pricking the cartridge to make connection between the charge and the priming. See BLASTING-TOOLS.

See under the following heads: —

Aneurism-needle.
Astatic needle.
Betweens.
Blasting-needle.
Blunts.
Bolt-rope needle.
Cataract-needle.
Crochet-needle.
Darning needle.
Dipping-needle.
Epinglette.
Etching-needle.
Fissure-needle.
Knitting-machine.
Ligature-carrier.
Magnetic needle.
Mariner's-compass needle.
Needle.
Needle-beam.
Needle-case.
Needle-forceps.
Needle-guard.
Needle-gun.
Needle-making machine
Needle-telegraph.
Needle-threader.
Needle-wrapper.
Nerve-needle.
Netting-needle.
Roping-needle.
Sewing-machine needle.
Sharps.
Surgical needle.
Tag.
Tatting-shuttle.
Threader.

Nee'dle-bar. 1. (*Knitting.*) In a stocking-frame, a bar in which the needles are fitted with their leads.

2. (*Sewing-machine.*) The reciprocating bar to whose end the needle is attached.

Nee'dle-beam. (*Civil Engineering.*) A transverse floor-beam of a bridge, resting on the chord or girders, according to the construction of the bridge.

Nee′dle-bear′er. (*Surgical.*) A *porte-aiguille* forming a handle for a needle.

Nee′dle-car′ri-er. (*Surgical.*) A *porte-aiguille.*

Nee′dle-case. A book or wrapper in which needles are kept in the pocket or the work-table.

Nee′dle-file. A long, round, narrow file used by jewelers.

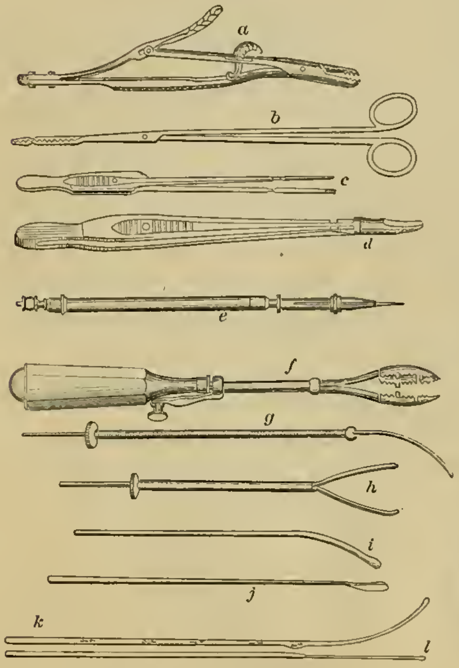
Nee′dle-for′ceps. An instrument to hold a needle to sew up wounds that cannot be reached by the hand, such as in vesico-vaginal fistula or uterine operations, or to hold very minute needles in operations about the eye or in staphyloraphy.

Sands's and Sims's, late American inventions, rank among the best.

a is a locking forceps.

b c d are forms used for general purposes of driving and holding needles, catching and twisting silver wires, applying and moving sponge-tents, etc.

Fig. 3306.



Needle-Forceps and other Instruments.

e is a draftsman's needle-holder.

f is a modification of Roux's needle-holder, which may be used in the operations of vesico-vaginal fistula, cleft palate, etc., and is made to serve as a handle to the instruments accompanying it, and which are manufactured one half their full length. When the handle is applied to either one it gives it its full length.

g combines the *applicator* with the sponge-tent expeller.

h is a sponge-holder and ligating forceps.

i, a lead sound, which easily follows the curve of the uterus.

j, intra-uterine scarifying knife, blunt point.

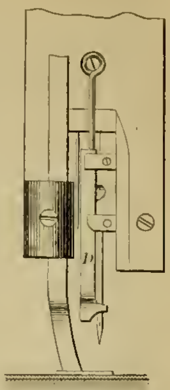
k, Simpson's sound.

l, uterine probe of silver.

Nee′dle-guard. (*Sewing-machine.*) A sliding piece which moves with the needle and keeps it in line during rapid movement, so that it shall not strike wide of the hole in the cloth-plate.

That in the example is a supporting brace or bar *D*, which slides vertically. In this instance, as the feed is effected by the needle, the bar has a lateral movement coincident with that of the needle.

Fig 3307.



Needle-Guard.

Nee′dle-gun. (German, *Zündnadelgewehr.*) A fire-arm which is loaded at the breech with a cartridge carrying its own fulminate, and which is ignited by a *needle* or pin traversing the breech-block and struck by the hammer.

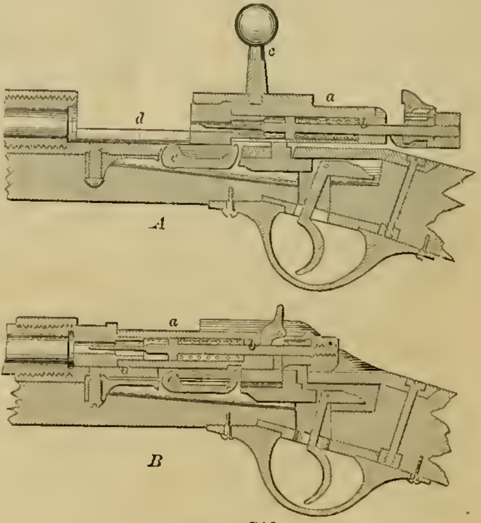
There are many guns of this construction, such as the converted Enfield (see CONVERTING); but the one which has attained so great celebrity, though by no means the best of its class, is the Prussian needle-gun, which performed so effective a part in the Prusso-Austrian war of 1866. See FIRE-ARM, cut *C*, Plate XVI. The French chassepot-gun is shown at *B*, same plate.

The Prussian piece was invented by Mr. Dreyse, who is said to have spent over thirty years in trying to construct a perfect breech-loading fire-arm.

It was introduced to some extent into the Prussian service about 1846, but was much improved afterward. It has since been superseded in the North German army by the Mauser rifle (Fig. 3308). *A* shows the breech mechanism in position for loading, and *B* at half-cock.

The breech-piece *a* is perforated to receive the needle *b*, and is operated by the lever *c*, by which it is turned quarter round and drawn backward, retracting the needle until a catch thereon drops into a notch by which it is retained until released by the action of the trigger, when it is driven forward by a spiral spring.

Fig. 3308.



Mauser Rifle.

An extractor works in a groove at the side of the shoe *d*, withdrawing the cartridge-case when the breech-piece is drawn backward. This movement brings the case in violent contact with the ejector *c*, by which it is thrown out.

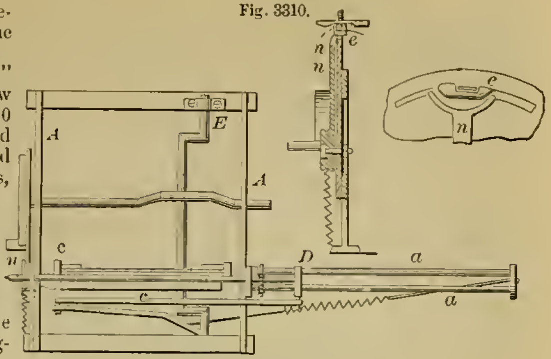
A Berlin correspondent of the London "Times" gives an account of the performance of this new arm: "On a distance of 1,500 metres (1,640 yards), out of 480 shots, 399 hits were effected in five targets placed behind each other; and on 1,400 metres (1,564 yards), out of 480 shots, 460 hits are reported."

Nee′dle-hold′er. 1. A draftsman's instrument for holding a pricking-through needle. (*c*, Fig. 3306.)

2. A surgeon's appliance for holding needles during operations. See NEEDLE-FORCEPS.

Nee′dle-in′stru-ment. (*Surveying.*) One which owes its accuracy and value to the magnetic needle only, such as the *plain* or the *Vernier compass* or the *Vernier transit*.

Fig. 3310.

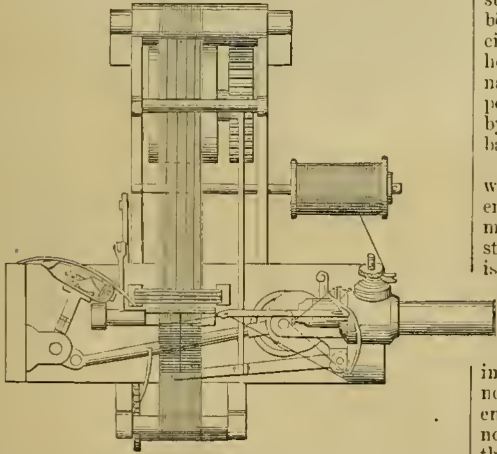


Earnshaw's Needle-Loom.

Nee′dle-loom. One in which the weft is carried by a needle instead of a shuttle. The usual form of loom for narrow wares, such as ribbons, tapes, bindings, etc. In the example, the filling is carried through the shed by a reciprocating eye-pointed needle, and the loop of the weft locked at the selvage by the passage through it of a shuttle and its thread. The weft-retractor swings freely on a pin; its shorter arm, when thrown fully back by a projection, rests in a notch on the needle-guide, until the pull of the needle passing through the shed detaches it and draws the retractor forward, taking up yarn from the bobbin.

The shuttle operates in an arc of a circle parallel to the plane of the warp, so that in approaching to enter the loop of the weft-yarn it moves nearly parallel with and close to the selvage of the web being woven, and afterward gradually moves away from the warp, so that in completing its movement at the same time as the needle completes its retiring movement it pulls its yarn or thread tight in a direction transverse to the warp.

Fig. 3309.



Robjohn's Needle-Loom.

In Fig. 3310, the needle is eye-pointed and the weft-thread is carried by it in lieu of a shuttle. A shuttle-thread engages the loop, and the rod is retracted, leaving two filling-threads in the shed. The needle-stock *D* slides on bars *a a* projecting from the side of the loom, and is actuated by a rocker-shaft *E*, a vibrating arm *c*, and connections. The ordinary cap-piece of the reed is removed to permit free manipulation of the warp. The shuttle *c* has a segmental guide groove, and is operated by a divaricated arm upon a rocker-shaft *n*, its two horns engaging the back end of the shuttle alternately.

In Jackson and Merrill's needle-loom, the weft-thread is carried by a needle through the shed and is interlocked by a shuttle-thread, returning to its normal position before the shed changes. The needle is passed through the under part of the shed near the reeds, so as to preserve it from contact with the warps. The needle then receives a swinging movement that passes its end around a standing shuttle or bobbin, the needle returning through the shed near the point of weaving, so that the lay has to move the weft-thread but a short distance.

See also RIBBON-LOOM; NARROW-WARE LOOM.

Nee′dle-mak′ing. Needles are made from soft steel wire, which is received from the manufactory in coils. The wire is cut by fixed shears into lengths sufficient to make two needles; these blanks, being bent, require straightening, which is done by placing several thousands of them between two broad heavy rings and heating them to redness in a furnace. They are then removed, and placed, still in position within the rings, on a flat iron plate, and by means of a curved bar, termed a *smooth file*, rolled back and forth until perfectly straight.

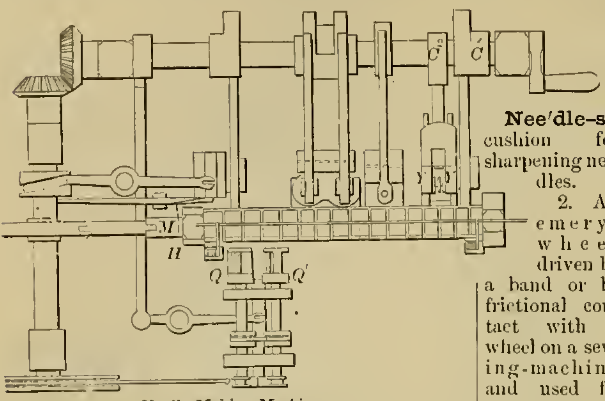
Each piece is then sharpened at both ends. The workman takes up a number at a time and holds the ends against a grindstone, forming the points. By means of a die and counter-die, two grooves are stamped by a press on each side of the wire, which is next pierced under a press with two holes, forming the eyes. A number of pieces are then strung on two fine wires and broken each in two by filing and bending. The roughness about the head is removed by filings, several at a time being placed in a small vise. During these processes the needles, having become somewhat bent, are straightened by rolling on a flat plate, as before. They are now brought to a red heat, and tempered by plunging them into oil. 50,000 at a time are then put in a canvas bag with emery, oil, putty-powder, and soft-soap, and rolled to and fro under pressure until they become bright.

The better class of needles have their eyes drilled. The final process is polishing the points, which is effected first by a rotating hone and afterward by a buff-wheel.

Nee′dle-mak′ing Ma-chine′. Of late years machines have been introduced by which needles are formed from the roll of wire without the intervention of hand labor.

Fig. 3311 illustrates Barton's machine. In this, the wire is fed forward to a rack *M*, and cut to length by the cutter *H*, being received in a groove of the bed-piece below the rack. The rack has a reciprocating movement both longitudinally and vertically; the latter serving to pick up the blank from each groove in the bed-plate, and the former to advance it to the next groove. At each groove it is subjected to the action of a die or punch, which dies successively form the groove for the eye and punch the eye. These are operated by the cams C^1 C^2, etc. It is then in the same way advanced, so as to be milled by the milling-tool *Y*, after which it is brought back, and while partially held by the reciprocating rack its point is finished by the revolving sharpeners *Q Q'*.

Fig. 3311.

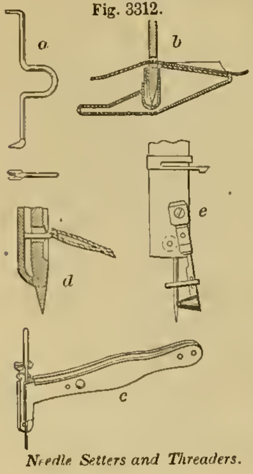


Needle-Making Machine.

Nee'dle-pa'per-ing Ma-chine'. (*Metal-working.*) The needles are placed point foremost in a hopper whose bottom is divided by partitions forming spaces corresponding in width to the length of the needles. The hopper has a traversing motion by which the needles are arranged in rows, and on arriving at the proper point a pusher is caused to strike the end of each row, sticking the needles in the paper, which is advanced and crimped as they are presented to it.

Nee'dle-point'ing Ma-chine'. This comprises a grooved grindstone, to which the wires, cut to the desired length, are applied by an inclined plane. A disk covered with rubber revolves transversely to the grindstone, turning the needles round so as to present each point of their circumference to the stone, at the same time continuously furnishing a fresh supply for its action.

Fig. 3312.



Needle Setters and Threaders.

Nee'dle-set'ter. An attachment to a sewing-machine to allow the needle to be set in its bar, so that the eye of the needle shall be at the proper distance from the end of the bar, in order that the loop may be properly formed and at the right place for the hook or shuttle beneath the fabric. Fig. 3312 shows several forms.

a is a trial bar, whose upper end rests against the needle-bar and its lower point in the eye of the needle.

b is a shield which fits against the eye of the needle and has a channel to lead the thread.

c is a clasp to hold the needle, a point determining the position of the latter in the clasp which is placed against the needle-bar in adjusting the needle.

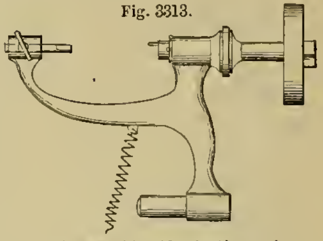
d has a bar with a hook to draw the thread through the needle-eye.

e has a latch which is brought down when required to indicate the adjustment of the needle in the stock.

Nee'dle-sharp'en-er. 1. An emery cake or cushion for sharpening needles.

2. An emery-wheel driven by a band or by frictional contact with a wheel on a sewing-machine, and used for pointing needles.

Fig. 3313.



Sewing-Machine Needle-Sharpening Attachment.

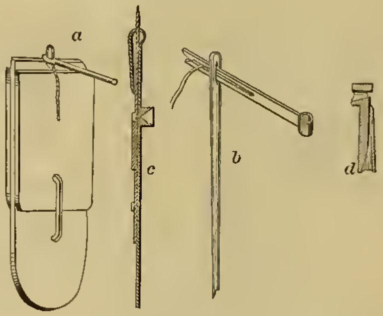
Nee'dle-tel'e-graph. A telegraph in which the indications are given by the deflections of a magnetic needle whose normal position is parallel to a wire through which a current of electricity is passed at will by the operator.

In practice, the needle is rendered astatic (see Astatic Needle), and inclosed by a coil by which the effect of the electric current is multiplied. This is the principle of the *galvanometer* and of the electric telegraph of Cooke and Wheatstone, which is used in England. See Indicator-telegraph.

Nee'dle-thread'er. A device to assist in passing a thread through the eye of a needle. There are two kinds, and many varieties of a kind.

a is a form in which the thread is caught in a crotch and pushed through the eye of the needle.

Fig. 3314.



Needle-Threaders.

In *b* it is caught by barbs and drawn through the eye.

In *c* and *d* the needle is adjusted opposite to a cone which directs the thread.

Nee'dle-wrap'per. A case or housewife to hold needles for the pocket or work-table.

Neg'a-tive. 1. (*Photography.*) A picture upon glass, in which the lights and shades are exactly reversed; the actual shades being represented by the transparent glass, the lights of the object showing dark by the opaque material (reduced silver) on the glass.

The *negative* is used to obtain *positives*, being laid upon the sensitized paper which is acted upon by the sun's rays passing through the glass. The rays being but little impeded by the transparent portions make the darks of the *positive*, and being intercepted by the opaque silver make the lights and light shades of the positive picture.

Negatives are usually taken on glass coated with a film of collodion, which is sensitized for the purposes of the camera. The principal use of negatives is for obtaining positive prints.

2. (*Electricity.*) The metal or equivalent placed in opposition to the *positive* in the voltaic battery.

The *negative* may be coke, carbon, silver, platinum, or copper, and forms the *cathode.*

The *positive* is usually zinc, and its pole is the *anode.*

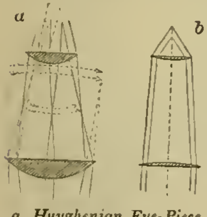
In the following order of metals the most negative is at the head of the list: —

Platinum.
Gold.
Antimony.
Silver.
Nickel.
Bismuth.
Copper.
Lead.
Iron.
Tin.
Cadmium.
Zinc.

Neg′a-tive-bath. (*Photography.*) The *bath-holder*, also known as the "bath," is a vessel used to contain the nitrate of silver solution, or bath used by photographers for making negatives. It is made most commonly of glass, but also of hard rubber and porcelain, and sometimes wood covered with asphaltum and other substances. Formerly, horizontal baths were used for large plates; these were tilted so as to throw the fluid to one end, the plate was then introduced with the collodion side upward, and the fluid allowed to return in an even wave over its surface by restoring the bath-holder to the horizontal position. Upright bath-holders are now almost always used. The best are made of glass, blown and pressed for negative plates of moderate dimensions, and constructed of pieces of thick plate-glass cemented together for larger sizes, protected externally with a strong covering of wood. The length and depth of such a vessel must suit the negative plate which is to be immersed in the upright column of solution; its width may vary from three quarters of an inch to two or even three inches. The latter, though less economical of solution in the first instance, are more so in the long run.

Neg′a-tive Eye-piece. The *Huyghenian*, or *negative eye-piece*, *a*, is the usual combination of lenses at the eye-end of a telescope or microscope. It was designed by its inventor to diminish the spherical aberration by producing the refractions at two glasses instead of one, and also to increase the field of view. It consists of two plano-convex lenses, the eye-glass and the *field*-glass, each of which presents its convex side towards the object-glass.

Fig. 3315.



a. Huyghenian Eye-Piece (Negative).

The glasses are separated from each other by about half the sum of their focal distances, the image viewed by the eye being formed between the two lenses.

b shows the *positive* eye-piece, in which the convex sides of the lenses are turned toward each other. See Positive Eye-piece.

Neg′a-tive-well. A name for an absorbing or draining shaft, bored or dug in the ground and used to carry water through a retentive to a porous stratum in which it may escape. See Absorbing-well; Drain-well.

Nei-gel′li-cloth. An Indian fabric made of *pat* or *sunn* hemp. *Crotalaria juncea.*

Ne-o-mon′o-scope. An instrument for magnifying photographs. Invented 1862.

Ne-paul′-pa′per. A strong, unsized paper made in Nepaul from the pulverized bark of the *Daphne papyraceæ.* Made many yards square.

Ne′phel-o-dom′e-ter. An instrument for ascertaining the distances of the clouds.

Ne′phel-o-rom′e-ter. An instrument for ascertaining the speed and direction of motion of the clouds.

Ne-phel′o-scope. An instrument contrived by Professor Espy to illustrate the law of the formation of aqueous vapor into clouds.

Nerve In′stru-ments. Dentists' instruments for obliterating or extracting the nerve in the root of a tooth.

Instruments for excavating and filling nerve-cavities are *burs, drills, excavators,* and *pluggers.*

Fang-fillers, canal-pluggers, pulp-canal reamers, probes, are also used about the nerve-canal, their purposes being indicated by their names. See Bur-drill.

Nerve-nee′dle. 1. (*Dental.*) A tool used for broaching out the nerve-canal to enable it to hold a dowel-pin which secures an artificial crown to the root of a natural tooth. See Broach.

2. (*Surgical.*) An *esthesiometer* is an instrument with a pair of needles, to ascertain the tactile sensibility of different parts of the body. It has two points, adjustable as to distance, and the object is to ascertain the nearest proximity at which the points give distinct sensations. The distances vary much at different parts of the body. See Esthesiometer. See also Neurotome.

Nest. 1. (*Gearing, etc.*) A connected series of cog-wheels or pulleys.

A set of articles of diminishing sizes, each enveloping the one next smaller in size; as a nest of crucibles, tubs, or the like.

2. *a.* A place for hens to lay. The ingenuity is scarcely appreciated by the hens, who have a modest preference for hiding upon such occasions.

The same may be said of the elaborate preparations for canaries during confinement.

b. A box for martins or sparrows on a post or in a tree.

Net. 1. A device for catching fish, birds, or other animals. It is made from a texture woven or knotted with large interstices or meshes.

Johnson defines network to be "anything reticulated or decussated with interstices between the intersections." The fabric is also used for securing or containing articles of various kinds. The *dip-net* is made in the form of a bag, the mouth of which is distended by a hoop, and is provided with a handle.

When long and narrow, having floats on one side and sinkers on the other, so as to prevent the escape of fish in shoal water, it is called a *seine.*

Nets were used by the ancients for fowling, hunting, and fishing. They were usually made of flax or hemp, and were large or small according to the purpose intended.

Nets extended on stakes and forming a corral are mentioned by the Roman writers.

A purse or tunnel net was used at the end of wing-nets.

Six kinds of fishing-nets are mentioned by Oppian.

Three of these were casting, landing, and drag nets.

The *seine* (*Sagena*) is a Greek net in name and in form.

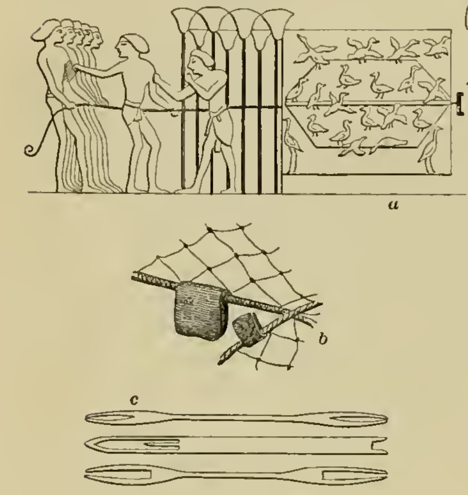
Corks or wooden blocks, to float the upper edge of a net, and weights to depress its lower edge, are seen in Egyptian paintings; exist on an old Egyptian net now in the Berlin Museum; and are mentioned by Pliny, Ovid, and other writers.

The Grecian fishing-nets also had corks and leaden weights.

Fishing was a great business in Egypt, and a painting in a tomb near the Pyramids represents a large drag-net, with floats and sinkers, in the act of being hauled by seven men, who stand on a decked boat and act under the direction of an overseer. *b* is a portion of a net with sinkers, from the Berlin Museum.

a, Fig. 3316, is an illustration from a painting in a tomb at Thebes, showing the mode of trapping the wild goose, which is still common on the banks of the Nile. It is similar to the common clap-net, and the rope was pulled by men secreted behind the reeds. The view shows the birds settling in the net, and a man standing behind the reeds enjoining silence. Another man stands directing the men. The reed represented is intended for the papyrus.

Fig. 3316.



Egyptian Nets and Netting.

The ancient Egyptians made bird-nets of split reeds. Such were used in catching quails by the unfortunate outcasts on the edge of the desert forming the boundary between Egypt and Syria. This community, if it can be so called, was made up of robbers who were banished by Actisanes the Ethiopian, who was then on the throne of Egypt. Actisanes had a scruple on the subject of the death penalty, and adopted the practice of cutting off the noses of robbers and banishing them to a land where they had very hard work to obtain a living, and could disturb nobody.

c shows an ancient Egyptian netting-needle, found in Thebes, and now in Mr. Salt's collection. Their netting-needles were of wood, very like our own, split at each end, and between 10 and 11 inches in length. Others were of bronze, and the slightly elastic prongs would close except when the twine passed. Their nets were of flax twine. Pieces have come down to our day, and are preserved in the European museums.

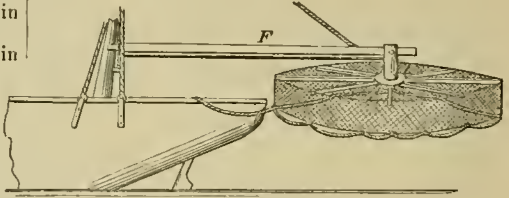
A netting-needle of wood, charged with the original thread, was found among other articles in a lady's work-basket.

In *netting*, the threads or cords are tied into hard knots at their intersections, so as to form meshes, which always continue of the same size.

The French government, in 1802, offered a reward of $10,000 to the person who would invent a machine for making knotted nets. It was adjudged to M. Buron, but the machine has not come into general use.

Fig. 3317 illustrates a device for casting a circular net. The net is extended upon a bolt beneath a boom *F*, and is cast by withdrawing the bolt.

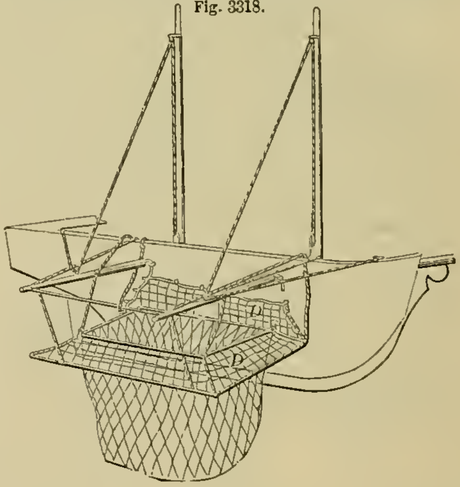
Fig. 3317.



Drop-Net.

In Fig. 3318, the net is suspended by booms from the vessel's side, and has a flanged edge *D*, which is raised when the net is "drawn," to prevent the escape of fish.

Fig. 3318.



Bag-Net.

2. A kind of lace made by machinery.

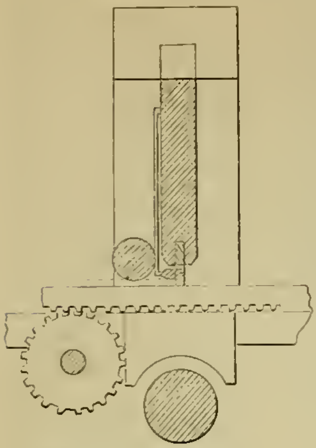
In the last century various kinds of these fabrics were made; called *whip-net*, *mail-net*, *patent-net*, *drop-net*, *spider-net*, *balloon-net*. The present varieties, deriving their name from the kind of mesh, are Point-net, Warp-net, and Bobbinet (which see).

Several varieties of machine-made *net* are named from some peculiarity of fabrication.

Broad-net is woven the whole width of the machine.

Quillings are narrow strips, of which many may be made simultaneously in the breadth of the machine.

Fig. 3319.



Machine for cutting Fly-Nets.

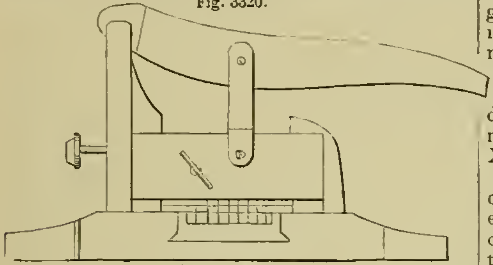
Fancy-net has a pattern worked in with gimp by the Jacquard; or by hand, called *lace-running.*

3. A covering for horses in harness, to deter or dislodge flies. Such nets are made by a succession of short slits in quincunx order, so that when the piece of leather is stretched out, the slits expand into wide openings.

In Fig. 3319, the leather is fed upon an intermittingly moving cutting-board underneath a pair of knives arranged in a guillotine sash; a spring-block steadies the leather and prevents its being drawn up when the knives rise.

In Fig. 3320 the cutters are confined in a lozenge-shaped cavity by wedge-blocks and a set-screw. The cutters have metallic blocks between them by which the breadth of the laces is governed. The knives are depressed upon the leather by a lever, and the leather is then drawn through beneath them.

Fig. 3320.



Fly-Net Machine.

Other nets are of cord, made in the manner of fishing-nets by shuttle and mesh-stick.

A substitute for nets for horses consists of leather strings, with a few bands to keep them in place at their proper distance apart.

Net-ma'son-ry. Reticulated bond, the joints of which resemble in appearance the meshes of a net.

Net'ting. Open-work fabric for curtains or screens. See MUSQUITO-CANOPY, etc.

Net'ting-ma-chine'. Lace is said to have been first made by machinery in 1768 by Hammond, a stocking-weaver of Nottingham, England, who invented what was known as the *pin-machine*, for making single-press point-lace in imitation of Brussels ground.

The *warp-frame* for making warp-lace was introduced in 1782. The first attempt to make bobbinet by machinery was in 1799, but no successful machine was produced prior to 1809, when Heathcote patented his machine, in which, by means of bobbins, a series of diagonal weft-threads are passed around and intertwisted with the parallel threads of the warp. Many subsequent improvements were made on this machine, which has been variously modified to produce different kinds of netted fabrics, among which we may enumerate —

The bobbinet-machine.
Lever-machine.
Straight-bolt machine.
Circular-bolt machine.
Traverse-warp machine.
Twist-machine.
Pusher-machine.

The *warp-machine*, based on the stocking-frame, was invented about 1795, and is employed in making lace, and also knit jackets, "Berlin" gloves, and similar articles. See BOBBINET-MACHINE; LACE-MAKING MACHINES.

Net'ting-nee'dle. A shuttle used in netting. One from the tombs of ancient Egypt is of the same form as used at the present day. (*c*, Fig. 3316.) See also TATTING-SHUTTLE.

Net'tings. (*Nautical.*) Nets of small rope used on board ship for various purposes, such as holding the hammocks when on deck, or for stowing sails. Also for hanging between the bulwarks and the rigging to repel boarders.

Net'tle-cloth. (*Fabric.*) A thick cotton stuff, japanned, and used as a substitute for leather.

Net'tling. (*Rope-making.*) *a.* A process whereby two ropes are joined end to end, so as to appear as one. The ends are scutched or beaten out, and spun or twisted together.

b. The tying of the yarns in pairs to prevent their becoming entangled or confused when laid upon the posts in the ropewalk.

Neu-rot'o-me. (*Surgical.*) A long, narrow scalpel, used by anatomists to dissect the nerves. *Neurectome.*

Erasistratus of the Alexandrian College of Surgeons, in the Ptolemaian period, wrote upon the nerves, and knew the distinction between those of motion and those of sensation. — *Ency. Brit.*, II. 751. Rufus of Ephesus, who was probably contemporary with Trajan, in his works on anatomy, divided the nerves into those of sensation and of motion. — *Nouvelle Biographie Générale,* Tome XLII. p. 882.

Nevertheless, Sir Charles Bell and Mr. Mayo are credited by Whewell (History of the Inductive Sciences, III. 425) with the discovery "that the two offices of conducting the motive impressions from the central seat of the will to the muscles, and of propagating sensations from the surface of the body and the external organs of sense to the sentient mind, reside in two distinct portions of the nervous substance."

New'el. 1. (*Carpentry.*) The post at the head or foot of a stairs, supporting the hand-rail.

The center-post of a winding stairs is a *solid newel.* Winding stairs around a central well are said to have an *open newel* or *hollow newel.*

2. (*Shipwrighting.*) An upright piece of timber to receive the tenons of the rails that lead from the breastwork of the gangway.

New-sand. (*Founding.*) Facing-sand.

News'pa-per. The newspaper, like many other useful inventions, seems to have originated in China. The Pekin "Gazette," the oldest daily in the world, was first issued about A. D. 1350. This is still in existence, and is an official journal, containing such information as the government chooses to make known. It is composed of three parts: 1. The court journal, or "copy of the door of the palace," which announces day by day the list of functionaries on duty, the actions of the emperor, the presentations, visits, departures, etc.; 2. The imperial decrees; 3. The reports of the great officers of the crown. It forms a pamphlet of 20 to 40 pages of coarse paper, printed from wooden types on one side only, and having a paper cover. It has a circulation of many thousand copies, which are distributed to subscribers in the city or sent in packages to the provinces. The subscription price is about $6 per year, but many copies are hired for the day and returned in the evening.

In the last century the Jesuits introduced copper types, rendering the paper much neater in appearance, as well as saving labor; but in 1820 the wooden type previously used was again brought into requisition.

Its contents are often of a curious nature. Recently a petition appeared, praying the emperor to confer a title of honor upon a female spirit who had performed various services, such as filling with water the channel of a river in a dry season, and destroying or dispersing bands of rebels. The rage for obtaining office, and the practice of stealing after obtaining it, indicate that China is not, in some respects, behind countries claiming a higher degree of civilization. The oldest applicant recently gazetted, aged 102 years, passed his civil-service examination with eclat, and numerous others are over 90, none of the juniors owning up to less than 70 years. A general is denounced for conducting but 3,000 men against the rebels instead of 5,000, the number for which he drew pay, pocketing the difference.

The origin of newspapers in Europe may be traced to the "Notizie Scritte" of Venice, written sheets, containing news items, etc., which still maintained their circulation at a comparatively recent period, owing to the restrictions placed on the press in Italy.

To Germany and England are due the first printed periodical publications.

The first English newspaper authentically known was entitled "News out of Holland"; it was established in 1619, and published at irregular intervals. This was succeeded by "Certaine News of the present Week," the first number of which was issued May 23, 1622, and was followed within the next five years by a number of other regularly published journals.

During the period of the Commonwealth and the Restoration their number multiplied, but none appear to have been published oftener than once a week until about the reign of Queen Anne, when the demand for news from the Duke of Marlborough's army led to their being issued tri-weekly.

The first London daily was the "Courant," published by Samuel Buckley in 1703. The first established newspaper in England, outside of London, is believed to have been the "Norwich Postman," 1706.

The first actually published in Scotland was at Edinburgh in 1654.

The "Dublin News-letter," the earliest Irish paper, was established in 1685.

In the United States a newspaper was attempted as early as 1690. The first number was dated September 25 of that year, but its farther issue was prevented by the colonial government, it being "published contrary to law, and containing reflections of a very high nature." In 1704 the "Boston News-letter," published "by authority," was established by John Campbell, and in 1719 the "Boston Gazette," also "by authority." To these succeeded the "New England Courant," by James Franklin, a brother of the Doctor. Andrew Bradford founded a paper at Philadelphia in 1719, and his father, William Bradford, issued the first newspaper published in New York, the "New York Gazette," in 1725. From this period they multiplied rapidly in the Colonies.

The common name "Gazette" is derived from the name of a Venetian coin, worth about a cent and a half, and which was the price of the Venetian newspaper first published.

The "Maryland Gazette" was established in 1727 or 1728; the "Virginia Gazette," 1736; the "Rhode Island Gazette," 1732; "South Carolina Gazette," 1731 or 1732; "Georgia Gazette," 1763.

The first paper in New Hampshire was published in 1756, but in the adjacent State of Vermont none existed prior to 1781.

After the Revolution, the history of newspaper progress becomes identical with that of the nation, the printing-press keeping closely in the van of Anglo-American civilization.

The honor of publishing the first paper west of the Alleghanies is claimed for John Scull of Pittsburgh, who, it is stated, founded the "Pittsburgh Gazette" in 1783.

The first north of the Ohio River, being the third or fourth west of the Alleghanies, is said to have been the "Centinel of the Northwest Territory," by William Maxwell, 1793.

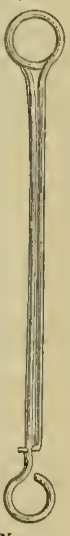
According to De Saint Foix, the earliest French newspaper, called the "Gazette de France," was established by Renaudot, a physician, who obtained a royal grant of the exclusive privilege of publishing the same for himself and family. He had previously been in the habit of collecting information and circulating news-sheets among his patients.

The first German newspaper was established at Frankfort in 1615. An illustrated war gazette, the "Niewtijdinge," published in the Low Countries, had, however, preceded this by ten years.

In Sweden, a newspaper was published as early as 1643, entitled the "Ordinarie Post Tidende."

Journalism in Spain and Italy, owing to the lack of general education, and restrictions on the liberty of the press, has, until recently at least, remained in rather a backward state. In the former country newspapers issued at irregular intervals were published during the seventeenth century, but those appearing regularly do not seem to have been introduced until the next; and in Italy, though never entirely suppressed, their continuance under the depressing influences by which they were surrounded, produced no one of extensive circulation or influence.

Fig. 3321.



Newspaper-File.

The same may be said of Russia, where the periodical press was first introduced under the auspices of Peter the Great; and of Turkey, whose first newspaper only dates back to 1795.

News'pa-per Ad-dress'ing-ma-chine'. A machine for printing addresses on newspaper wrappers or attaching printed labels to newspapers or their wrappers. See ADDRESSING-MACHINE.

News'pa-per-clamp. A means for fastening newspapers to a back, in temporary cover, or on a desk, so as to preserve them in a convenient condition for reference. See PAPER-FILE.

News'pa-per-file. A clamp to hold newspapers by the folded edge in convenient condition for reference and preservation. The two rods spring apart, but are retained by a hook. See PAPER-CLAMP.

News'pa-per Fold'ing-ma-chine'. A machine for folding newspapers for mailing. See FOLDING-MACHINE.

New-to'ni-an Tel'e-scope. A form of the reflecting-telescope, in which the rays are reflected from the surface of the object-mirror and intercepted by a small oval mirror placed in the axis of the tube at an angle of 45°. The image which would have been formed in the axis is thereby deflected and is viewed by an eye-piece attached at a right angle to the side of the tube. See REFLECTING-TELESCOPE.

The small mirror is fixed on the end of a slender arm connected to a slide, by which it is made to approach or recede from the large speculum, as may be required. See TELESCOPE.

Nib. 1. (*Husbandry.*) The handle of a scythe-snath. It has a ring slipping on the snath and tightened by a bolt or wedge.

2. (*Locksmithing.*) A separate adjustable limb of a permutation key.

3. *a.* One of the points of a pen. Pens have usually two nibs, but Perry's have three.

b. A small pen adapted to be placed in a holder for use. The usual form of steel pens. Quill nibs are also made and similarly held for writing. Such *quill nibs* have no *barrel*, as the cylinder of the quill is called. Steel pens having a cylindrical shape to hold on to a round stick are called *barrel-pens.*

4. The point of a crow-bar.

Nib'bling. (*Lens-making.*) Reducing a blank of glass to roundness preparatory to grinding it for a lens. The operation is performed by a pair of flat pliers of soft iron, called *shanks*, which crumble away the edge of the glass and do not slip, as tools with steel jaws would be apt to do.

Niche. (*Architecture.*) A hollow or alcove in the face of a wall for a statue, clock, etc.

Nick. 1. (*Printing.*) The notch on the bottom edge of the shank of a type, forming a guide to the compositor in *setting.*

2. The slit in the head of a screw at which the screw-driver is applied.

3. A notch or incision at a measured distance on an object. A cut to form a starting-point for a kerf.

Nick'el. Equivalent, 29.6 ; symbol, Ni. ; specific gravity, 8.279, which is increased by hammering to 8.82. Fuzes at about 2,800° F. A brilliant, silver-white, ductile metal discovered by Cronstedt in a mineral derisively termed by the miners *nick* or *copper-nick*, on account of its resembling copper ore in appearance, but disappointing them by yielding no copper.

Its ores are found in many parts of the world ; in America they have been discovered in Massachusetts, New York, New Jersey, Pennsylvania, Connecticut, Tennessee, Missouri, and Canada. The principal are smaltine or smaltite, from which smalts, zaffre, and cobalt are also extracted ; the residue after calcination, called *speiss*, yields some 50 per cent of nickel. Copper nickel contains about 45 per cent of nickel and a large amount of arsenic.

Millerite, a sulphide of nickel, containing 65 per cent of nickel and 35 per cent of sulphur, is found in New York and Pennsylvania, and is largely mined in the latter State.

Pyrrhotite, a species of sulphide of nickel, though containing but a small percentage, from 3 to 6 per cent of the pure metal, is so abundant and widely distributed as to constitute a principal source of supply.

The metal is also found in meteorites in proportions varying from 1 to 20 per cent.

Nickel acts upon the magnet, but more feebly than iron ; when heated to 350° F. it loses this power.

Its chief use is in alloys and for plating. It enters into the composition of albata, packfong, or tutenag, German-silver, and numerous other alloys having specific names conferred by their compounders.

The common varieties have 3 to 4 parts nickel : 20 copper ; and 16 zinc.

The finer varieties, 5 to 6 parts nickel ; 20 copper ; 8 to 10 zinc. (See ALLOY.) The pure metal is used for plating, and some of its alloys, containing a large proportion of the metal, for small coin.

In the ordinary process of reducing nickel, the ore is coarsely ground and roasted, mixed with ground fluor-spar, and treated with three times its weight of sulphuric acid, being at the same time gently heated and agitated in a leaden vat. Any hard mass resulting is broken into small pieces, calcined in a reverberatory furnace, and dissolved in hot water, extricating the sulphate of lime. The solid residuum contains several metals, which are separated by first dissolving it in a mixture of nitric and sulphuric acids, and allowing it to stand until crystallization ensues ; the crystals are now dissolved in water, and the iron precipitated by carbonate of soda ; copper is precipitated by a current of sulphureted hydrogen gas, and cobalt is separated by chlorine, which forms a chloride of nickel, leaving the cobalt free. The chloride is then treated with bicarbonate of soda in solution, evaporated and dried and calcined. The carbonate of nickel thus formed is mixed with charcoal and fluor-spar or other flux, and exposed to intense heat, which produces the metal in a state sufficiently pure for ordinary purposes. It may be obtained chemically pure by the application of a jet of hydrogen gas to the carbonate in process of reduction.

Nick'el-plat'ing. The surfacing of metals with nickel to render them less liable to oxidation by heat or moisture. The operation is effected by a heated solution or in the electro-bath. It has been applied to many articles, such as gas-tips, barrels, and other metallic portions of fire-arms, sieves exposed to water, culinary vessels, type-facing, buckles, and other hardware, buttons, etc., etc.

Kirwan, in 1782, precipitated nickel from its solutions. He says: "Zinc precipitates nickel from the marine acid. Iron clearly precipitates nickel from the nitrous acid." (*Phil. Trans*, Vol. LXXVII. pp. 73-84.)

Golding Bird in 1837 describes the electro deposition of nickel and other metals by the action of long-continued currents of low tension. (*Phil. Trans*, Vol. CXXVII. pp. 37-45.)

Shore, 1840, used a solution of nitrate of nickel in one compartment of battery, and weak sulphuric acid and zinc in the other, for deposition of nickel.

An alloy of nickel and tin made by melting under borax and glass was used for coating iron plates by Richardson and Braithwaite, 1840 The alloy was applied melted, as in tinning iron.

Alfred Smee made an electro deposition of nickel in 1841. (*Smee's Elements of Electro-Metallurgy.*)

Böttger, in the "Journal für Praktische Chemie," Vol XXX. p 267, 1843, says that among all the salts of nickel the ammonio sulphate of protoxyde of nickel is especially useful in plating brass and copper, and is much superior to cyanide nickel of potash, as recommended by Ruolz He proceeds at some length to state the effectiveness of the battery in producing a deposit of nickel on copper in half an hour, which would deflect the needle, and preserve the lower metal from the effect of nitric acid more perfectly than a coating of gold deposited in the same time.

Parkes, 1845, melted an alloy of nickel with a flux for coating metal plates.

Junot, 1852, alloyed silicum, titanium, tungsten, etc, with nickel for electro deposition.

Thomas, 1854, used ferro-cyanide of potassium and nitro-muriatic acid to obtain a nickel solution for the battery. In 1855 he used the same, with carbonate of ammonia and oxide of alumina.

Cheatley, 1855, deposited alloys of nickel by a battery (British patent 1543, of 1855).

An alloy of nickel was applied to iron plates by friction and heat by Barron in 1856

Shepard, 1858, deposited an alloy of silver and nickel The solution is made by adding carbonate of ammonia to a solution of nitrate of silver, then a similar solution of carbonate of nickel in carbonate of ammonia. An anode of one part silver and two parts nickel is used Cyanide of potassium may be used in the battery.

Adams, United States patent No. 57,271, 1866, coats gas-tips with nickel. Same, 1869, uses solution of sulphate of nickel in solution of sulphite or bisulphite of ammonia. Same, 1869, effects electro deposition by a solution of double sulphate of nickel and ammonia, free from acid or alkaline reaction. He uses a nickel and iron anode His patent, No. 102,748, claims the use of a nickel anode combined with carbon. Patent of 1871 uses a heated battery

Dr Adam's process consists in the deposition by electro-magnetic agency of metallic nickel from either of three solutions: —

1, one formed of the double sulphate of nickel and alumina; 2, of the double sulphate of nickel and potash; 3, of the double sulphate of nickel and magnesia.

These solutions are preferably used at a temperature above 100° Fah., and must be so prepared and used as to be free from any acid or alkaline reaction. For this purpose care must be taken to avoid the use of too high a battery power or the introduction of any foreign matter into the solution.

In Nagel's process, two parts of sulphide of the protoxide of nickel and one of ammonia are combined to form a double salt: this is dissolved in water, and a solution of ammonia added. The deposition is effected by a battery having a platinum positive pole, the solution being heated to about 100° Fah. Coating with cobalt is effected in an analogous way.

It has been proposed to color the nickel during deposition from a similar solution by using two anodes, one of iron, the other of nickel. If the coating indicates an excess of either metal, the corresponding anode is raised partially or wholly from the solution until the proper combination is produced.

Nickeling. Professor Sharples says: "The double sulphate of nickel and ammonium, which is the salt that is generally used, may now be had in commerce almost pure. Cast-nickel plates for anodes may also be obtained. The anodes should considerably exceed in size the articles to be covered with nickel. Any common form of battery may be used Three Daniell's or Smee's cells, or two Bunsen's, connected for intensity, will be found to be sufficient The battery power must not be too strong, or the deposited nickel will be black A strong solution of the sulphate is made and placed in any suitable vessel: a glazed stoneware pot answers very well, if the articles to be covered are small. Across the top of this are placed two heavy copper wires, to one of which the articles to be covered are suspended, to the other the anode. The wire leading from the zinc of the battery must then be connected with the wire from which the articles are suspended, the other battery wire being connected with the anode.

"In order to prepare the articles for coating, they must be well cleaned by first scrubbing them with caustic soda or potash, to remove any grease, and then dipping them for an instant in *aqua regia* and afterward washing thoroughly with water, taking care that the hand does not come in contact with any part of them This is accomplished by fastening a flexible copper wire around them, and handling them by means of it The wire serves afterward to suspend them in the bath.

"If the articles are made of iron or steel, they must be first covered with a thin coat of copper. This is best done by the cyanide bath, which is prepared by dissolving precipitated oxide of copper in cyanide of potassium. A copper plate is used as an anode. After they are removed from the copper bath, they must be washed quickly with water and placed in the nickel bath; if allowed to dry or become tarnished, the nickel will not adhere

"Great care must be used through the whole process to keep all grease, dust, or other dirt from the articles to be covered, or else the result will be unsatisfactory. The whole process is one of the most difficult that is used in the arts, it being far easier to gild, plate, or copper an article than to nickel it; but if due care be taken, the results will amply pay for the trouble." — *Boston Journal of Chemistry.*

Martin and Delamotte propose to use nickel salts with organic acids instead of those generally employed. The bath is prepared by dissolving 1,250 grams citric acid, 500 grams sal-ammoniac (or sulphate of ammonia), and 500 grams nitrate of ammonia in 15 liters of water. The solution is heated to 80° C., and gradually saturated with freshly precipitated hydrated protoxide of nickel. The heat is then removed, 2¼ liters of ammonia added, and water enough to make 25 liters, so that each liter of the bath contains about 50 grams of nickel. When cold, 500 grams carbonate of ammonia is added, the sediment allowed to settle, and filtered. The bath has a blue-black color, stands at 11° B., and is used at a temperature of about 50° C. Caustic potash or soda gives a thicker deposit.

In Professor Stolba's process, a quantity of concentrated chloride of zinc solution is placed in a clean metallic vessel, and to this is added an equal volume of water. This is heated to boiling, and hydrochloric acid is added drop by drop until the precipitate which has formed on adding water has disappeared. A small quantity of zinc powder is now added, which produces a zinc coating on the metal as far as the liquid extends. Enough of the nickel salt (chloride or sulphate) is then added to color the liquid distinctly green; the objects to be plated are placed in it, together with some zinc clippings, and the liquid is brought to boiling. The nickel is precipitated in the course of fifteen minutes, and the objects will be found to be completely coated The coating varies in luster with the character of the metallic surface; where this is polished, the plating is likewise lustrous, and *vice versa*

The following United States patents may be consulted: —

No. 57,271, Adams, 1866
No. 82,877, Remington, 1868.
No. 87,385, Winchester, 1869.
No. 90,332, Adams, 1869.
No. 90,476, Adams, 1869.
No. 92.337, Moore, 1869.
No. 93,157, Adams, 1869.
No 95,053, Smith, 1869.
No. 98,006, Adams, 1869.
No. 98,354, Crooke, 1869.
No. 100,038, Howard, 1870.
No. 100,961, Adams, 1870.
No. 102,748, Adams, 1870
No 103,201, Kuhns, 1870.
No. 106,823, Howard, 1870.
No. 109,475, Watrous, 1870.
No 113,612, Adams, 1871
No. 114 191, Parmalee, 1871.
No. 116,579, Farmer, 1871.
No. 116,658, Adams, 1871.

Nick'er. The cutting-lip at the circumference of a center-bit, which cuts in the wood the circle of the hole to be bored. The lip which removes the wood is the *router.*

Nick'ing-bud'dle. (*Metallurgy.*) A form of buddle used in washing lead ore.

Nick'ing-file. A thin file for making nicks in heads of screws.

Nick'ing-trunk. (*Metallurgy.*) A tub in which metalliferous slimes are washed. At the upper end is a trough which discharges a gentle sheet of water over a *nicking-board,* which divides the water into rills and gradually washes off the slimes, settling them on the flat surface of the table in the order of their respective gravities.

Nidged. Nigged; as ashlar.

Ni-el'lo. A method of engraving on gold or silver, which consists in running in along the engraved lines, while hot, a composition called *niello,* composed of silver and other metals more fusible than silver, as lead, copper, etc. This compound is of a black color. This ancient art was revived by the Italians about four centuries since, and in the practice of taking proofs of the work the art of copperplate printing was discovered. The suggestion seems first to have been improved by Tomasso Finiguerra.

The art is still practiced as a mode of ornamenting metal ware, but its principal use is in door-plates, plates for shop fronts, etc., in which the brass or zinc plates are engraved and the depressions filled with wax.

Nig'ged Ash'lar. (*Masonry.*) A building stone roughly dressed with a pointed hammer.

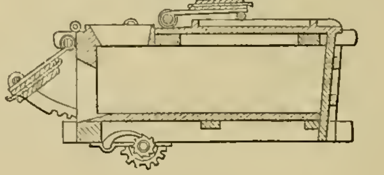
The tool is called a *scabbling-hammer,* and the operation *nigging* or *nidging.*

Nig'ger. (*Steam-engine.*) A steam-engine employed in hoisting; especially on shipboard and on the Western and Southern rivers.

Night-bolt. A spring-bolt in a lock, opened by a knob from the inside of the door, by a key from the outside, but capable of being fastened so as to be immovable from either side.

Night-cart. One employed in carrying away the contents of cesspools and privies. The example is the box of a cart with tightly fitting shutters at the rear part of the box. The upper shutter is held down by levers and holding chains. The discharge-shutter is pivoted at the upper edge and is operated by segmental racks and pinions turned by a hand-lever. The joints are packed to prevent leakage and confine the odor.

Fig. 3322.



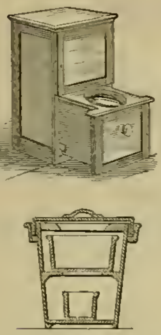
Night-Cart.

Some forms of carts are loaded by means of pipes and an air-exhaust. Barrels, in some cases, are substituted for cart-boxes, and are filled by means of the pressure induced by the condensation of steam which has previously driven the air from the barrels.

Night-chair. A Commode or Earth-closet (which see) for the sick-room. It is usually made like a chair with a pan in the seat and means for perfectly inclosing the contents, so as to prevent the emission of odor. A common form has a lid whose edge dips into a circular trough around the seat.

In the example, the covered pail contains a pan for the feces and one for the disinfectant which deodorizes the mephitic vapors.

Fig. 3323.



Disinfecting Night-Chair.

Night-latch. A form of door-lock in which the spring-latch may be opened by a key from the outside, or may be fastened shut so as to be immovable from the exterior of the door.

Night-light. A short thick candle with a small wick so proportioned as to burn in a little puddle oil of melted tallow without burning the paper envelope of the cylinder of tallow.

When made of spermaceti or stearine it has no envelope, and the wick is made to bend over in burning, being totally consumed so as not to drop ashes in the tallow. A *mortar.*

Nill. Scales of hot iron from the forge.

Ni-lom'e-ter. An instrument similar to a tide-gage for measuring the rise of the Nile during its periodical floods. One is situated on the island of Er-Ródah, and consists of a graduated pillar, upon which the hight of the water is read off. The pillar stands in a well which communicates with the river.

The rise of the Nile has always been a subject of great anxiety in Egypt, as upon the periodical saturation of the ground and the coating of soil which is left upon it, the success of the year's husbandry depends.

From the earliest historic period nilometers have been placed in prominent positions in Egypt, to enable the officers to watch the rise, which was proclaimed by criers.

Asama (a governor of Egypt under the Khalif Suleiman) erected the nilometer in the vicinity of what was afterward Grand Cairo, year Hegira 97.

"Citizen Langles has been employed in examining the various nilometers from Alouyah, above the cataracts, to Lower Egypt. He finds 15 between the isle of Elephantina and the mouth of the Nile." — *Nat. Institute of France*, 1800.

The rise seems to have been less in former times than now. In the days of Mœris it is said that 8 cubits were sufficient; 15 or 16 were required in the time of Herodotus, 453 B. C. At the present day 18 cubits is considered the lowest inundation at Cairo.

Hear the "Father of History": —

"One fact which I learnt of the priests is to me a strong evidence of the origin of the country. They said to me that, when Mœris was king, the Nile overflowed all Egypt below Memphis, as soon as it rose so little as 8 cubits. Now Mœris had not been dead 900 years at the time when I heard this of the priests; yet at the present day, unless the river rise 15 or 16 cubits, it does not overflow the lands. It seems to me, therefore, if the land goes on rising and growing at this rate, the Egyptians who dwell upon Lake Mœris, in the Delta (as it is called), and elsewhere, will one day, by the stoppage of the inundations, suffer permanently the fate which they told me they expected would some day or other befall the Greeks. On hearing that the whole land of Greece is watered by rain from heaven, and not, like their own, inundated by rivers, they observed, 'Some day the Greeks will be disappointed of their grand hope, and then they will be wretchedly hungry,' as much as to say, 'If God shall some day see fit not to grant the Greeks rain, but shall afflict them with a long drought, the Greeks will be swept away by a famine, since they have nothing to rely on but rain from Jove, and have no other resource for water.'" — Herodotus, II. 13.

Wilkinson, very unreasonably as it would appear, combats the idea of Herodotus, and states that the rise at Memphis has always averaged about 16 cubits; say 40 at Assouan, 36 at Thebes, 25 at Cairo, and 4 at the mouth of the river. See Wilkinson's "Herodotus," Am. ed., 2d Vol., pp. 252 – 254.

In the time of Pliny 12 cubits were a famine, 13 a scarcity, 15 was safety, 16 plenty. At the present day, 18 cubits is the lowest, and at this hight the canals are cut and distribution commences; 19 cubits are tolerable, 20 adequate, 21 excellent, 22 abundant, and 24 ruinous, as invading the houses and stores of the country.

The nilometer at Cairo has been erected for many centuries, but it is not nearly so ancient as that at Elephanta, which consists of a staircase between two walls descending to the Nile. One wall has engraved upon it a series of marks representing the hight to which the water has risen on certain occasions. The cubits here are divided into 14ths, or double digits, and measure 1 foot 8.625 inches. This nilometer was described by Strabo, 54 B. C.

The nilometer at Memphis was transferred by Constantine to a church in the vicinity of the Serapeum of Alexandria; Julian sent it back to the building at Memphis, where it remained till its destruction by Theodosius.

At the present day the rise is watched for with anxiety, and proclaimed by 4 criers.

The object of the nilometers formerly was to settle the amount of taxation to be imposed upon the country. It may still be the basis of the impost of taxes in that overridden country. *Eminent domain* there includes the land, the poor fellahs upon it, and the water.

The effect of the rise is a gradual elevation of the soil of the country, amounting to about 6 inches in a century at Elephanta. The land at that point has been raised 9 feet in 1,700 years; at Thebes about 7 feet, and less toward the Delta, where the periodical rise is about 4 feet. Many of the sites of antiquity are buried beneath the surface, and some of the ancient buildings yet remaining, which were originally placed outside of the cultivatable land, are now surrounded by arable tracts.

The cause of the inundation is the water that falls in Abyssinia in the rainy season. Homer and the Koran are right in ascribing it to water sent by God from heaven.

Calisthenes, the pupil of Aristotle, and afterward Agatharcides of Cnidus (2d century B. C.), and Strabo, ascribed it to the same true source, — the rainy season in Ethiopia.

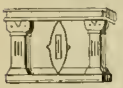
The rainy season in Ethiopia commences (Kenrick) about the spring equinox and prevails till after the summer solstice. The Upper Nile of course first feels the rise ; at Khartoom early in May ; at the Cataracts about the first of June. It becomes visible in Egypt about the middle of June. About the middle of August half the rise is attained, and the dikes are then cut ; the rise occupies about 100 days, as stated by Herodotus. The maximum is about the 25th of September. After remaining stationary for 12 or 14 days, it commences sinking, and is within its banks again about the 10th of November. Its minimum stage is about the middle of May ; the depth at Cairo is then about 6 feet.

The increase of the Nile during inundation is 9-fold its quantity during an ordinary stage. The rate of flow during inundation is 6 feet per second at E' Sinout, about the middle of Egypt ; during low water the rate of flow is from 1⅓ to 2 knots per hour. The immediate banks of the river are seldom covered, and serve as highways. The general breadth of the river is about ⅓ of a mile. It receives no tributaries after leaving Abyssinia, and consequently does not increase in size.

A *low* Nile causes famine. We read of such in Genesis ; one A. D. 1200, cited in Abdollatiph's History of Egypt ; two in 1784–85, mentioned by Volney. The latter was very destructive, and was caused by light rainfall in Ethiopia. Multitudes sought food in Palestine and Syria.

Nine-pin Block. (*Nautical.*) A block whose shell is spindle-shaped, resembling one of a set of nine-pins. Its ends are swiveled in an upper and lower bar, so that the plane of the sheave may be presented in any direction. It acts as a fair-leader under the cross-pieces of the bitts.

Fig. 3324.



Nine-Pin Block.

Ni-o'bi-um. Symbol, *Nb.* A rare metal, not specially useful in the arts. Once called *columbium.*

Nip. (*Mining.*) The gradual approach of the strata above and below a seam and terminating it.

Nip'per. (*Nautical.*) Strong seizings for binding the messenger to the cable, to form slings, etc. They are made from clean unchafed yarns drawn from unlaid rope.

Nip'per-gage. (*Printing.*) A ledge adjustable on the tongue of the feed-board of a power-press. Used in keeping the required margin uniform.

Nip'pers. 1. A grasping tool with cutting jaws. *b c d e f* show several forms with various presentations of the blades.

2. (*Dentistry, etc.*) The mechanical forceps or nippers used by dentists are for operating on the plates. The following cuts of the operative portions will explain their construction.

g, nipper for cutting off chambers and cutting off backings from plates.

h, nipper for cutting out plates.

i, punch for rivet-holes.

j, plate-bender for upper plate.

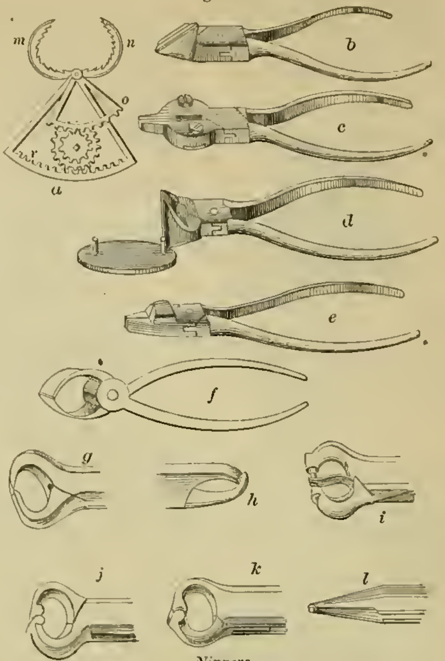
k, plate-bender for lower plate.

l, clasp-bender.

3. (*Hydraulic Engineering.*) Nippers (*a*) for cutting off the heads of piles under water consist of two serrated jaws *m n*, one attached to the small sector *o*, and the other to the large sector *r*. On each sector is a cogged arc engaged by two pinions on an axis which is perpendicular to the plane of oscillation of the nippers. A rotary reciprocation is imparted to the nippers, which cuts off the pile, the jaws being gradually approached by rotation of the axis and pinions as the teeth bury themselves in the wood.

4. (*Printing.*) The clasps which catch the sheet and conduct it to the form.

Fig. 3325

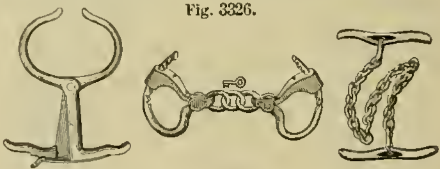


Nippers.

5. (*Wire-drawing.*) The tool for pulling the wire through the plate.

6. Hand-cuffs or foot-shackles for prisoners.

Fig. 3326.



Police Nippers.

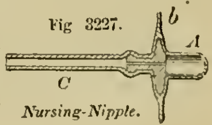
Nip'ple. 1. (*Machinery.*) A small, rounded, perforated protuberance ; as the nipple of a gun on which the percussion-cap is placed. A *teat.*

Solid, it is a stud, boss, knob, button.

2. The teat of a nursing-bottle.

Nip'ple, Ar'ti-fi'cial. 1. A concave shield of hard wood, ivory, or india-rubber, fitted to the breast. Inserted in its center is a cup to cover the nipple, made of india-rubber or prepared cow's teat. It is used by women with sore breasts as a protection, to prevent babies biting the nipple while sucking. A *nipple-shield.*

Fig 3227.



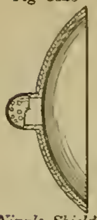
Nursing-Nipple.

2. A nipple attached to a milk-bottle for the infant. The nipple *A*, shown in the example, has a stop-flange *b* to keep it from passing too far into the infant's mouth. A perforated button is a means of attaching the india-rubber tube *C* to the nipple.

Nip'ple-seat. (*Fire-arm.*) The *hump* on the side of a barrel on which the nipple is screwed and through which the fire is carried to the charge.

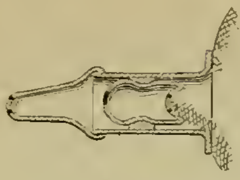
Nip'ple-shield. One for the protection of the mother's nipple, that it may not be bitten by the nursing infant. It has a cap of horn or vulcanite,

Fig 3328.



Nipple-Shield.

Fig. 3329.



Artificial Nipple and Shield.

and the nipple-shield is a fine, elastic, perforated membrane of india-rubber.

Or, as in Fig. 3329, the interior adjustable sliding screen limits the elongation of the nipple when suction is applied.

Nip'ple-wrench. (*Fire-arm.*) The spanner with sides which fit the square of the nipple, and which is used for screwing it to and unscrewing it from the barrel.

Ni'ril. The vibration or chattering of a turning-tool not accurately centered or fitted.

Ni'tric-ac'id Fur'nace. The nitric-acid furnace consists of a number of parallel horizontal cast-iron retorts, arranged in pairs, which connect by luted tubes with a series of receivers and two-necked Woulfe-bottles, wherein the fumes are condensed and collected.

The retorts are charged with nitrate of potash or soda and sulphuric acid. The resulting sulphate is scraped out after removing the end of the retort.

In the *gallery-furnace* the retorts are sunk in sand-pots whose lower surfaces are exposed to the heat of the furnace fire.

Ni-trine'. An explosive compound patented by Nobel, August 14, 1866; formed of glycerine, sulphuric and nitric acids, free of hypo-nitric acid.

Ni'tro-gly'cer-ine. *Nitroleum, glonoin,* or *blasting-oil.* Discovered by Sobreso, professor of applied chemistry at Turin, in 1847, and introduced into this country in 1864 by Nobel, a Swedish engineer.

An oily liquid of a specific gravity of 1.6, having a sweet aromatic taste, colorless when pure, but, as manufactured, it is usually light yellow. If heated up to 100°, no change takes place; heated gradually to 193°, it is decomposed, losing its explosive power. When not under pressure it burns quietly. Heating when confined may create a partial decomposition, and an explosion from the pressure thus generated. An electric spark will pass through it without causing explosion unless a series of sparks are passed through it until decomposition is caused and heat generated. Fire alone ordinarily will not explode it. Jarring nitro-glycerine, even when at a temperature of 50° C., will not explode it. Explosions occur: 1. When confined and heated to 180° C.; 2. If struck so as to create heat and pressure; percussion causes it to explode with difficulty when frozen, which takes place at 8°, but striking it when in that state with a sharp hard substance, as a pick, will then easily explode it. — *Journal of Applied Chemistry.*

It is prepared by successively adding small quantities of glycerine to a mixture of nitric and sulphuric acids and pouring the compound into water, when the nitroleum, which is insoluble in and heavier than water, falls to the bottom of the vessel.

The acids used should be of the purest quality, and great care taken to avoid the introduction of foreign matters; otherwise slow decomposition, which may finally result in spontaneous explosion, occurs. For this reason it is better to have it made on the spot and used soon after making.

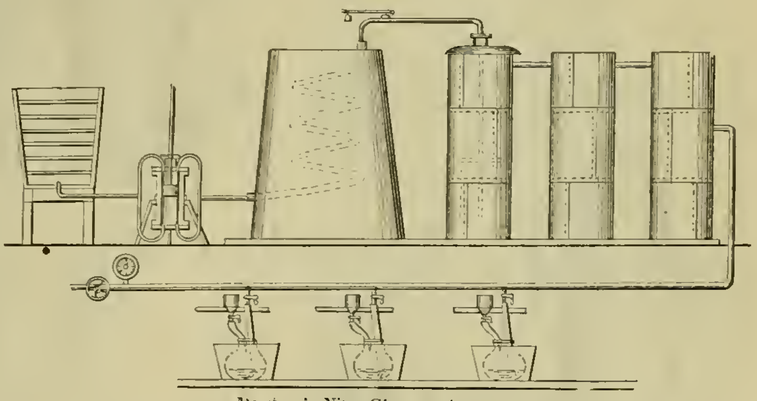
It may be purified by dissolving it, very gradually and at a temperature not exceeding 50° F., in sulphuric acid, and separating the nitroleum by the gradual addition of nitric acid, and then pouring, in a fine stream, into pure cold water from which the air has been expelled by boiling; in the preparation the temperature of 50° should in no case be exceeded.

In Mowbray's process, a current of cold, dry air is passed through the vessels in which the compound is made, for carrying off the hypo-nitrous acid and to cool and agitate the mixture.

The vessels are lined with glass.

This substance has been extensively used for blasting purposes; in the Mt. Cenis and Hoosac tunnels, the operations at Blossom Rock, harbor of San Francisco, in the improvements of the East River, New York, and elsewhere. (See BLASTING; TUNNEL.) Developing about ten times the explosive power of gunpowder, it requires far less drilling and operates so as to lift the rock from its bed without shattering it to such an extent. The number of fatal explosions resulting from it have been an obstacle to its more general use, but these are claimed to have resulted generally from improper manufacture, exposure to too great heat in transportation, or carelessness in handling.

Fig. 3330.



Mowbray's Nitro-Glycerine Apparatus.

Among the most prominent accidents occurring from these sources were the explosions at Aspinwall and in the office of Wells, Fargo, & Co. at San Francisco, by the former of which forty-five and by the latter six lives were destroyed. In the case of the Aspinwall disaster the nitroleum had been shipped from Hamburg, where the temperature was 55° or 60° to a tropical climate where the temperature in the hold of the steamer was probably more than double this. It was inclosed in cork-stopped vessels, packed in cases with sawdust. The explosion has been attributed to the disengagement of gas, which, by the corrosion of the corks, escaped into the surrounding sawdust, forming a new and easily ignited compound, which, becoming mixed with the undecomposed nitroleum which escaped, was easily exploded at such a high temperature by the rough handling to which it was subjected by the stevedores. The sheriff, surveyor, and four other persons were killed by an explosion at Newcastle on Tyne, England, while engaged in burying some cases of this compound in a pit beyond the city limits for safety.

It is noticeable that most of the accidents recorded have occurred in moving, transporting, or liquefying the compound after congelation, and not in blasting.

For farther information see the following patents: —

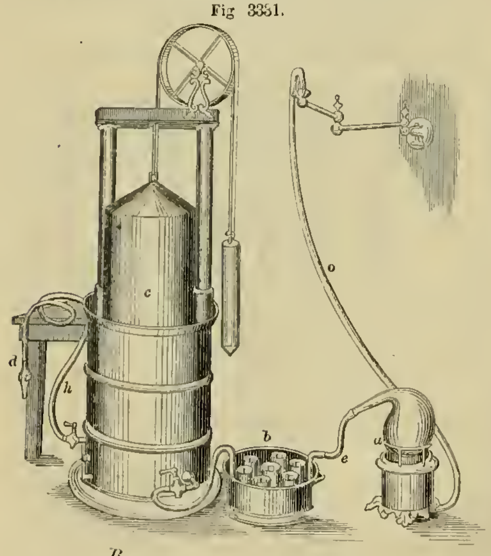
No. 50,617, Nobel, 1865; re-issued, 1869.
No. 56,620, Shaffner, 1866.
No. 57,175, Nobel, 1866
No. 60,567, Shaffner, 1866
No 60,572, Shaffner, 1866.
No. 60,573, Shaffner, 1866.
No. 76,499, Mowbray, 1868.
No. 78,317, Nobel, 1868.
No. 85,906, Chester and Burstenbinder, 1869
No. 86,701, Shaffner, 1869.
No. 87,372, Shaffner, 1869.
No. 93,752, Shaffner, 1869.
No. 93,753, Shaffner, 1869.
No. 93,754, Shaffner, 1869.
No. 93,756, Shaffner, 1869.
No. 98,382, Horsley, 1869
No. 98,425, Shaffner, 1869.
No. 98,426, Shaffner, 1869.
No. 98,427, Shaffner, 1869.
No. 98,854, Ditmar, 1870.
No. 99,069, Ditmar, 1870.
No. 99,070, Ditmar, 1870.
No. 106,606, Mowbray, 1870.
No. 106,607, Mowbray, 1870.
No. 112,848, Roberts, 1871.
No. 112,849, Roberts, 1871.
No. 112,850, Roberts, 1871.
No. 117,577, Taylor, 1871.
No 120,776, Roberts, 1871.

Ni-tro′le-um. A name for NITRO-GLYCERINE (which see).

Ni-trom′e-ter. An instrument for detecting the quality of niter.

Ni′trous-ox′ide Ap′pa-ra′tus. Nitrous oxide (N O), commonly called laughing-gas, is frequently employed in dental surgery as an anæsthetic. It may be procured by simply heating nitrate of ammonia, or by the action of nitric acid on copper or mercury.

Fig 3331.



S. S. White's Nitrous-Oxide Apparatus.

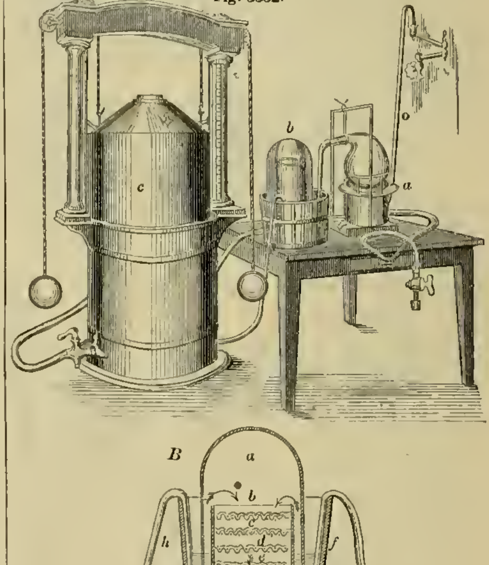
The apparatus shown in Fig. 3331 is designed for the production and retention of this gas on a large scale, for the purpose of inhalation.

It consists of a retort and heater *a*, purifier *b*, gasometer *c*, which may contain 40 to 50 gallons, and inhaler *d*. The gas generated in the retort passes through the pipe *e* to the purifier *b* containing a solution for removing impurities; in this are arranged seven inverted tumblers, shown in plan at *B*, through which the gas successively passes from one to another by the pipes *f g*; on leaving the last tumbler it is received into the gasometer *c*.

The inhaler *d*, shown in section at *C*, is connected by pipe *h* with the gasometer, and has two valves *k l* opening in opposite directions. On applying the mouth to the end *m* and making an inhalation, the valve *k* opens, while during the act of expiration it closes; the valve *l* is at the same time opened, allowing the gas, which has passed through the lungs, to escape through the opening *n*. *o* is a pipe conveying gas to a burner which heats the retort.

The general arrangement of the apparatus shown in Fig. 3332 is identical with the foregoing, but the purifier *B* consists of a glass dome *a* covering the cylinder *b*, which has several disks *c d e* of wire-gauze on which lime is placed for absorbing impurities. The gas enters through the pipe *f* opening above the diaphragm *g*, and circulates, as indicated by the arrows, through the cylinder *b*, finally passing into the gasometer by the pipe *h*.

Fig. 3332.



Nitrous-Oxide Apparatus.

Johnston Brothers of New York furnish liquefied nitrous-oxide gas for dental purposes. They compress 1,200 gallons of gas into a cylinder 24 inches long and 6 inches in diameter; or over 100 gallons into a cylinder 12 inches long, 3½ in diameter. The pressure is about 800 pounds to the square inch at 60°. It is shipped in chilled wrought-iron bottles with steel faucets.

Nob. A head; a knob.

(*Artillery.*) The plate under the swing-bed for the head of an elevating screw.

No′bert's Test-plate.

" F. Nobert, a manufacturer of optical instruments, residing at Barth, Pomerania, has, during the last twenty-five years, been renowned for producing the finest rulings on glass which have hitherto been executed. These rulings are used for two purposes; as a test of the defining power of microscopic objectives, and as a means of determining the wave-lengths of the undulations of the several portions of the solar spectrum.

" Those intended for microscopic use are known as *Nobert's test-plates*. They are executed on the under surface of a piece of exceedingly thin glass (1/200 of an inch thick or less), which is either cemented to a slip of ordinary plate-glass such as is used in mounting microscopic objects, or, in exceptional cases, to another piece of thin glass, about 1/100 of an inch thick, the two being mounted over a circular hole drilled in a thin plate of brass. The latter arrangement is intended to permit the ruling to be illuminated from below by achromatic combinations of short focus.

" When one of these test-plates is examined with the naked eye, it looks as if a single straight line not wider than a hair had been engraved beneath the glass cover, and this when held in the light glows with spectral colors as the plate is moved. If this apparent line be examined with a microscope of adequate power, it is found to be composed of a number of bands, each consisting of a group of fine lines, the distances between which vary according to a fixed rule. Nobert has issued a number of kinds of these plates, which differ in the number of bands and in the distance of the lines of the finest band from center to center. The following are the best-known varieties, arranged in the order of their issue: —

Designation of Plate.	Distance of the lines from center to center in fractions of a Paris line.*	
	In the coarsest band.	In the finest band.
Ten-band plate	1/1000	1/4500
Fifteen-band plate	1/1000	1/5000
Twenty-band plate	1/1000	1/6000
Thirty-band plate	1/1000	1/8000
Nineteen-band plate	1/1000	1/10000
New twenty-band plate . . .	1/1000	1/20000

* The Paris line is rather longer than the English line. One English inch equals 11.25935 Paris lines.

" Of these, the nineteen-band plate has been most used during the last ten years. The new twenty-band plate has only recently appeared, as will be explained hereafter.

" The following table gives the number of lines in each band of the nineteen-band plate and of the new twenty-band plate, so far as known, with the distance of the lines of each band from center to center, in fractions of a Paris line, and the number of times this distance would be contained in an English inch.

Number of Band.		No. of lines in each band.	Distantia linearum in fractions of Paris line.	No. of spaces to the English inch.
In the nineteen-band plate.	In the new twenty-band plate.			
I.	I.	7	1/1000	11,259
II.		10	1/1500	16,889
III.	II.	13	1/2000	22,519
IV.		15	1/2500	28,148
V.	III.	17	1/3000	33,778
VI.		20	1/3500	39,408
VII.	IV.	23	1/4000	45,037
VIII.		25	1/4500	50,667
IX.	V.	27	1/5000	56,297
X.		30	1/5500	61,926
XI.	VI.	34	1/6000	67,556
XII.		37	1/6500	73,186
XIII.	VII.	40	1/7000	78,816
XIV.		43	1/7500	84,445
XV.	VIII.	45	1/8000	90,075
XVI		48	1/8500	95,705
XVII	IX.	51	1/9000	101.334
XVIII.		54	1/9500	106,964
XIX.	X.	57	1/10000	112,594
	XI.	Not known.	1/11000	123.853
	XII.		1/12000	135,112
	XIII.		1/13000	146,372
	XIV.		1/14000	157,631
	XV.		1/15000	168,890
	XVI.		1/16000	180,150
	XVII.		1/17000	191,409
	XVIII.		1/18000	202.668
	XIX.		1/19000	213,928
	XX.		1/20000	225,187

" It will be seen by this table that the first ten bands of the new twenty-band plate correspond to the alternate bands of the nineteen-band plate, and that the ten remaining bands are all closer than its nineteenth band, the lines of the twentieth band being just twice as close.

" Long after copies of the nineteen-band plate had found their way to all parts of the civilized world, the lines of the finer bands remained invisible to the most skillful microscopists. This resulted not merely from the closeness of the lines, but also from their extreme delicacy and paleness. Nobert, who was himself unable to see them, supposed that there was a physical reason why lines separated by a distance less than the shortest wave-length of visible light, would forever resist resolution; an opinion which has since been shown to rest upon a misinterpretation of the physical law invoked. In 1869, however, the lines of the sixteenth, seventeenth, eighteenth, and nineteenth bands were not only seen and counted, but they were photographed by Dr. J. J. Woodward and one of his assistants in the Army Medical Museum at Washington, and the feasibility of resolving them was thus placed beyond doubt. Prior to this, various microscopists had believed that they had resolved these bands, but as they had not succeeded in ascertaining the number of lines in each individual band their claims were not universally accepted.

" On the receipt of the Museum photographs, Nobert for the first time acknowledged that the highest four bands had been resolved, and promised that he would endeavor to rule still finer lines. The new twenty-band plate was the result of his subsequent efforts. One of these plates was furnished by him to President Barnard of Columbia College in 1872, and in the spring of 1873 another was received at the Army Medical Museum. Systematic endeavors with the best modern objectives have failed as yet to resolve any of the bands of this plate beyond the tenth, and hence perhaps some will be disposed to deny that they have actually been ruled as stated, but it must be remembered that similar doubts were raised with regard to the finer bands of the nineteen-band plate before they were resolved; and the appearances presented by the new bands are so similar to those of the higher bands of the old plate, when viewed by a power inadequate to resolve them, that it seems probable that Nobert has again succeeded in outstripping the present resolving power of our best microscopes, as he did in former times; that the new bands are actually ruled as claimed, and that they will serve, as the higher bands of the old plate did, a most useful purpose by stimulating practical opticians to still farther improvements in the construction of objectives.

" The method by which Nobert prepares these rulings has been kept secret. Various attempts have been made to imitate them, but without success, because no one else has been able to construct a point suitable for executing such work; the best diamond splints make marks which are ragged and uneven when examined by high powers, and diamond-points, prepared by grinding with diamond-dust in the most careful manner, are yet too coarse to imitate the beauty and regularity of even the lines of the coarsest bands of Nobert's plates. Could a suitable point be prepared, there would appear to be no serious difficulty in constructing a machine to execute the rulings.

" Used, with suitable precautions, as a test of the resolving power of microscopic objectives, the plates of Nobert appear to offer great advantages over diatoms and other natural objects. In the case of the latter, individuals of the same species vary greatly in dimensions and in difficulty of resolution, while in Nobert's plates the variation is reduced to a minimum. The ruling is executed with such marvelous precision that no perceptible differences can be detected in the dimensions or difficulty of similar bands on different plates, and they afford also a convenient means of assigning numerical values to the resolving power of the objectives tested.

" To resolve the highest bands of the nineteen-band plate or the corresponding ones of the twenty-band plate, objectives of the best quality are required, and should be used with oblique illumination. A coal-oil lamp may be employed as the source of light, but the most satisfactory results are attained by using monochromatic (blue) sunlight, which may be obtained by means of a suitable prism, or by reflecting the sunlight from a mirror through a thin layer of a saturated solution of the ammonio-sulphate of copper.

" Any of the test-plates of Nobert can also be used for determining the wave-lengths of light. Nobert has, besides, prepared a variety of plates especially for this purpose. When closely ruled lines on glass are illuminated by an oblique pencil of light, and viewed with a low power of very small aperture, the line of vision being perpendicular to the plane of the ruling, the latter will appear as a colored band, the color varying with the angle which the luminous pencil forms with the plane of the ruling. Now it has been shown that this angle, the wave-length of the color seen, and the distance of the lines apart, stand in a fixed mathematical relation to each other; so that if the distance of the lines is precisely known and the angle carefully measured, the wave-length of the color seen can readily be computed. The fidelity with which Nobert's rulings are executed at the distances stated by their maker gives them a high value for this purpose. One of the most ingenious of these plates is the so-called *wave-plate*, in which there are seven bands, the lines of which stand in such a relation to each other as to distance, that when they are illuminated with light thrown with such obliquity that the first or coarsest band appears red, the second is orange, the third yellow, the fourth green, the fifth blue, the sixth indigo, and the seventh violet. Viewed with a suitably high power these bands are seen simply as groups of fine black lines, the distances of which from center to center can readily be measured by a micrometer.

"For farther details with regard to Nobert's plates, the reader may consult F. Nobert in 'Poggendorff's Annalen,' Bd. 58, 1852 The treatises of Carpenter and Harting on the Microscope, and a number of papers published in the 'Quarterly Journal of Microscopical Science,' and the 'Monthly Microscopical Journal,' since 1868."

Kindly furnished for this work by Colonel J. J. Woodward, M. D., United States Army.

Nock. (*Nautical.*) The upper front corner of a 4-cornered, fore-and-aft sail; such as a *spanker*, a *trysail*. Also called the *throat*.

Noc′to-graph. *a.* A writing-frame for the blind.

b. A nightly account or report. The converse of the *diary*.

c. An instrument or register which records the presence of watchmen on their beats.

Noc-tur′nal; Noc′tur-la′bi-um. (*Nautical.*) An instrument to take the altitude or depression of some of the stars about the pole, in order to find the latitude and the hour of the night. — ADMIRAL SMYTHE.

Nod′dy. A small, two-wheeled, one-horse vehicle.

Node. A small hole in the gnomon of a dial to indicate the hour by its light, as the gnomon itself does by its shadow.

Nog. 1. (*Mining.*) One of the square blocks of wood which are piled on one another to support the roof of a mine.

2. (*Building.*) A wooden block of the size of a brick, built into a wall as a hold for the nails of the finishing work which is nailed thereto.

3. (*Shipbuilding.*) A treenail driven through the heel of a *shore* which supports a ship on the *slip*.

Nog′ging. (*Building.*) A wall or partition of scantling with the interstices filled in with brick. Brickwork carried up in panels between *quarters*.

Nog′ging-piece. Horizontal scantling laid between courses occasionally.

Noils. Combings, waste, tangles, and knots of wool removed by the comb.

Non-cir′cu-lar Wheel. A wheel whose perimeter is not circular; a pair of such being used to transmit a variable velocity ratio between a pair of parallel axes. Such wheels may be elliptical, scroll, hyperbolar, etc.

Non-con-dens′ing Steam-en′gine. A steam-engine, usually high-pressure, in which the steam on the non-effective side of the piston is allowed to escape into the atmosphere. In contradistinction to an engine in which the steam in advance of the piston is condensed, to create a partial vacuum and thus add to the effective value of the steam which impels it.

Non-condensing engines are lighter than *condensing* engines of equal power, as the latter contain a large number of bulky and heavy parts of which the other is destitute. Condensing engines are generally more economical of fuel.

The comparative lightness and compactness render the *non-condensing* engine suitable for locomotives and steamboats of light draft. The Western and Southern rivers are comparatively shallow at certain points or seasons, and *non-condensing* engines are used in those sections of the country. The Eastern rivers and Northern lakes are deep, and the *condensing* engine is used thereon.

Pumping and *factory engines* of large size are usually *condensing*. A notable example to the contrary is George Shield's pair of horizontal pumping-engines at the Cincinnati Water-Works. They were put in operation about 1846.

The escaping steam of non-condensing engines is usually made to heat the feed-water. In locomotives it is exhausted into the chimney to increase the draft. This was first done by Trevethick in 1802. It was at first designed probably to put out the sparks, avoid noise, and get rid of the steam without the addition of a second pipe.

The following from Haswell is based upon a uniform steam pressure of 60 pounds per square inch (steam gage), cut off at one half the stroke, deducting one sixth for friction and losses, with a mean velocity of piston of 250 feet per minute: —

Nominal Horse-Power of several Non-condensing Engines.

Horses' power.	Diameter and stroke of cylinder.	Revolutions. Min.	Horses' power.	Diameter and stroke of cylinder.	Revolutions. Min.	Horses' power.	Diameter and stroke of cylinder.	Revolutions. Min.
No.	Ins. Ft		No	Ins. Ft.		No	Ins. Ft	
9	6×1	125	46.1	12×4.5	32	159.7	22×5.5	30
9.2	6×1.5	85	55.3	14×3	47	160.7	22×6	28
12.2	7×1	125	56.3	14×3.5	41	163.6	22×6.5	26
12.5	7×1.5	85	58	14×4	37	169.4	22×7	25
16.3	8×1.5	85	60	14×4.5	34	183.7	24×5.5	29
16.9	8×1.75	75	60.8	14×5	30	193.5	24×6	28
21.1	9×1.5	87	64.8	15×3	48	194.7	24×6.5	26
21.3	9×1.75	75	66.1	15×3.5	42	193.5	24×7	24
21.4	9×2	66	66.6	15×4	37	198.7	24×7.5	23
21.5	9×2.5	53	66.8	15×4.5	33	227.1	26×6	28
26.1	10×1.5	87	67.5	15×5	30	228.5	26×6.5	26
26.6	10×1.75	76	77.1	16×3.5	43	227.1	26×7	24
27.2	10×2	68	77.8	16×4	38	233.2	26×7.5	23
27.5	10×2.5	55	78.3	16×4.5	34	237.9	26×8	22
28.2	10×3	47	79.4	16×5	31	266	28×6.5	26
28.7	10×3.5	41	81.7	16×5.5	29	274.4	28×7	25
28.8	10×4	36	82.9	16×6	27	270.5	28×7.5	23
33.9	11×2	70	99.1	18×4.5	34	275.8	28×8	22
33.3	11×2.5	55	103.7	18×5	32	279.9	28×8.5	21
33.4	11×3	46	103.4	18×5.5	29	304.2	30×6.5	26
33.9	11×3.5	40	105	18×6	27	315	30×7	25
34.9	11×4	36	128	20×5	32	324	30×7.5	24
39.2	12×2	68	127.6	20×5.5	29	331.2	30×8	23
39.6	12×2.5	55	129.6	20×6	27	336.6	30×8.5	22
40.6	12×3	47	130	20×6.5	25	340.2	30×9	21
41.3	12×3.5	41	134.4	20×7	24	359.1	30×9.5	21
41.5	12×4	36	154.9	22×5	32	360	30×10	20

Non′i-us. A sliding graduated scale on a graduated plate adapted to subdivide the divisions of the scale on which it moves. So called from Peter Nonnez or Nonnius (his Latinized name), a Portuguese mathematician of Alcazar, born in 1497. See VERNIER.

The nonius scale of a quadrant or sextant is fixed to the oblong opening near the lower end of the index-bar. It divides degrees into minutes and these into seconds.

Non-pa-reil′. (*Printing.*) A size of type between agate and minion.

Agate.
Nonpareil, 143 ems to the foot.
Minion, 128 ems to the foot.

Noo′dle. (*Domestic.*) A strip of rolled dough, used in soup.

A noodle-making machine, patented January 13, 1874, has a frame in which two rollers revolve, with a plate between them, which roll out a sheet of dough. Above the upper roller is another, armed with a series of circular disk-cutters that project below slots in a metallic guard. The metallic plate, with the sheet of dough upon it, is passed between the upper plain roller and the roller with the cutters, thus forming the dough into strips.

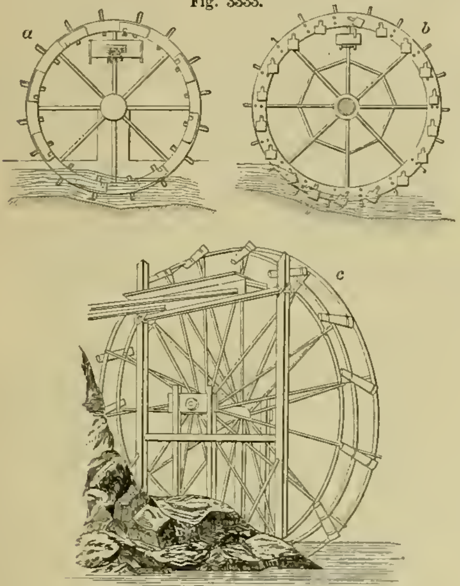
No′ri-a. A water-raising device (Arabic, *Na′Ura*), which has traveling pots or buckets, submerged below and discharging at their point of greatest elevation.

The modes of constructing and operating are various: —

1. The original form seems to be a wheel with buckets or pots each pivoted to the rim at a point above its center of gravity, so as to hang perpendicularly. These are submerged in the water at their lowest point, and, rising, are upset by contact with a fixed obstacle at their highest point, discharging into a chute or trough which conducts the water to a reservoir. *a b*, Fig. 3333, show two forms of the device, — a wheel with boxes in its rim, and one with suspended buckets.

The Chinese *noria c* is made of bamboo, excepting the hub of the wheel and the posts on which it rests. The buckets are bamboo tubes, inclined so as to hold nearly to their capacity till they reach their culminating-point. The wheels are from 20 to 40 feet in diameter, according to situation, and are driven by the impinging of the stream upon peripheral float-boards. One described by Sir George Staunton was 30 feet in diameter; had 20 buckets, 4 feet long and 2 inches diameter in the clear, holding $\frac{1}{10}$ of a gallon; 12 gallons to a revolution, 4 revolutions and 48 gallons per minute; over 300 tons per day.

Fig. 3333.



Norias, or Bucket-Wheels.

The reference to water, and to means for obtaining it, are very frequent in the Bible. In the much-misunderstood text in Ecclesiastes we find a reference to the *noria*: —

"Or ever the silver *cord* be *loosed*, or the golden *bowl* broken, or the *pitcher* be broken at the fountain, or the *wheel* broken at the cistern."

These wheels have been used from time immemorial in raising water for irrigation, in Assyria, Egypt, Persia, Syria, Arabia, and Palestine, and no doubt in China and India, but have undergone many modifications.

Thompson, in his "The Land and the Book," says: "This system of water-wheels is seen on a grand scale at Hums Hamath and all along the Orontes. The wheels there are of enormous size, 80 or 90 feet. They are driven by the river itself, paddles being attached to the rim, upon which the stream is turned by means of a low dam, carrying the huge wheel around with its load of ascending buckets. There is perhaps no hydraulic machinery in the world by which so much water is raised to so great an elevation at so small an expense. With their loads they slowly revolve on their groaning axles, each singing a different tune, — a concert wholly unique and half infernal, which, once heard, will never be forgotten."

The wheel with jars attached is one form of the Roman *antlia*, known by the same name also in Greek.

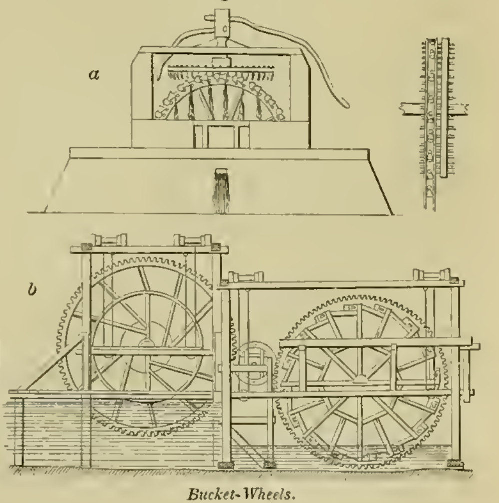
A substantially similar form of wheel is used on the river Eisbach, in the Tyrol; it also is rotated by the force of the current impinging on radial floats on or near the periphery of the wheel.

In other places in the East the wheel is driven by manual or animal power.

Another form of the *noria* is much used in Syria and Palestine, in raising water for irrigation (*a*, Fig. 3334). A central post has a circular sweep-pole, to which a mule is attached. Cogs on the central shaft engage others on a horizontal shaft, and operate the wheel upon which traverses a continuous rope furnished at intervals with jars or wooden buckets. The rope descends on one side with empty buckets and rises on the other side with full ones, which discharge into a chute leading to the cistern. These wheels are kept going day and night by relays of men and mules; in some cases being the joint property and care of the inhabitants of a whole village.

The great bucket-wheel (*b*, Fig. 3334) employed by Perronet at the construction of the Bridge of Neuilly, France, was 16½ feet in diameter, 4½ feet in width, and had 16 buckets and 118 cogs. The water-wheel by which the bucket-wheel was driven was 18 feet in diameter and had 128 cogs. The float-boards were 20 feet long, 3 feet wide, and were set at an angle of 15° with the radius. The lantern-wheels which acted as pinions to the large cog-wheels of the bucket-wheel and water-wheel were 4 feet in diameter and had 30 trundles. The axle of the trundles was 12 inches in diameter, and varied in length according to the relative proximity of the water-wheel and the bucket-wheel. The former was in the Seine,

Fig. 3334.



Bucket-Wheels.

and was rotated by the current of the river; the latter was in one of the coffer-dams which were constructed for the purpose of establishing foundations for the piers of the bridge. The axles of the lantern-wheels varied in length from 38 and 54 to 108 feet.

The term *noria*, having been applied generally to traveling water-raising buckets, has included the chain-pump, which in some treatises is called the *Spanish noria*. A new feature, however, is found in this, namely, a tube up which the pistons — no longer buckets — ascend.

The true Spanish *noria* has earthen pitchers secured between two ropes which pass over a wheel above and are submerged below. See CHAIN-PUMP.

No′ri-um. A metal discovered in combination or in company with zircon, and but little known

Nor′ma. 1. A square used by carpenters, masons, and others to lay off and test their work.

2. A pattern, templet, gage, or model.

Nor′man. (*Nautical.*) A bar or pin in a hole of a windlass or capstan, or on the cross-piece of the bitts, whereon to fasten or veer a rope or cable.

Nor-we′gi-an Stove. An apparatus which may be used either to retain heat derived from other sources or serve as a refrigerator. It consists of a square wooden box lined with a soft, non-conducting substance; cows' hair is the substance actually employed. The lid is similarly lined. The interior is arranged for one or more saucepans, which, when inserted in the stove, are completely surrounded by the material. The meat or other substance in the saucepan being brought to the boiling-point in the ordinary manner, the pan is inserted in place in the stove, where, the radiation of heat being prevented by the lining, the contents remain at a boiling heat a sufficient time to insure their being thoroughly cooked.

When used as a refrigerator, the lining prevents the access of warm air to the cooler object within. No heat is of course ever applied to the apparatus, which is designed merely to maintain the temperature of an object already heated.

It is only adapted for articles cooked by water or steam.

Nose. 1. (*Machinery.*) A pointed or tapering projection in front of an object.

2. A nozzle, as of a bellows, a pipe, a tuyere.

3. The beak or rostrum of a still.

4. (*Lathe.*) The end of a mandrel on which the chuck is secured.

Nose, Ar′ti-fi′cial. A prosthetic nose, made of india-rubber or gutta-percha, colored in imitation of nature and applied in place of the organ removed by disease or accident.

The taliacotian operation makes an artificial nose of the natural flesh and skin, which adhere to the prepared base and grow there. See RHINOPLASTIC PIN.

Nose-bag. A bag of stout canvas with a leather bottom, and having straps at its upper, open end, by which it may be fastened to a horse's head while he is eating the contained provender.

Nose-band. (*Saddlery.*) The lower band of the military bridle, passing over in front and attached to the cheek-straps. A *musrole*.

Collapsible nose-bands and similar devices to check runaway horses by stopping respiration are described in English patents: —

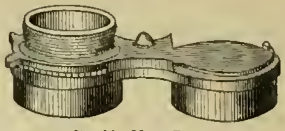
No. 1,576 of 1853.
No 1,014 of 1858; pallets to stop nostrils.
No. 2,597 of 1858; pallets to stop nostrils.
No. 529 of 1859
No. 1,184 of 1859; pallets to stop nostrils
No. 1,881 of 1860; pallets to stop nostrils.
No. 13 of 1861.
No. 1,624 of 1861; closing the blinkers.

Nose-bit. Another name for the *pump-bit* or *shell-auger*, used in boring out timbers for pump-stocks or wooden pipes. (See BIT.) A *slit-nose* bit.

Nose-hole. (*Glass-making.*) The open mouth of a furnace at which a globe of *crown-glass* is exposed during the progress of manufacture, in order to soften the thick portion at the neck, which has just been detached from the *blowing-tube*.

Nose-key. (*Carpentry.*) A fox-wedge.

Fig 3335.



Double Nose-Piece.

Nose-piece. 1. (*Optics.*) That which holds the object-glass of a microscope. Double, triple, or quadruple nose-pieces are sometimes attached to the nose of a microscope, and hold as many object-glasses of varying power, which are brought into requisition as desired.

2. (*Harness.*) The nose-band of a bridle.

Nose-pipe. The section of pipe containing the contracted orifice attached to the end of the blast-pipe, and placed within the tuyere of a blast-furnace.

The nose-pipes, through which the air issues into the furnace, vary in size with the nature of the coke and the ore. In Staffordshire they are usually from $2\frac{5}{16}$ to $2\frac{8}{16}$ inches in diameter.

Nos′ing. (*Carpentry.*) *a.* The rounded front edge of a *tread* which projects over the *riser* of a stair.

b. The prominent edge of a molding or drip.

Notch. An indentation cut in an object. A *croze*, for instance.

Notch-board. (*Carpentry.*) The board which receives the ends of the steps and risers in a staircase.

Notch′ing. 1. (*Railroad Engineering.*) A system of carrying forward excavations for railroads by a series of steps, upon which the work is simultaneously proceeding. Also called *gulleting*.

2. (*Carpentry.*) A mode of joining timbers or scantling in a frame. It is either square or dovetailed, and is made use of for connecting the ends of wall-plates and bond-timbers at the angles, letting joists down on girders, binders, sills, plates, or purlins.

Halving, *scarfing*, and *cauking* are forms of notching, and form a *lap*-joint.

Notch′ing-adze. (*Carpentry.*) A light adze with a bit of large curvature or nearly straight for notching into timbers in making gains, etc.

Note. 1. (*Printing.*) These are of three kinds: —

a. Shoulder-notes. At the top of the page, giving book, chapter, and date, as in reference Bibles.

b. Side-notes. Marginal or *set-in* notes, containing abstracts of the text, as in law-books, or reference notes to parallel passages.

c. Bottom-notes. Containing commentaries and annotations.

2. A size of paper.

3. (*Music.*) A character whose shape indicates its duration, and whose place on the staff indicates its pitch.

Nou-e′. (*Surgical.*) A bandage with knots to press upon the parotid region after extirpation of the parotid gland.

Now′el. (*Founding.*) The inner portion of the mold for casting of large hollow articles, such as tanks, cisterns, and steam-engine cylinders of large size. It answers to the *core* of smaller castings. See *loam-work*, under MOLDING.

Noyl. The short refuse left upon the teeth of the combs in preparing long-stapled wool for drawing and spinning. See WORSTED.

Noz'zle. 1. (*Hydraulics, etc.*) A spout or projecting ventage, as of —

a. The fireman's pipe at the end of the hose.

b. The snout of a pair of bellows or a tuyere.

c. The projecting ventage of a faucet, of rain-water spouting, any discharge-pipe, etc., etc.

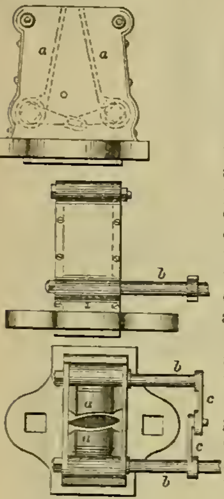
2. (*Steam-engine.*) *a*. The steam-port of a cylinder.

b. In English practice the *nozzle* includes those portions of a steam-engine in which are placed the valves that open and close the communication between the cylinder and the boiler and condenser in low-pressure or condensing engines, and between the cylinder and boiler and atmosphere in high-pressure or non-condensing engines.

c. The exhaust of *locomotives* and some other engines, such as the agricultural and saw-mill engines, known as *portable*, is directed into the chimney, the origiual purpose of which was to urge the draft. This was adopted in the locomotive of Trevethick in 1802, by Hedley in his locomotive of 1813, and by several of the competitors at the great trial of locomotives on the Liverpool and Manchester Railway in 1829. It is a valuable feature in agricultural engines, besides its function as a blast, in dampening the sparks which might set buildings or straw on fire.

The locomotive engineer governs his blast by means of a variable exhaust-nozzle, which he opens or partially closes according to the requirements of the engine, its immediate duty, and the state of the fire.

Fig 3336.



Exhaust-Nozzle of Locomotives.

In the illustration the nozzle is shown as having two leaves *a a*, on axes *b b*, which are moved simultaneously by means of the link *c c*, one of the axes *b* being connected to a hand-lever in the cab of the locomotive. For position of the nozzle, see PETTICOAT-PIPE.

Noz'zle-block. One in which two bellows-nozzles unite.

Noz'zle-mouth. The aperture. A *tuyere*.

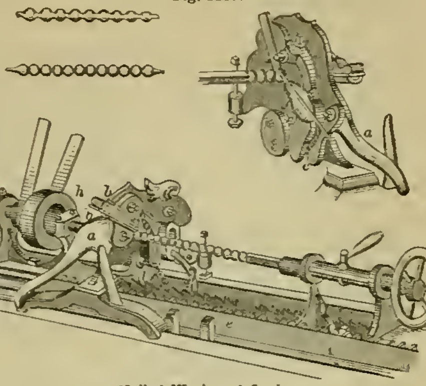
Noz'zle-plate. (*Steam-engine.*) A seat for a slide-valve of a steam-engine.

Nulled-work. Turned work resembling a series of beads strung on a rod. Much used in spindles and rolls for bedsteads, chairs, cribs, and other articles of furniture.

It is made in lathes whose cutter is automatically raised and depressed as the feed-screw draws it along on the bed. Fig. 3337 shows Alcott's lathe with Rennie's attachment. This consists of the lever *a*, with the adjustable knife-holders *b b* and attached arm *c*, back-rest *d* and rack *e*, with which the arm *c* engages.

In operating the machine, the lever *a* is turned up and the carriage propelled forward, the stick being rounded by the knife *g*; the carriage is then brought back to its first position, and by moving the lever up and down, the carriage is, through the arm *c* engaging with the rack *e*, advanced the proper distance and the nulls or beads formed by the cutter *h*.

Fig. 3337.



Nulled Work and Lathe.

A device for forming tenons on the ends of the piece may also be attached.

Num'ber-ing-ma-chine'. A machine for impressing consecutive numbers on account or record books (a *paging-machine*), coupons, railway certificates, bank-notes, railway tickets, etc.

The notes of the Bank of England were numbered by a machine invented by Bramah, 1806. It printed the numbers upon them consecutively at a rate which dispensed with the labor of 100 clerks out of 120 who were detailed for that duty during the issue of £1 notes.

The foundation idea is that of Blaise Pascal (1650), and consists of disks or wheels decimally numbered on their peripheries, the whole mounted on one axle, upon which they turn freely, acting upon each other in serial order, as explained under ARITHMOMETER. The first wheel of the series containing the units is moved one figure between each impact, and when the units are exhausted the tens come into action, and act in coincidence with the units, which continue their action. So on of the 100s, 1,000s, etc.

Bramah's numbering-machine, improved by Oldham, had 5 brass circles with studs carrying the numerals, so as to be able to number up to 99,999. The bank-note was presented on a table above, and the tympan brought down upon it, forcing the paper against the numbered studs, which were presented through openings in the bed. After each impression the first wheel of the train was rotated one spoke, bringing the next unit into presentation. The unit-wheel acted upon the 10-wheel as soon as the number 9 was reached and printed; the 10-wheel acted upon the 100-wheel, and so on, as seen in Watt's *registering-machine*, *gas-meters*, *arithmometers*, and numerous analogous machines and contrivances. The type-wheels were inked by a *dabber*. The machine had several crude movements, but is interesting as among the first of the automatic shifting instruments for serial indications or work, including the modern numbering and paging machines, calculating-machines and registers, the indicating-apparatus of meters, etc.

Trouillet's numbering-machine (French) is adapted either for hand or for use in a press. It consists of an axle containing a number of wheels, having on their perimeters the ten numerals separated by spaces. An instrument with 6 wheels will number from 000,001 to 999,999. The position, after every impact, is changed by means of a small lever that rises alongside of the wooden handle, the immediate change being on the unit-wheel, and that acting upon the 10-wheel as its own numerals become exhausted, and it prepares to commence again at 1. So on with the 10 and 100 wheels to the end of the series.

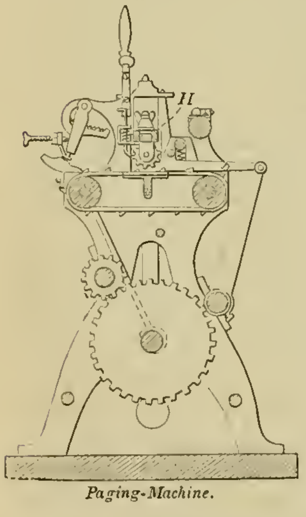
In the machine used in the Bank of France each note receives five impressions from the machine at once, distinctive of its relations to the remainder of the issue. One of these is its number of order, and increases from note to note; the others are significant of the class or of the particular series to which the note belongs, and change with the commencement of each new series. It is entirely automatic, taking up each note separately from the supply on one side, transporting it to the printing-table to be stamped, and subsequently removing it and depositing it in the receptacle for finished notes. The notes are lifted by a gentle force of aspiration produced by an air-pump, and acting through a hollow plate perforated on the under side, and having a regular succession of movements.

Bailey's machine is designed for imprinting successive numbers on railway-tickets and their coupons at one operation. It also partially separates the coupons from each other and from the ticket, so that they may be readily torn apart.

Edmonson's prints the names of places on tickets, at the same time numbering them consecutively. The cards are fed singly to a horizontal table under a type-box containing the form, which is vertically reciprocated to receive ink from the rollers and to print the cards, which are held in place by guides extending from the feeding-tube to the receiving-tube. The numbers are engraved on the peripheries of wheels by which they are impressed on the cards.

Hoe's machine has peculiar mechanism for rotating the registering disks and a separate apparatus for inking them.

Fig. 3338.



Paging-Machine.

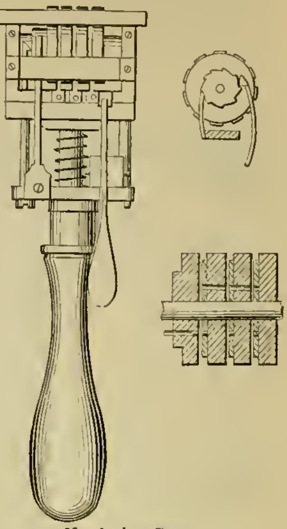
In Hill's machine (Fig. 3338) the numbering-apparatus moves with the bed of a press operated in the ordinary manner, the inward movement of the bed-plate causing a spring-pawl to engage with a ratchet, and presenting the required number. A cross-head *H* is arranged to slide in vertical guides formed in the side-frames. In the longitudinal opening in the cross-head are fitted the stems of a number of hangers, each of which carries a numbering-wheel, and each wheel has a number of projecting types for imprinting the numerals. The desired movement is imparted to the numbering-wheels by rods, one of which is arranged to slide vertically in a bracket attached to each hanger. These rods have bent lower ends, which are made to engage with the teeth of a ratchet-wheel adjacent to the numbering-wheels, and thus impart the desired motion to the latter. See also PAGING-MACHINE.

Num'ber-ing-press. See NUMBERING-MACHINE.

Num'ber-ing-stamp. One for delivering consecutive numbers by successive impressions. A series of wheels have the series of figures from 0 to 9, and these have the usual connection by which pressure applied to an object sets in motion the unit-wheel. This is communicated to the next, carrying the tens, hundreds, and so on throughout the series. See NUMBERING-MACHINE.

Num'ber-print'-ing. The process whereby successive numbers are printed automatically on tickets, bank-notes, etc.

Fig. 3339.



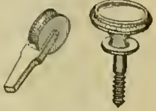
Numbering-Stamp.

Various machines have been invented for this purpose, prominent among which are Bramah's, Shaw's, Edmonson's, and Trouillet's. See NUMBERING-MACHINE. Called a *numbering-machine* or *paging-machine*.

Nun-buoy. A buoy of a spindle shape, or formed of two cones joined at their bases.

Nurl'ing. The indentations or fluting on the edges of coins, the heads of temper and set screws, and similar objects. It is sometimes called *milling*, and in the mint is called *reeding*. The crenated edge on coin is intended to prevent clipping or filing the edges of the coin, which might otherwise be done to some extent without discovery, except by careful weighing.

Fig. 3340.



Nurling-Tool and Nurled Head.

Nurling applied to the edges of temper-screws is to make them more easy to grasp by the fingers and thumb. It is very common in surveying-instruments, on compasses, dividers, calipers, etc., and generally upon all instruments where a screw is to be loosened or tightened, in the ordinary uses of the instrument.

A *nurling-tool* has a roller whose periphery has a sunken groove, indented so as to form the counterpart of the bead which is to be nurled on the head of the temper-screw. It is held against the portion of the object to be nurled, while the said object is rotated in a lathe.

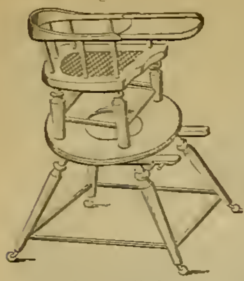
The nurling on the edge of a coin is made in the coining-press. By the great pressure (from 40 to 75 tons), the metal of the blank is forced outward into the indentations of the collar, which holds it while pressed between the two dies, forming the obverse and reverse respectively.

Nurl'ing-tool. (*Turning.*) A milling-tool. One for indenting the heads of temper and tangent screws, etc.

Nurs'er-y-chair. One for nursery uses; the example is convertible into a high-chair for table use, or with shelf in front for toys; or, when the upper part is removed, the lower forms a pan-chair.

Nurs'ing-bot'tle. One arranged to enable an

Fig. 3341

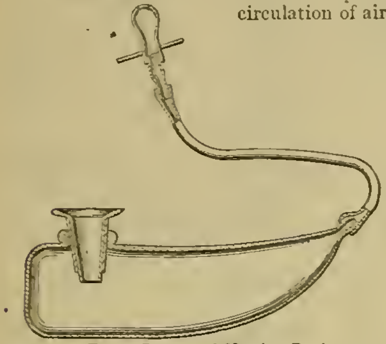


Nursery-Chair.

infant to draw milk from it by the natural action of sucking. Fig. 3342 is adapted to be used both as a breast-pump and a nursing-bottle. In Fig. 3343 the tubular stopper has a flexible leather tube extending up from the bottom of the bottle, so that it may nearly empty the bottle without drawing air. A nipple is attached to the projected end.

Nurs'ing-lamp. One for heating infants' food at night. The lamp-case is water-tight, and is submerged to heat the water in a bath. Pipes and chimneys afford a circulation of air.

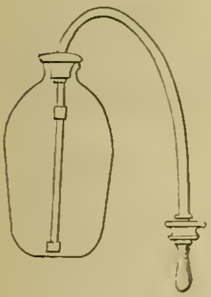
Fig. 3342.



Breast-Pump and Nursing-Bottle.

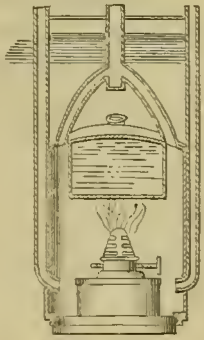
Nut. 1. (*Machinery.*) A piece of metal *a* tapped and adapted to be screwed on the end of a butt *b*.

Fig. 3343.



Nursing-Bottle.

Fig. 3344.



Nursing-Lamp.

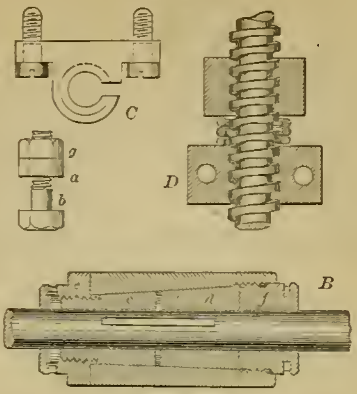
A second nut *g*, screwed down upon the first, is called a *jam-nut*, *check-nut*, *pinching-nut*, or *lock-nut*. (See NUT-LOCK.) A *nut-lock* is a device of any kind for fastening a nut; a *lock-nut* is a nut or bur which fastens another nut.

B shows a shaft and sleeve with two bushes *c d*, one drawn by a *drawing-nut e*, the other driven by a *forcing-nut f*.

C D are forms of elastic nuts. One has an opening which permits expansion, and the other screws down upon a spiral spring.

2. (*Vehicle.*) Axle-nuts are screwed on to the ends of the spindles or arms of carriage-axles, to hold the wheels on the spindles. The exercise of ingenuity in this line has been in devices to prevent the nuts from becoming unscrewed, and thus allowing the wheels to roll off. In the ordinary method, a closely fitting nut is screwed on the threaded end of the spindle, the threads on the near side of the carriage being left-hand threads, and those on the off side, right-hand threads, so that the ordinary motion of the wheels tends to roll the nuts on, and not off.

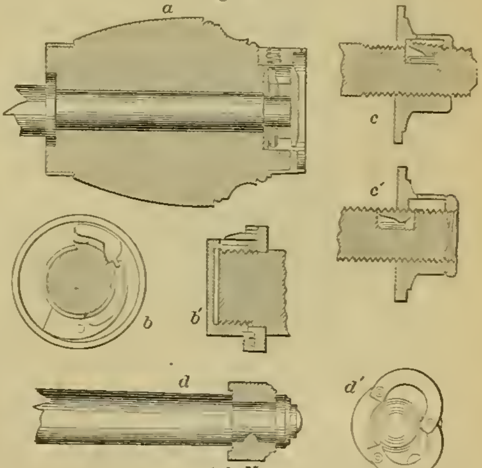
Fig. 3345.



Bolts and Nuts.

Sometimes the nut is fastened by a key of metal or leather, sometimes by a jam-nut. In the examples, *a* has a flanged cap instead of a screw-nut, and this is held by a transverse key slipped through a hole in the hub-band. *b b'* are views of an axle-nut which is secured on the axle by combining with it a spring friction-brake, which acts on the thread of the screw. The lever or arm of the brake extends beyond one of the faces of the nut, so that the brake may be withdrawn from the thread of the screw by the act of putting on the screw-wrench, to take off or put on the nut.

Fig. 3346.



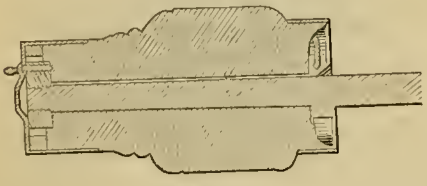
Axle-Nuts.

In *c c'*, when the nut is screwed up to its place, the lever-key is thrown into such position as to prevent the nut becoming unscrewed. To unscrew the nut, the lever-key is turned to a horizontal position by entering a small iron pin through a hole and causing it to bear upon the key while the nut is started back. The two figures illustrate the respective positions of the lever-key.

In *d d′* the divided nut is clamped in a groove of the spindle, the shoulders of the groove being formed respectively of the enlarged, bearing portion of the spindle and of the outer boss. One portion of the nut may be hinged to the other, and the jaws opened to enable it to be placed in its seat; or the two pieces may be locked together in any convenient manner.

In Fig. 3347, a cap covers in the outer end of the hub, and is not removed for the purpose of taking off the wheel. A pin is thrust in from the outside through a hole in the cap, and engages with a groove in the axle-nut, so as to lock the two together. The wheel being then rotated in the proper direction, the cap and nut revolve, and the latter is unscrewed from the end of the spindle, releasing the wheel without soiling the fingers by handling the nut.

Fig. 3347.



Young's Axle-Nut.

Many devices to prevent nuts from becoming unscrewed are found in machinery subject to jar, and particularly in railroad-rail fastenings and fish-plates. See Nut-lock.

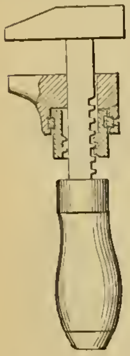
3. The screwed sleeve which operates the movable jaw of a monkey-wrench.

4. One of the rollers or crushing-cylinders of a cider-mill.

5. (*Nautical.*) A projection on the *shank* of an anchor to hold the *stock* in place.

6. (*Fire-arm.*) The tumbler of a gun-lock.

Fig. 3348.

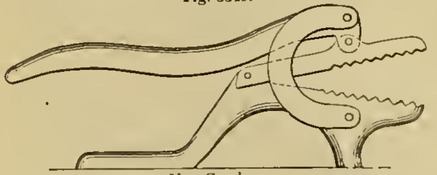


Monkey-Wrench.

Nut-crack′er. An implement with jaws for cracking hard-shell nuts, such as hickory, walnut, Brazil, etc. The short arm of the lever is pivoted to the moving jaw, and it has fulcrum bearing in shackles which are pivoted to the fixed jaw and curved backward to give access to the jaws.

Nut-fas′ten-ing. See Nut-lock.

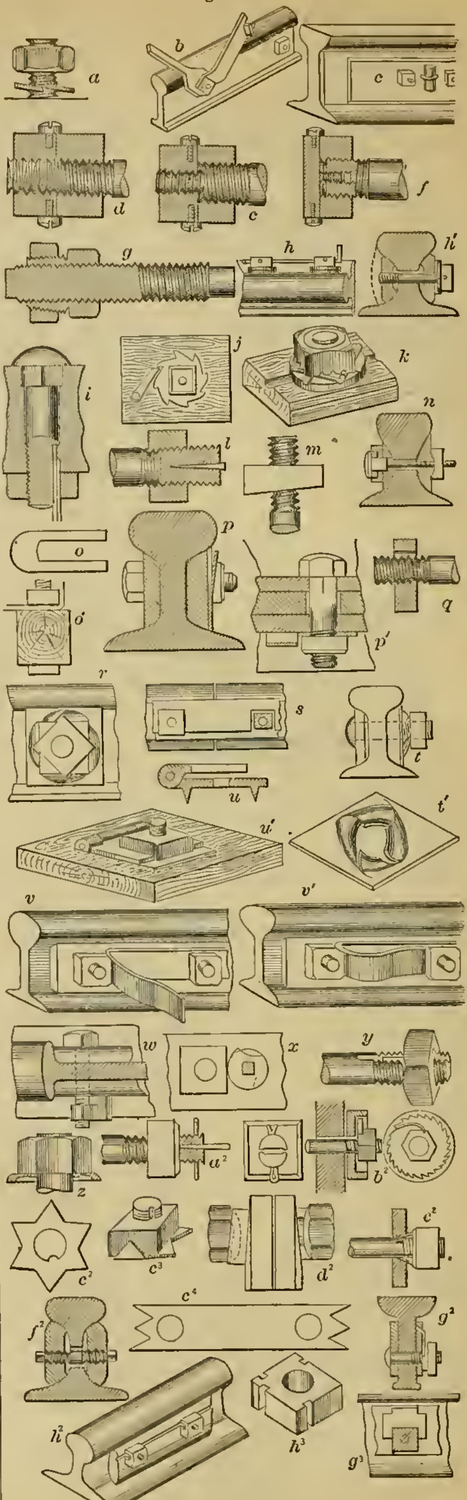
Fig. 3349.



Nut-Cracker.

Nut-lock. (*Machinery.*) A means for fastening a bolt-nut in place, preventing its becoming loose by the jarring or tremulous motion of the machinery. Such are used upon fish-bars of railways,

Fig. 3350.



Nut-Locks.

upon harvesters, and in many other places. In railways especially there has been a great demand to hold the nuts from being loosened by the shocks of the passing trains.

Fig. 3350 shows a number of these devices, some of which are American, others foreign. They require but little description, being simple and readily represented by drawing.

a has a washer cut obliquely so as to present cutting edges which sink into the nut and bar respectively.

b has a plate which fits between the two nuts of a fish-bar.

c has a plate which fits over the nuts, and is held by a staple and key.

d e are forms of jam-nuts, right and left handed, the outer one being of smaller diameter and allowing the lower nut to be slipped over it. They also have exterior set-screws.

In *f* the left-hand screw is interior, and its head jams against the face of the lower nut.

g has a conical screw portion, having longitudinal slits which allow it to be pinched down upon the bolt-screw by the outer nut.

h h' has a through-pin which transfixes the nuts.

i has a feather which lies in a longitudinal groove in the bolt and a spline-way in the nut.

j has a ratchet-washer and a click; the nut is partially imbedded in the washer.

k has pins which enter opposite grooves in the contacting faces of the washer and nut.

l has a split bolt and spreading wedge.

m has an unequal-sided washer, which causes one side to jam against the object and partially imbed itself.

n has a concave-faced nut which slips on to a seat on the washer or fish-bar.

o o' show a bifurcated washer, the legs of which are bent up against the nut.

p p' has a split washer, one part of which springs up against the side of the nut.

q is a gravitating nut, being heavier on one side.

r has a washer with wings which spring up against the sides of the nut.

s has a notched plate which slips over recesses in the nuts.

t t' has spring wings on the washer to hold the nut.

u u' are two views of a washer with a hinged section which holds the nut.

v v' show forms of flexible washer-strips.

w has a nut with a gravitating extension-piece.

x has a cam which jams against the nut.

y is a bolt with groove for spline, and a corresponding groove on each side of the nut.

z is a nut which jams down upon a yielding washer.

a^2 shows two views of one having a split bolt, and a wedge held by a key.

b^2 shows two views of a nut with internal ratchet and a spring-click on the bolt.

c^2 c^3 c^4 are the Noblet washer, which has a portion to turn up against the nut, and a farther portion which may be turned down against the object, if desired.

d^2 is the Nicholson (1852) bolt with a semi-spherical bearing surface, and nut made to suit.

e^2 is Adam's wedge-formed washer (1856).

f^2 has a right and left double-ended screw-bolt.

g^2 g^3 are two views of a form in which a washer beneath the nut has a lip which projects into a slot in the fish-bar.

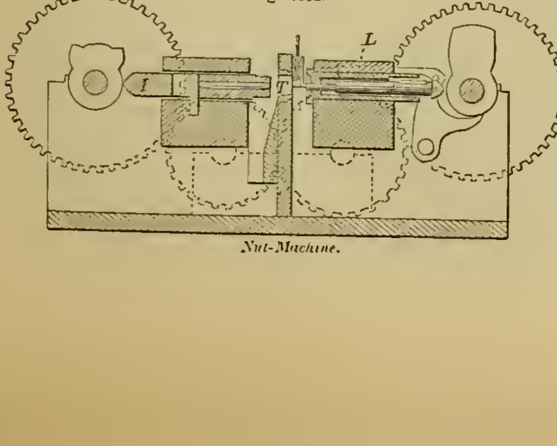
h^2 has a long washer-slip with a piece turned up to form a key.

h^3 shows the grooved nut.

Nut-ma-chine'. A machine for forming nuts from the solid bar by cutting or swaging.

In Fig. 3351, the heated bar is placed against a gage, the slide *I* is forced forward and the blank is cut from the bar; the blank is forced into the die *T*, to which the rounded header has been advanced by the movement of the slide *L*. The advance of the punch perforates the nut and forces the piece into the hollow left by the recession of the slide *I*, whose second forward movement discharges the nut.

Fig. 3351.

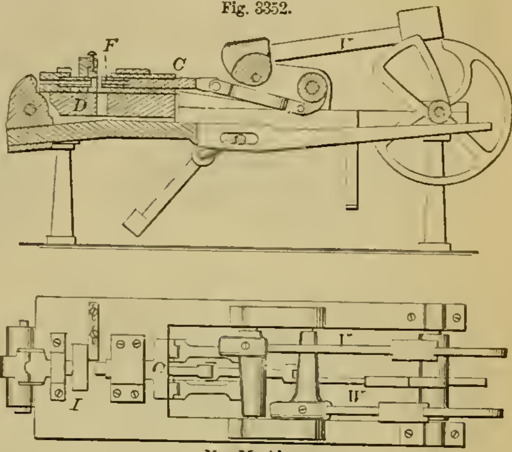


Nut-Machine.

In Fig. 3352, the blank is cut from the heated rod by the punch *D*. The ram *C* moves forward, carrying the holing-punch *F*, which is advanced, making the hole in the nut, after which they recede from each other, allowing the nut to be pushed out by the follower *I*. The swaging and holding punches are actuated by toggle-joint connection with the levers *V V'*, producing a hammering action rather than a positive limited pressure.

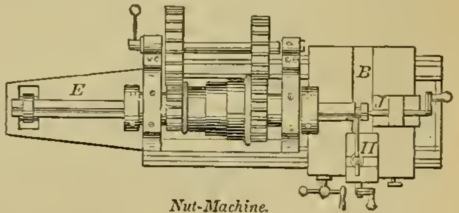
In Fig. 3353, the sliding carriage *B* carries the cutter *H* (the cutting edge of which is beveled to cause any desired chamfer), and the borer *J*. The rod *E*, of hexagonal or other shape adapted to the kind of nut required, passes through similarly shaped rings, which prevent it from slipping during rotation. When 6 or 8 blanks have been cut by advancing the carriage, this is drawn back, the bar is fed forward, and a new series of turning and drilling operations commences.

Fig. 3352.



Nut-Machine.

Fig. 3353.

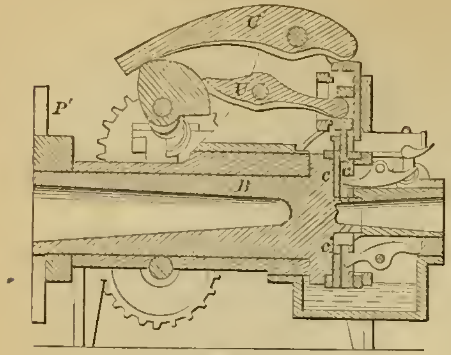


Nut-Machine.

In the machine (Fig. 3354) the dies are arranged around the bed-roller *B*, which is intermittingly moved by the curved arms *P P'*, etc., so as to bring each die at the proper moment under a corresponding punch, actuated by the levers *U U'*, which cut out the nuts from the heated bar. They are then delivered from the die by plungers *c*. Punches, operated by cams, perforate the nut.

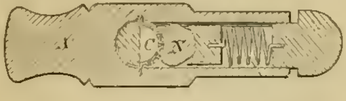
Nut'meg-grat'er. The largest four Banda islands are exclusively devoted to the growth of nutmegs, producing yearly 400,000 pounds of nutmegs and 130,000

Fig. 3354.



Nut-Machine.

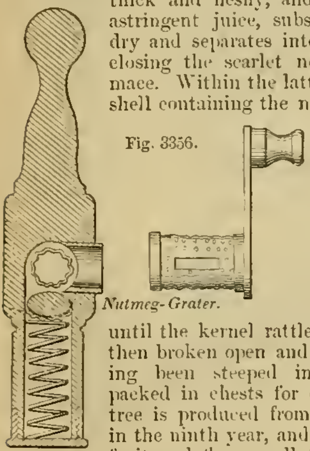
Fig. 3355



Nutmeg-Grater.

pounds of mace. The nutmeg-tree grows 30 feet high, and resembles the orange, the pale yellow flowers and fruit, in various stages of maturity, being all together on the tree. The fruit is at first of a light green color, becoming yellow when ripe, with a longitudinal form. The external covering, at first thick and fleshy, and filled with acrid astringent juice, subsequently becomes dry and separates into two valves, disclosing the scarlet network known as mace. Within the latter is a thin brown shell containing the nutmeg. The fruit is gathered and divested of its outer coverings, the mace being carefully collected and dried in the sun. The nuts are dried in the sun, or in an oven, and smoked until the kernel rattles. The shells are then broken open and the kernels, having been steeped in lime-water, are packed in chests for exportation. The tree is produced from the seed, flowers in the ninth year, and continues bearing fruit and flowers all the year round for seventy years.

Fig. 3356.



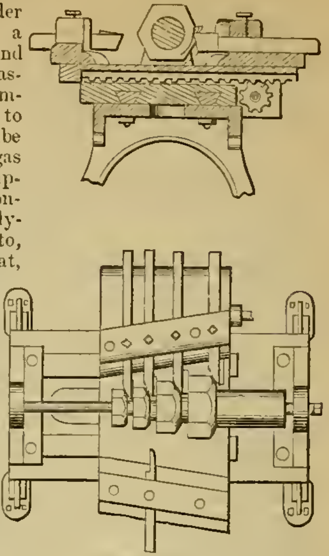
Nutmeg-Grater.

Besides the old-fashioned grater, in which the nut and the knuckles are impartially rasped, may be mentioned two other kinds. In Fig. 3355, the nutmeg *N* in the tube of the stock *A* is pressed by the spring against the grater *C*, which is reciprocated in the transverse opening.

In Fig. 3356, the grater revolves in a stock, and the nutmeg is pressed against it by a spiral spring which bears against a removable cap, covering the opening by which it and the spice are introduced.

Nut-plan′er. A series of nuts of different sizes are screwed to the mandrel, and one side of the latter is a sliding tool-rest, to which are screwed a series of tools, having each two cutting edges, by which a number of nuts can be simultaneously faced and beveled.

Fig. 3357.

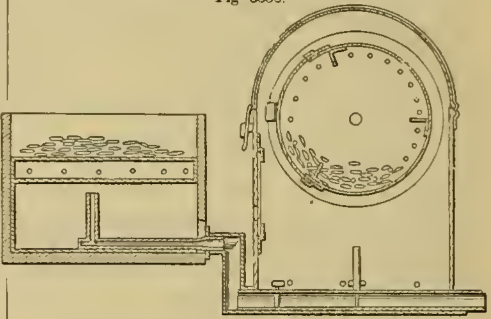


Nut-Planer.

Nut-roast′er. A rotary cylinder is confined in a hot-air case, and provided with gas-burners. A warming-apparatus, to which the tube that supplies gas to the roasting-apparatus is connected for supplying heat thereto, is so arranged that, after the nuts have been roasted and placed in the said warming-apparatus, the flow to the roasting-burner may be stopped, while that to the warming-apparatus continues.

Nut-shap′ing Ma-chine′. A machine for the purpose of shaping the external faces of hexagonal nuts. Six horizontal revolving cutters are arranged radially at the same level, and driven by a single bevel-wheel gearing into the six bevel-pinions that carry the cutter-spindles. The cutters are so fixed in their spindles that when the cutting edges of one tool are horizontal, those of the adjoining one are vertical, and they consequently miss one another in revolving, and can thus operate on work the faces of which are narrower than the breadth of the cutters; by this means the contiguous faces of hexagonal nuts are all shaped simultaneously by the revolving cutters. The nuts to be shaped are threaded upon a vertical center mandrel, to which a vertical feed-motion is given, traversing the nuts upward or downward in the middle of the revolving cutters; and the shaping of the six faces of the whole row of nuts on the mandrel is completed in a single traverse of the machine.

Fig 3358.



Peanut-Roaster.

Nut-tap′ping Ma-chine′. For cutting screw-threads in punched nut-blanks. A machine resembling a drill-bench, with taps mounted on the ends of its mandrels.

Nut-wrench. A spanner for rotating nuts. See Monkey-wrench, and list under Wrench.

O.

Oak'um. (Anglo-Saxon, *acumba.*) 1. The coarse portion separated from *strick* (strike: A.-S., *strican*) of flax or hemp in hackling.

2. Untwisted rope; used for *calking* the seams of a ship's plank, being forced thereinto by chisel and mallet. A first-rate ship of war requires 67,000 pounds of oakum to close the seams.

Oar. 1. (*Nautical.*) An instrument for rowing. A long paddle which rests in tholes on the gunwale in rowing.

A long oar, used occasionally to assist a vessel in a calm, is a *sweep*, and is operated by two or more men.

Small oars are *sculls;* one rower wielding a pair, sitting midlength of the *thwart*. *Sculling* a boat is performed by an oar shipped in a half-round hole at the stern, the oar being moved with a twisting action from side to side.

A *rigged oar* is one in which the oar is pivoted to the gunwale and moved by a rod, or otherwise by a rower sitting abaft it, so that he may face forward.

The *blade* of the oar, also known as the *wash*, is the broad flat part which is dipped into the water in rowing. The *blade* was formerly known as the *pala*, which survives in the term *peel*, yet applied to it. The term *pala* meant a spade; the older forms of paddles might be used for digging.

The *loom* of the oar is the shaft, beginning at the blade, and terminating in the *handle*, which is of rather smaller diameter than the *loom*, in order to afford a good hand-hold to the rower.

The oar when in use rests in *rowlocks* in the gunwale of the boat or between *thole-pins*, which are round pegs, inserted in holes bored in the gunwale.

To *boat* oars means to cease rowing and lay the oars in the boat.

To *feather* oars is to turn the blades in a horizontal position on lifting them from the water at the end of each stroke, to afford as little resistance as possible to the water in withdrawing, and to the air.

To *ship* oars is to place them in the rowlocks or between the thole-pins, ready for use.

An oar is frequently used for steering: in which case it is sometimes an ordinary oar shipped in a swiveled fork at the stern, as in whale-boats; or it may be a broad paddle attached to a long arm, working on a swivel near its center, or similar device, as is often the case in keel-boats, scows, etc.

To *lie on the oars* is to raise them from the water and hold them horizontally.

To *muffle the oars* is to put sheepskins in the rowlocks to prevent any sound in rowing.

To *toss the oars* is to raise them vertically, resting on the handles. It is a form of salute.

To *unship the oars* is to take them out of the rowlocks.

Single-banked is when the oars are rowed, one to each thwart, starboard and port sides alternately.

Double-banked is when two opposite oars are pulled by two rowers seated on the same thwart, or by two men at each oar.

The term *bank*, as applied to galleys, meant a tier of oars, as *double-banked*, *single-banked*, etc.

Says Pliny: "The Copæ invented the oar, and the Platæans gave it its broad blade." We suppose he means a fair distinction between the oar which rests in tholes and the paddle which is handled without receiving a fulcrum support on the gunwale.

The great ship of Ptolemy Philopator had forty ranks of rowers; the oars of the longest row were 38 cubits in length (say, 57 feet). These were loaded with lead on the part inside of the rowlocks, so as to evenly balance.

The scarcity of timber in Eastern lands had a great deal to do with the importance and peace of nations thereabouts. The possession of Lebanon and Bashan was not one of the least of the points in dispute between the two branches of the Macedonian Empire represented by the Seleucidæ and the Ptolemies.

These struggles fill up the time between the death of Alexander and the absorption of the country by the Romans, and form the history which was so remarkably portrayed in prophecy by Daniel several hundred years before. See the 11th chapter of Daniel.

While the fir-trees of Senir furnished the planks, and the cedars of Lebanon the masts, the oaks of Bashan contributed the oars of the famous galleys of Phœnicia. Being the great carriers of that day, and having direct dealings with Britain, India, Greece, Spain, Africa, and many ports whose names remain but whose localities are difficult to determine, these "princes of the sea" and artificers upon the land were in demand wherever an extra amount of intelligence, taste, skill, and daring was required. Two lands at least contributed the timber of their vessels, another the cordage, another the sails, another the oars, others the ivory, ebony, and sandalwood for adornment; Palestine contributed its iron.

Copper from the same land and the Caucasus was mingled with the tin from the far-off Cassiterides, the first contribution of Britain to the common stock of the world's merchandise, and which had the honor of forming with copper the alloy which made the brazen (*bronze*) laver and furniture of Solomon's Temple.

Though littoral Tyre was destroyed by Nebuchadnezzar, and insular Tyre by "young Ammon," the "rough he-goat, the king of Grecia," yet she survived in her colonies until the Roman maelstrom drew them all into its vortex and swamped the distinctiveness of many nations.

The best picture of the time is that given in Ezekiel xxvii. (which see).

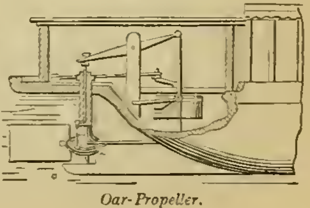
Machines are made for dressing, planing, riving, and splitting oars, but do not differ so specially from machines for getting out and dressing stuff for other purposes as to require elaborate description here.

2. (*Brewing.*) A blade or paddle with which mash is stirred in the tun.

Oar-lock. (*Nautical.*) A means of pivoting an oar on the gunwale. A Rowlock (which see).

Oar-pro-pel'ler. 1. A device to imitate by machinery the action of sculling. Two submerged blades at the stern are attached to an oscillating, vertical shaft and brought broadside to the water and feathered, alternately, so as to make an effective and a return stroke. The horizontal shaft

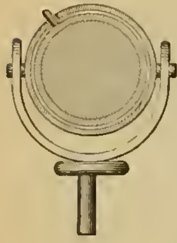
Fig. 3359.



Oar-Propeller.

of the blades receives an oscillation in a vertical plane, while the sleeve to which its hub is secured is oscillated in a horizontal plane, so that it receives a double oscillation, once around its own axis and also around the axis of the vertical shaft.

Fig. 3360.



Oar-Swivel.

In another form, the blades are oscillated with their rock-frame, and are feathered, so as to move forward edgeways and move backward flatways to propel the boat.

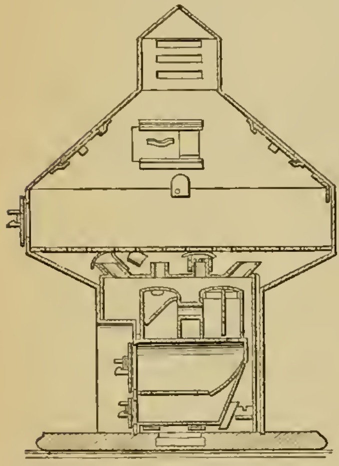
A canal-boat, propelled by oars, was used on the Sankey Canal, Lancashire, England, in 1797. The oars made 18 strokes per minute, and were operated by a steam-engine.

Oar–swiv′el. A pivotal device for an oar on the gunwale. A *rowlock.* In the example, the oar is hung in gimbals, which allow it vibration in any plane, and it has besides a capacity for rotation on its own longitudinal axis in feathering. See Rowlock.

Oast. A hop-drying kiln.

The kiln has an upward draft, the floor being perforated and the hops lying upon hair-cloth. In the example, the furnace is covered by an arch of brick-work or metal, forming an air-chamber around the furnace from which the air is conveyed to the foraminous bottom of the kiln.

Fig 3361.



Oast.

Ob′e-lisk. 1. A quadrangular, slender stone shaft, with a pyramidal apex. The width of the base is usually about one tenth of the hight, and the pyramidal apex has about one tenth of the whole length. It is Egyptian in its conception and execution. Obelisks were erected in pairs, and are yet numerous on the ancient sites, and no doubt many prostrate ones are buried in the soil of Egypt, which has risen from the deposit of the Nile 9 feet in 1,700 years at Elephantine, and 7 feet at Thebes. The deposit of mud at Thebes, therefore, since Amunoph I., would be about 17 feet.

There are about a dozen Egyptian obelisks erected in Rome. The largest is that from Heliopolis. It is of granite, and now stands before the north portico of the Church of St. John Lateran, where it was erected in 1588. Its whole hight is about 149 feet; without the base, 105 feet. It was removed to Alexandria by Constantine, and to Rome by his son Constantius, and placed in the Circus Maximus. It was overthrown, broken into three pieces, and a piece was removed from its base before re-erecting. It weighs about 985,600 pounds. Its partner yet stands at Heliopolis. It is marked with the name of Osirtasen I., about 2100 B. C. Roman obelisks were also imported by Augustus and Caligula.

Other obelisks are found at Constantinople, Paris, Arles, Florence, etc.

The Egyptian obelisks are usually of granite, but there are two small ones in the British Museum made of basalt, and one at Philæ of sandstone. The date of the Flaminian obelisk, which is covered with hieroglyphics, is supposed to be about 1600 B. C.

The obelisk in Paris, erected in 1833, was brought from Luxor. It is 76 feet in hight. Of the needles of Cleopatra, so called, one is standing, 63 feet in hight, and the other is lying upon the ground.

"The mode of raising an obelisk seems to have been by tilting it from an inclined plane into a pit, at the bottom of which the pedestal was placed to receive it. A roller of wood was fastened at each side to the end of the obelisk, which enabled it to run down the wall opposite to the inclined plane to its proper position." — Wilkinson.

For a full description of the mode of moving and re-erecting an Egyptian obelisk, see the quarto "L'Obélisque de Luxor, Histoire de sa Translation à Paris," Paris, 1839. See also Cresy's "Cyclopedia," ed. of 1865, pp. 38, 40; also pp. 1013 – 17.

2. A reference-mark in printing (†); also called a dagger.

Ob′ject–find′er. (*Optics.*) A means of registering the position of a microscopic object in a slide, so that it may be readily found in future.

Maltwood's finder is a glass slide 3 × 1¼ inches with a scale occupying 1 square inch ruled into 2,500 squares. See "Beck on the Microscope," p. 67.

Ob′ject–glass. (*Optics.*) The glass at that end of a telescope or microscope which is presented toward the object. The *objective.* By it an image of the object is formed, to be viewed by the eye-glass. In good instruments of either kind the object-glass is achromatic and composed of several lenses, one being of flint-glass and the other or others of crown-glass. See Achromatic-lens; Lens; Telescope; Eye-glass; Field-glass.

Ob-ject′ive. (*Optics.*) That lens or combination of lenses in a microscope or telescope which brings the image of an object to a focus in order to be viewed through the eye-piece. The object-glass. Though acromatic lenses had been applied to telescopes by Dollond near the middle of the eighteenth century, yet in 1821, according to Biot, opticians regarded the construction of a good achromatic microscope as an impossibility.

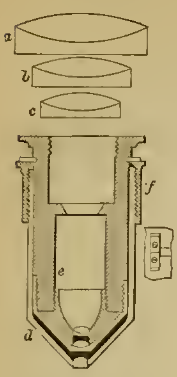
In 1827 Professor Amici of Modena exhibited in England and Paris a horizontal microscope whose object-glass, of large aperture, was composed of three superimposed lenses. A microscope constructed by Chevalier, on Amici's plan, was awarded a silver medal.

The theory of the subject was about this time investigated by Sir John Herschel, Professor Airy, and others, and, acting on their theoretical views, Mr. Joseph Jackson Lister succeeded in effecting one of the greatest improvements in the manufacture of achromatic object-glasses by uniting a plano-convex flint lens with a convex lens by means of Canada balsam.

This diminishes by nearly one half the loss of light occasioned by reflection where the surfaces unite, and prevents the dampness or the formation of mold at the junction.

Mr. Ross, who subsequently devoted much time to the improvement of objectives, employs three lenses of this kind in order to correct the chromatic and spherical aberrations corresponding to varying distances of the object, when it has to be viewed through an interposed plate of glass.

Fig. 3362.



Microscopic Objective.

This is effected — supposing the posterior and middle combinations *a b* to have together an excess of negative aberration — by causing the anterior combination *c* to have an excess of positive aberration, and varying its distance from the other pairs.

For this purpose the anterior lens is set in the end of a tube *d* (as shown in the lower portion of the figure), which slides on a cylinder *e*, containing the remainder of the combination, and is caused to approach or recede therefrom by turning the screwed ring *f* or by simply sliding the tube on the interior cylinder, afterward clamping it.

An aperture is made in the tube *d*, through which is seen a mark engraved on the cylinder. A longer and shorter mark are engraved on the tube; and by bringing the former into coincidence with the mark on the cylinder the adjustment is perfected for an uncovered object. When the shorter mark is made to coincide with the mark on the cylinder, the proper adjustment is attained for correcting the aberration occasioned by glass $\frac{1}{100}$ of an inch in thickness.

Ob′ject-staff. (*Surveying.*) A staff the same hight as the level, forming a sight to be viewed from thence in determining levels.

A leveling staff consists of a graduated strip sliding in the dovetail groove of an upright bar, and provided with a cross-bar to whose crucial point the eye of the leveler is directed. The said bar is raised or lowered until it meets the level, and the hight is read on the staff. The sliding is for purposes of extension when the level is above the top of the main bar.

Ob-lique′ Arch. One which conducts a road or railroad across a river, canal, etc., in an oblique direction; also called a *skew-arch.*

O′bo-e. (*Music.*) Or *hautboy.* A double-reed instrument with a compass of two octaves and a sixth, and written on the G clef. It has three pieces besides the reed-piece.

b. A reed-pipe stop of an organ, tuned in unison with *open-diapason*, and depending for the peculiar quality of its tone upon the shape of the tube through which the sound of the reed is transmitted. See Stop.

Ob-serv′a-to-ry. 1. A building provided with instruments for astronomical observations. See Astronomical Instruments; Armillary-sphere, etc. See list under Optical Instruments.

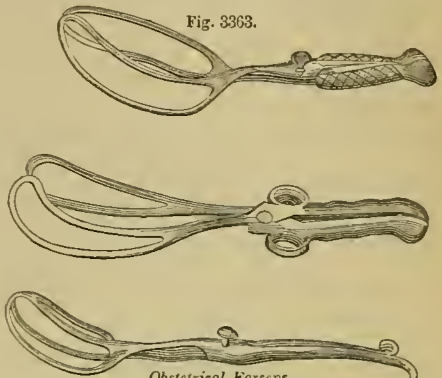
2. A chamber of observation at such an altitude as to look over adjacent objects and afford an extensive view. Used as a lookout-station for the fire-alarm service, for signaling, for meteorological observations, etc.

The iron observatory on the roof of the Equitable Life Insurance Company, on Broadway, New York, is 22 feet high above the roof of the building, which is 130 feet above the sidewalk. The probabilities of the weather are indicated by balls 12 feet in diameter, displayed upon two signal-staffs and visible from various points on Long Island Sound, Sandy Hook, and the inland waters of the Hudson and Harlem rivers. In the building is a large map, displaying the territory throughout which the service has its stations, reaching from Mexico to Canada, and from the Atlantic to the Pacific coast. The state of the weather is indicated by dials at each of these stations on the map, from which reports are received every five hours.

Ob-stet′ri-cal Chair. One capable of affording convenient position for the delivery of the child and access of the midwife.

Ob-stet′ri-cal For′ceps. (*Surgical.*) An accoucheur's instrument for grasping the head of the child and facilitating delivery. They are of varied shapes and construction, and have specific means, such as rings or hooks, to assist the hand when force is applied. The instrument was described by Butler in 1732.

Fig. 3363.



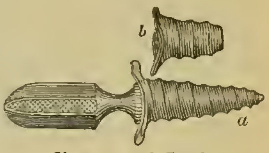
Obstetrical Forceps.

Ob-stet′ri-cal In′stru-ments. (*Surgical.*) For assisting delivery, measuring the pelvic opening, etc. Among them may be enumerated the *cephalotribe*, *crochet*, *forceps*, *obstetrical supporter*, *pelvimeter*, *perforator*, *placenta-forceps*, and *hook.* Herophilus of Alexandria, of the school of Ptolemy, wrote on obstetrics.

Ob-stet′ri-cal Sup-port′er. One having braces around the hips and knees, and affording holds for the hands, to assist the muscular exertions of the mother during parturition.

Ob′tu-ra′tor. (*Surgical.*) An instrument for distending an opening, as in the example, which shows a pointed screw-shaped appliance, used in cases of lithotomy. The instrument shown at *a* is thrust through the portion *b*, and together with it is driven, by pressure and rotation, through the opening made by the gorget, distending it. The *obturator a* is then withdrawn by backward rotation, leaving the *canula b* in situ, to form a channel through which the *lithontriptor* or *lithoclast* is introduced to crush the stone.

Fig. 3364.



Obturator and Canula.

Ob′verse. The face of a coin or medal. The other side is the *reverse.*

An *obverse* tool has the smaller end toward the haft or stock.

Oc′ta-chord. (*Music.*) A musical instrument having 8 strings.

Oc′tant. (*Optics.*) An instrument for measuring angles, resembling a quadrant or sextant in principle, but having an arc of 45°, the eighth part of a circle. See Sextant.

Oc′tave Flute. (*Music.*) A flute having a pitch an octave higher than the ordinary flute. A *piccolo.* See Musical Instruments, Fig. 3263.

Oc-ta'vo. A sheet printed with 8 pages on each side. 8vo.

Oc'to-bass. (*Music.*) An instrument of the viol family, the low octave of the violoncello. It has three strings tuned in fifth and fourth. It has movable keys to press the strings upon frets of the neck. The keys are moved by levers governed by the left hand, and by pedal keys on which the foot of the player acts. Its compass is one octave and a fifth.

Oc-to-dec'i-mo. A sheet printed to make 18 pages on a side. 18mo.

Oc'to-style. (*Architecture.*) Having eight pillars on a front.

Oc'u-lar; Oc'u-laire. The eye-piece of a telescope or microscope.

Odd-side. (*Founding.*) When many castings are required from one pattern, or from a number of patterns, molded in the same flask, the *false-part* is prepared with care in an odd-flask, and is preserved indefinitely. By the use of a good *odd-part*, much time is saved in making the parting.

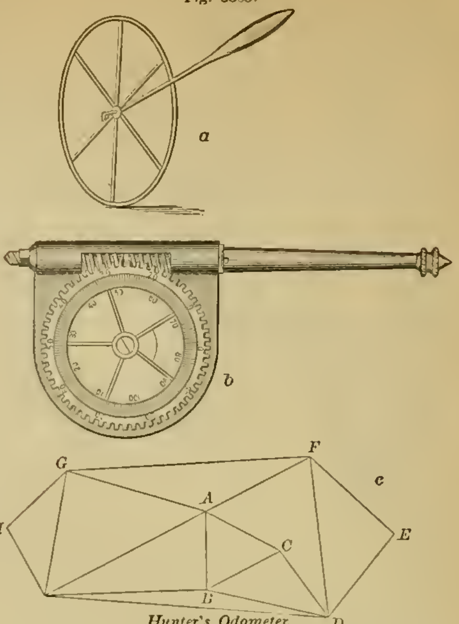
O-dom'e-ter. "The machine for *measuring distances when traveling,*" Vitruvius says, "was discovered by the ancients and is yet found very useful." (50 B. C.) When adapted for a chariot or traveling carriage, the wheels were made of such a diameter that every revolution would advance the vehicle 12½ feet. Thus 400 revolutions passed over 5,000 feet, or a Roman mile. The diameter of the wheels was therefore nearly 4 feet. A drum-wheel was fixed to the inner side of the hub of the wheel, and had one small projecting tooth, which, at each revolution, turned one tooth of a cog-wheel journaled in a box above and having 400 teeth. This cog-wheel had a single projecting tooth which acted on a third wheel which had holes equal in number to the number of miles in an ordinary day's journey.

In each hole of the third wheel was placed a small ball, and these were brought consecutively to an opening in the case through which they dropped into a metallic vase; indicating audibly the transit of one mile at each sound of the ball. By the numerical proportion of the gearing, a ball was dropped at every 400th revolution of the carriage-wheel to whose hub the first drum-wheel was attached. At the end of the journey the number of balls indicated the number of miles traveled.

Vitruvius, in his tenth book, describes a machine of this kind for a carriage, and which, in his opinion, would answer for a ship. We are told by Capitolinus, in his life of the Emperor Pertinax, that among the effects sold, of the Emperor Commodus, there were carriages which "measured the road and pointed out the hours" (et alia iter metientia, horasque monstrantia).

Hunter's odometer *a*, the working parts shown enlarged at *b*, has a light wheel, 6 feet in circumference. This is driven by a handle grasped by the pedestrian. On the axis of the wheel is a worm, which engages two cog-wheels which have 100 and 101 teeth respectively. 100 revolutions of the axis will turn each wheel 100 teeth, so that the zeros of the wheels will be one degree of the scale apart. Another 100 revolutions of the wheel will make their zeros 2 divisions distant, and so on. In the cut the zeros are 78 divisions apart, and the upper index points to 26 of the scale. As each revolution of the wheel is 2 yards, and the revolution of the first cog-wheel is 2 × 100 = 200, each degree of variation is equal to 200 yards. 78 × 200 + [26 × 2] = 15,652 yards.

Fig. 2365.



Hunter's Odometer.

The range of the instrument is when the zero of the second cog-wheel has again reached the zero of the first, which shows 101 × 100 = 10,100 revolutions of the axis, which being 6 feet, the range is found to be 10,100 × 6 = 60,600 feet = nearly 11½ miles.

The odometer is employed in mapping districts of country, filling details of roads and lanes in triangulations. One form used by the United States Coast Survey is a wheel 2 feet 7½ inches in diameter, 8 feet 3 inches in circumference, traversing one rod in 2 revolutions. The index in the box points to miles and rods traversed.

Odometers are sometimes used in hacks and carriages for casual hire, to determine the distance.

Fernel, physician to Catharine de Medici, Queen of France, measured with an instrument of this kind, in 1550, a degree of the meridian between Paris and Amiens, and found it to be 303 toises less than Picard afterward found it to be. It is supposed that the revolutions of the wheel were noted by striking on a bell.

The measurement of a degree of latitude has been made and recorded not less than fourteen times in the last 1,000 years. Its length varies in different countries, as the facts show and theory had supposed.

Eratosthenes, B. C. 276, attempted the measurement of the size of the earth, by ascertaining the distance between Alexandria and Syene, the differences of latitude between which places he had found to be $\frac{1}{50}$ of the earth's circumference.

Some previous measurements are mentioned under Armil (which see). Hipparchus of Nicæa in Bithynia, 162 B. C., laid down a map by the determination of the latitude and longitude of places. A degree was measured on the shores of the Red Sea by the Khalif al Maimoun, the son of Haroun al Raschid, about A. D. 820.

The exact determination of the length of a degree was considered of so much importance that, in 1735, the Academy of Sciences of Paris dispatched two commissions, one to Peru, the other to Lapland.

The latter party accomplished their mission and returned in 16 months; the former party, after contending with great hardships for 10 years, accomplished their mission, as Frenchmen in pursuit of an idea will do, if anybody can.

Since the work of the French Academicians, measurements have been taken in India, France, England, Hanover, Lithuania, and Sweden. One curious discovery resulted, as stated by Sir John Herschel: —

"The earth is not exactly an ellipsoid of revolution. The equator itself is slightly elliptic, the longer and shorter diameters being respectively 41,852,864 and 41,843,096 feet. The ellipticity of the equatorial circumference is therefore $\frac{1}{4283}$, and the excess of its longer over its shorter diameter 2 miles."

The polar axis is 41,707,796 feet in length.

It is many years since better devices superseded the old plan of measuring the surface, as adopted by Fernel in 1550. Picard's more correct estimate was made in the next century, but it is not recorded whether he made it by a direct measurement by rods and chains, or by a measured base-line and subsequent triangulation.

The base-line on which the Ordnance Survey, the triangulation of Britain, is founded, is 5.2 miles nearly. It is said that the greatest *possible* error in the length of this line is 2 inches. See SURVEYORS'-CHAIN.

The diagram *c*, Fig. 3365, will explain.

"A level piece of ground is selected near the meridional arc proposed to be measured. On this a straight line *A B* is traced, and its length accurately found by the application of rods of metal, wood, or glass. The ground adjoining the arc to be measured is then divided into triangles by means of signals *C, D, E, F, G, H, K*, erected at convenient distances or on remarkable points of the country; and the angles which the signals make with each other determined by a theodolite or similar instrument. The sides *A C, B C*, are then deduced from the measured base *A B*, and thence successively the sides of the other triangles. In this manner the whole distance between the stations which form the terminal points of the arc is determined by a series of trigonometrical calculations. The reductions for the differences in the levels of the respective stations must next be applied, and also for their altitude above the level of the sea." — BRANDE.

The following table shows the length of a degree of latitude at every tenth degree: —

Latitude.	Length of degree in English feet.	Latitude.	Length of degree in English feet.
0	362,734	50	364,862
10	362,843	60	365,454
20	363,158	70	365,937
30	363,641	80	366,252
40	364,233	90	366,331

The length of the degrees of longitude at every tenth degree is as follows: —

Latitude.	Length of degree of longitude in English feet.	Latitude.	Length of degree of longitude in English feet.
0	365,152	50	235,171
10	359,640	60	183,029
20	343,233	70	125,254
30	316,493	80	63,612
40	280,106	90	0

Odometers were possessed by Augustus, the Elector of Saxony, A. D. 1553–86, and the Emperor Rodolphus II. 1576–1612. In the eighteenth century they became common, and descriptions are found in scientific reports and works of that date. Hohlfield, born at Hennerndorf, in Saxony, in 1711, seems to have much improved the instrument.

A new French instrument, termed a "compteur mécanique," or calculating-machine, not only reckons the distance traversed, but indicates as well the exact sum of money due to the driver. Two dials are fixed on the back of the driving-seat: one contains a clock, while on the other the distance traveled is indicated by a hand acted on by the wheels; it is entirely beyond the control either of cabby or his "fare." The apparatus is put in and out of gear by the lowering and raising of a lever bearing the word "libre," which is only visible when the cab is empty, and the "compteur" consequently unemployed. There is no danger of the driver omitting to lower this lever as soon as he is hired, it being evidently his interest to have the greatest possible distance paid for; while, on the other hand, it would be useless for him to try to make a fictitious fare by driving about with his "compteur" in motion, for a card in the interior of the machine registers the distance traversed during the day, and the money to be accounted for to the cab-owner. The great difficulty has hitherto been to find a means of marking the time spent in visits, shopping, blocks in the streets, etc., when the wheels and the tell-tale are necessarily at a standstill. M. Bruet, the inventor of the new register, has now overcome this difficulty by a contrivance, by means of which, as soon as the wheels cease to act on the indicator, the clock which forms part of the machine keeps the tell-tale hand moving at a rate which credits the driver with eight kilometers (about five miles) an hour, or two francs, according to the Parisian tariff.

Table of Lengths of Foreign Road Measures.

Place.	Measure.	U. S. Yards.
Arabia	Mile	2,146
Austria	Meile (post)	8,297
Baden	Stunden	4,860
Belgium	Kilometre	1,093.63
Belgium	Meile	2,132
Bengal	Coss	2,000
Birmah	Dain	4,277
Bohemia	League (16 to 1°)	7,587
Brazil	League (18 to 1°)	6,750
Bremen	Meile	6,865
Brunswick	Meile	11,816
Calcutta	Coss	2,160
Ceylon	Mile	1,760
China	Li	608.5
Denmark	Miil	8,238
Dresden	Post-meile	7,432
Egypt	Feddan	1.47
England	Mile	1,760
Flanders	Mijle	1,093.63
Florence	Miglio	1,809
France *	Kilometre	1,093.6
Genoa	Mile (post)	8,527
Germany	Mile (15 to 1°)	8,101
Greece	Stadium	1,083.33
Guinea	Jacktau	4
Hamburg	Meile	8,238
Hanover	Meile	8,114
Hungary	Meile	9,139
India	Wussa	24.89
Italy	Mile	2,025
Japan	Ink	2.038
Leghorn	Miglio	1,809
Leipsic	Meile (post)	7,432
Lithuania	Meile	9,781
Malta	Canna	2.29
Mecklenburg	Meile	8,238
Mexico	Legua	4,633
Milan	Miglio	1,093.63
Mocha	Mile	2,146
Naples	Miglio	2,025
Netherlands	Mijle	1,093.63

* 1.60931 miles = 1 kilometre.

Place.	Measure.	U. S. Yards.
Norway	Mile	12,182
Persia	Parasang	6,076
Poland	Mile (long)	8,100
Portugal	Mitha	2,250
Portugal	Vara	3.609
Prussia	Mile (post)	8,238
Rome	Kilometre	1,093.63
Rome	Mile	2,025
Russia	Verst	1,166.7
Russia	Sashine	2.33
Sardinia	Miglio	2,435
Saxony	Meile (post)	7,432
Siam	Roënung	4,333
Spain	League legal	4,638
Spain	League, common	6,026.24
Spain	Milla	1,522
Sweden	Mile	11,660
Switzerland	Meile	8,548
Turkey	Berri	1,828
Tuscany	Miglio	1,809
Venice	Miglio	1,900

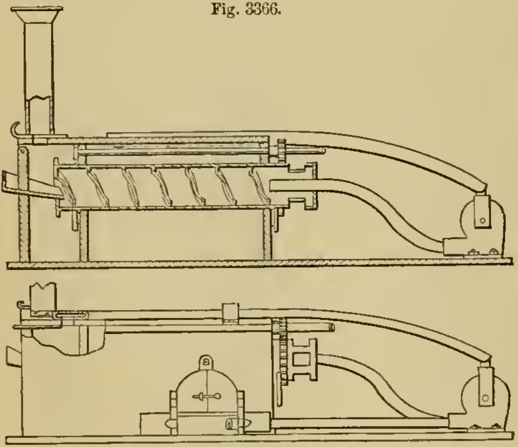
O-don′ta-gra. A form of dental forceps.

O-don′to-graph. (*Gearing.*) An instrument for marking or laying off the teeth of gear-wheels; invented by Professor Willis. It consists of a graduated card or thin board, having one edge beveled at an angle of 75°. This is applied to the radii terminating at the centers of the interspaces between the teeth and the centers from which the curves forming their flanks and faces are laid off from tables printed on the instrument.

Œ-nom′e-ter. A hydrometer adapted to determine the strength of wines.

Of′fal-dry′er. The bones, offal, manure, or other material to be dried, being passed into the rotary cylinder, are caused to traverse the same throughout and discharged at the end adjacent to the fan. The hot fan-blast, together with the steam and offensive gases, may be allowed to pass off directly through the chimney, but by closing a damper they may be conducted to the fan and driven into the ash-pit of the furnace.

Fig. 3366.

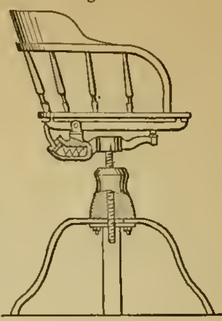


Offal-Dryer.

Off-cut. That part of a sheet which is cut off before folding, and then placed within the other previously folded portion. This occurs in some modes of imposing.

Of′fice-chair. Preferably a chair which may be raised or lowered by a screw, on which it may be rotated, and also admitting of being tipped back. Casters complete the list of adaptabilities, and leave but strength and sumptuous upholstery to be desired.

Fig. 3367.



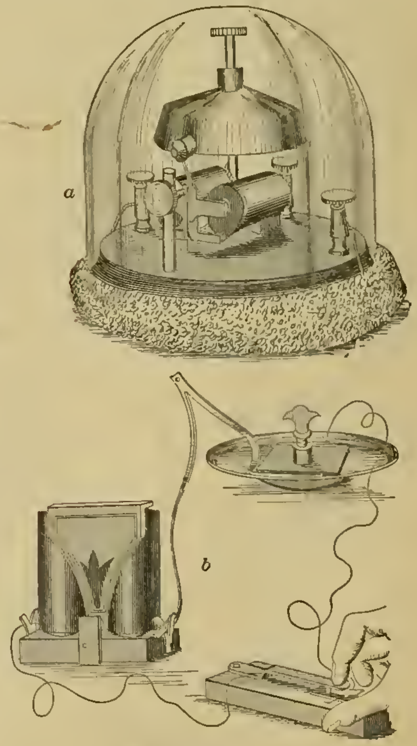
Office-Chair.

Of′fice-tel′e-graph. A form of miniature telegraph for signaling from one room to another in a building.

It consists of a little electric bell, shown at *a*, Fig. 3368; these instruments are placed upon the desks in the various departments of an establishment, and from them wires extend to the desks of the managers, on which buttons are fixed, which connect with the wires. When the manager wishes to communicate with any particular person on the premises, he touches the button corresponding to the wire leading to the bell where the individual is at work. The touch sounds the bell, and, as a variety of signals may be sent, one bell may serve to signalize different persons who are within its hearing. This instrument, with bell, battery, and some yards of wire, is made for $5.

Another form of telegraph, shown at *b*, Fig. 3368, is used for purposes of experiment and instruction as well as communicating messages, and consists of an electro-magnet, sounding armature, a galvanic battery, telegraph-key, connecting-wires, and chemicals, all complete for working. The battery is composed

Fig. 3368.



Miniature Telegraph.

of two small plates, one of lead, one of zinc, the latter covered with paper as a septum, both plates set in a common saucer, in water in which a few grains of sulphate of copper are dissolved.

Off'set. (*Masonry.*) *a.* A ledge on the face of a wall at the point where its thickness is decreased.

b. A break or recess in a front, setting back from the general surface.

O-gee'. 1. A wave-like molding, having an inner and outer curve, like the letter S. Swelling in the upper part and hollow below, is the *cyma-reversa*; hollow in the upper part and swelling below, is the *cyma-recta*. (See Molding.) In its peculiar forms, or with other members of peculiar character, the ogee is known as *rampant ogee*, *quirked ogee*, etc.

2. A pointed arch, the sides of which are each formed of two contrasted curves. See Arch.

O-gee'-plane. A joiner's plane for working ogee-moldings.

O'give. Arches or branches of a Gothic vault, which, instead of being circular, pass diagonally from one angle to another, and form a cross with the other arches which make the sides of the squares, whereof the ogives are diagonals. The middle, when the ogives cut or cross each other, is called the key, sometimes carved in the form of a rose. The members or moldings of the ogives are called nerves, branches, or veins; and the arches which separate the ogives, double arches.

Oil-bag. A sack of horsehair or cocoa-nut fiber, used in pressing oleine from the stearine in a press.

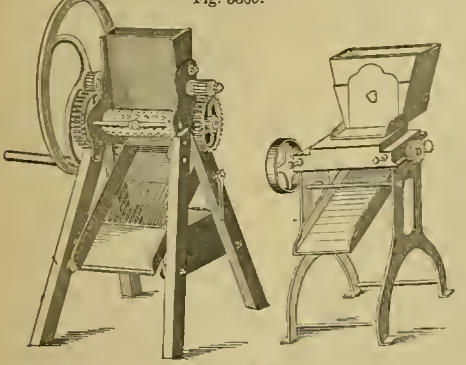
Oil-box. A box containing a supply of oil for a journal, and feeding it by means of a wick or other device. An *oil-cup*.

Oil-cab'i-net. A box or reservoir in which oil is kept in store, either by a retail dealer or in the storeroom of a factory or machine-shop. Cans or oilers are filled from the cabinet by means of a small pump.

Oil-cake. The marc or refuse after oil is pressed from flax, rape, or hemp seed; or from cocoa-nut pulp. Used for cattle-feed or manure.

Oil-cake Mill. A machine to crumble flaxseed oil-cake as a food for stock. The illustration shows a machine with a pair of studded rollers which may be set at such a distance apart as shall give the result required. The machine may be set to nine different grades of fineness without affecting the mesh of the gearing.

Fig. 3369.

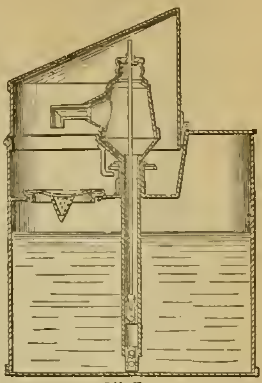


Oil-Cake Mill.

The other illustration is a machine to be run by band and pulley.

Oil-can. 1. One for storage of oil, from which it is withdrawn for sale or use, as the case may be. In the example, the oil-can from which the oiler is filled is placed in the tray, whose floor has an opening for the stock of the pump, which is steadied by a sleeve, and held down by a hook, which engages a flange on the sleeve.

Fig. 3370.

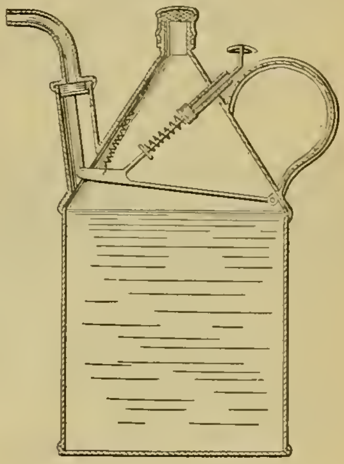


Oil-Can.

2. One for holding oil for supplying lamps, oil-cups, or journals, as in the example, Fig. 3371, in which the spout and vent-hole have stoppers projected against their outlets by the spiral springs and pivoted bar. The sliding trigger opens both at once.

3. An *oiler* for lubricating bearings; one on a larger scale is shown in Fig. 3372, in which the tubular handle has a plunger, which is depressed by the thumb to force the oil from the nozzle. The plunger is connected to the stem of a valve near the point of the nozzle; the valve is opened simultaneously with the depression of the plunger.

Fig. 3371.



Oil-Can.

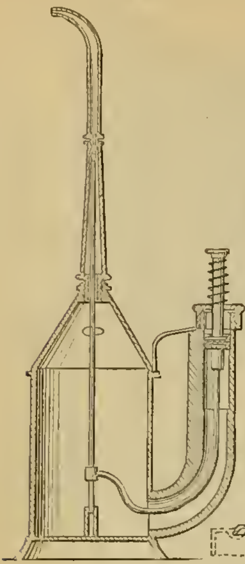
For the smaller kinds of oilers, see Oiler.

Another kind of oil-can is that in which oil in measured quantities is shipped and sold. The ingenuity in this case consists in the nozzle, in the means of making and fastening the joints, so as to be economical of material, ready in construction, and convenient in use. See also Paint-can.

Oil-car. Oil-cars may be seen upon our railways carrying large cylindrical vessels resembling the Western two-flue steamboat-boiler, and with a dome at the midlength. Another form of car-tank is a frusto-conical vat, like a mash-tun; two or three of which are accommodated on a platform-car. Another form is like that in the figure, in which oblong square tanks are built so as to occupy the car-bed, upon which they are fastened by cleats and stay-rods. The tanks are made of matched planks bolted together.

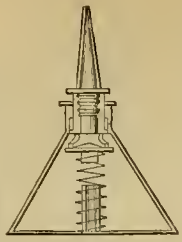
See Oil-tank.

Fig. 3372.



Oiling-Can.

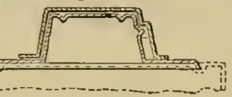
Fig. 3373.



Oiler.

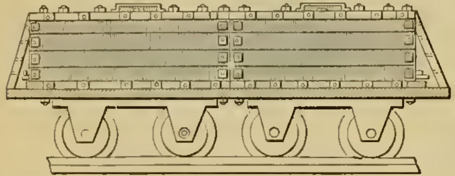
Oil-car'ry-ing Ves'sel. One having built-in tanks in the hold to hold oil in bulk. It has conveniences for loading and discharge, and also for allowing expansion and contraction of the oil without overflow of the liquid or collapse of the tank.

Fig. 3374.



Cap for Oil-Can.

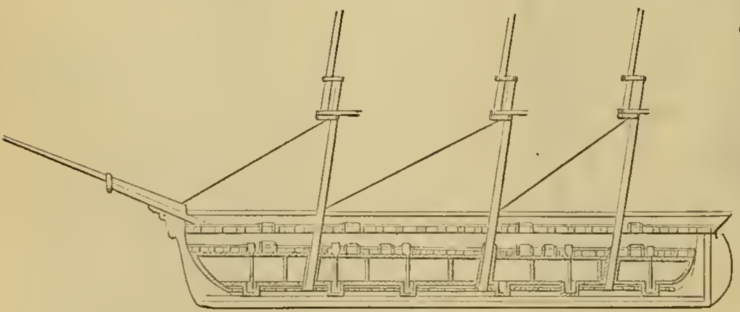
Fig. 3375.



Tank-Car.

Molasses is also carried in bulk from the West Indies to Portland and elsewhere.

Fig. 3376.



Oil-Carrying Ship.

Oil-cel'lar. An oil-reservoir in the bottom of a journal-box.

Oil-cloth. A tarpaulin.

Painted canvas for floor-covering. The latter description is prepared from cloth especially woven for the purpose, frequently of great width, and covered on each side by a peculiar series of processes, with paint. Figures or patterns in oil-colors are afterward printed on one side by means of wooden blocks. See Floor-cloth.

Floor oil-cloth is manufactured from jute, made principally at Dundee, Scotland. This is woven into widths of frequently from 18 to 24 feet, in looms at which two men, one on each side, are employed in throwing the shuttle. The length of the warp often exceeds 100 yards. The pieces are cut to the desired size, and these smaller pieces are stretched upon upright wooden frames, each of which has a series of scaffolds, reached by a ladder at one end of the frame.

When the canvas is perfectly stretched, a weak solution of size is laid on with a brush, and while yet damp it is well rubbed with pumice-stone, filling up the interstices between the threads and preventing the paint from penetrating too far, so as to render the fabric brittle. When this is dry the paint, which is of a very thick consistence, containing little or no spirits of turpentine, is applied in dabs with a short thick brush. These are then partially scraped off with a long elastic trowel, the paint at the same time worked into the cloth, leaving a level surface. This is allowed to dry from 10 to 14 days, when a second and sometimes a third coat of thinner paint is smoothly applied with the trowel, finishing the under side. In the mean time the other side, which is to be finished, is similarly sized and pumiced and a coat laid on with the trowel, and carefully pumiced so as to remove all knots or inequalities from the surface. To this succeed two more layers, each laid on with the trowel and rubbed with pumice, over which a fourth coat, called the *brush color*, forming the ground of the future pattern, is thinly laid on with a brush.

The whole series of operations occupies from two to three months, and when the final coat is dry the cloth is removed to the printing-room. The printing is performed on a long flat table, by means of engraved wooden blocks, the cloth being drawn along the table as required.

One block is required for each color forming the pattern.

The process is thus performed: A number of cushions, one for each color, is placed upon a table, and by the side of each cushion is a pot of color. The cushions consist of a pad of flannel covered with smooth floor-cloth. A boy, called the *tierer* or *tearer*, takes up a portion of color on a brush and spreads it evenly over the cushion. The cloth being spread upon the table, its upper surface is slightly roughened with a steel scraper and afterward with a brush, to enable it better to take the color. The printers, each of whom is provided with a block for containing a separate color, follow one another in succession; each charging his block by pressing it down on the cushion. The first takes it to the cloth and, applying it to his part of the pattern, hits it several taps with the handle of a heavy hammer, leaving an impression in one color only; the second, third, etc., follow, each printing in a similar way his own portion of the pattern in a different color from his predecessor. As the work proceeds the cloth is turned over and descends, through an opening in the floor, to the drying-room, where it sometimes remains several months.

Oil-cock. A faucet admitting oil from an oil-cup to the journal. See OIL-CUP; LUBRICATOR.

Oil-cup. When portable, for oiling machinery, they are considered as OILERS (which see). When attached to a boxing, or otherwise permanent, and devoted to a special bearing, valve, piston, etc., they are considered as LUBRICATORS (which see). Devices for holding oil, in which capacity and storage are elements in their usefulness, are considered under OIL-CAN; OIL-TANK; OIL-CAR.

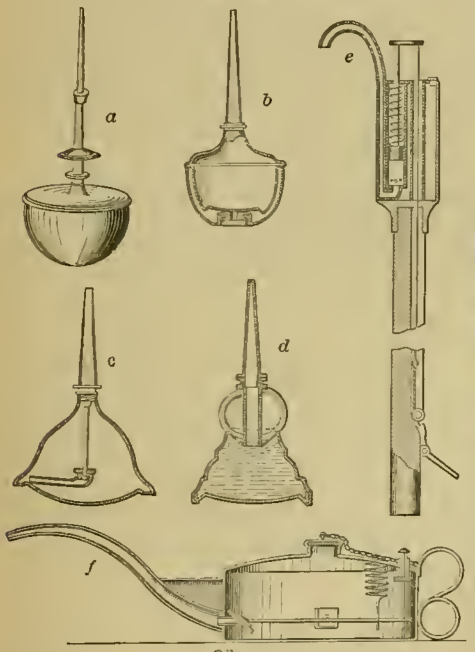
Oiled Leath'er. Leather dressed with oil; as CHAMOIS-LEATHER (which see).

Oiled Pa'per. Transparent paper used for tracing. See TRACING-PAPER.

Oiled Silk. (*Fabric.*) Silk which has been treated with a boiled oil, so as to render it water and perspiration proof. Used as sweat-pads, as a lining in hats and bonnets to resist the perspiration, and over wet dressings of wounds to prevent evaporation.

Oil'er. A can for applying oil to a journal. From the numerous forms the following may be selected:—

Fig 3377.



Oilers.

a is Olmstead's oiler, made of thin sheet-metal, the bottom of the bulb being weighted so that it always stands upright.

b is Broughton's oiler, having an outer shell, an internal reservoir of elastic material, and an opening in the bottom for a thumb-piece, by which the reservoir is compressed to discharge oil.

c has a swiveled tube attached by an elbow to the discharge-tube, and which reaches the oil collected at the lower portion of the can when tilted.

d has a transparent chamber between the nozzle and the reservoir.

King's oiler, *e*, is for reaching shafting in an elevated position; the oiler is placed on the end of a handle, and the oil ejected at the goose-neck by a plunger actuated by a wire and a trigger-lever on the handle.

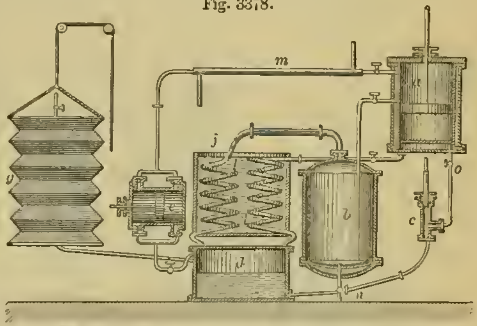
f is an oiler for large machinery, steamships, etc. It is air-tight, and will not discharge when upset, nor when tilted, until the air-valve is pressed by the thumb, although the spout is always full.

An early form of this useful little appliance is to be seen in the British Museum. It is a small horn with a plate on the end, and a nozzle through which the oil exuded. Whether the flat end at the base of the horn is elastic, so as to assist in ejecting the oil, does not appear. It was found at Thebes by Mr. Burton, associated in a basket with several other carpenter's tools, all of which are in the same magnificent collection. The other tools are chisels, drills, drill-bow, saws, mallet, and nail-bag. See cut under MALLET.

Oil-ex-tract'ing Ap'pa-ra'tus. Other than the grinding-mill and press, chemical means have been used for extracting oils from seeds, nuts, grain, fruit; also oil from wool. The seeds or nuts are crushed or ground, immersed in bisulphide of carbon, which extracts the oil and resin they contain, but leaves the substance otherwise unaltered. The solution is then removed, the bisulphide distilled off, leaving the oil, like the raw oils extracted by pressure, contaminated to some degree with resinous and coloring matters, which are removed by a second process of refining.

This process was invented by Moison of Mouy, in France, and used by him in cleansing wool from the *suint*, as also from the grease and tar with which the sheep had been treated or marked. It was afterward adopted to separate oils, fats, and resins from the substances with which they are combined, and for supplementing the mechanical processes by operating upon oil-cake, the marc of olives, etc.

Fig. 3378.



Moison's Apparatus for removing Oil from Wool.

In Moison's process the wool to be subjected to treatment is introduced into a cast-iron cylinder *a*, surrounded by a jacket into which steam may be conducted when it is necessary to raise the temperature. 214 pounds of wool are placed in this cylinder at once. Within the cylinder is a false bottom perforated with numerous holes, with a small free space beneath it. Upon the top of the wool is placed a circular follower or compressor, fitting the interior of the cylinder, and perforated also with holes like the false bottom. Three rods connected with this follower pass through stuffing-boxes in the lid, and may be driven downward by means of fixed screw-nuts, the rods having screw-threads cut upon their prolongations above the cylinder to compress the wool to about one half its original volume. The lid being luted on, bisulphide is introduced by pump *c* from reservoir *d*, forced through the layer of wool and overflows into the still *b*, where it is volatilized by steam in the jacket. The vapor of the bisulphide is conducted from the still to the refrigerator *j*, where it is condensed in the spirals *l l* and returned to the reservoir *d*. When no more oil comes over, the pump is stopped, the vessel *a* discharged by the stop-cock *o* leading to reservoir *d*, and the oil remaining in the still from the distillation of the bisulphide is withdrawn at the stop-cock *n*. The proper changes of stop-cocks being made, the air-pump *e* is brought into requisition to fill the upper portion of chamber *a* and drive the bisulphide downward out of the wool. To make this more complete, at the latter stages, the air from pump *c* is led through the steam-jacketed chamber *m* to enable it to volatilize the bisulphide of carbon in *a*. *g* is a gas-holder to hold any superfluous gas, to keep the capacity adjusted to the varying volume of the contents. The boiling-point of the bisulphide of carbon is 118° Fah.

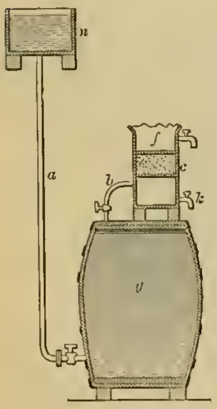
The process is adapted to dissolving the oils contained in the strippings of machine-cards in factories, and saving the waste from the axles of car-boxes, the journal-boxes of machinery. See also Sim's and Hutchinson's processes and machines, patented 1869, 1870, 1871. These are also particularly intended for extracting fusel-oil from grain.

Oil-fil'ter. Robinson's oil-filter acts by the upward pressure of a column of water below the oil.

The operation is as follows: —

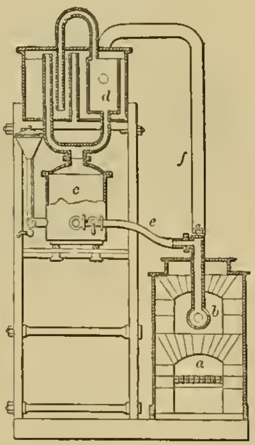
The butt *g* of oil being placed on a stillion, communication is made with its lower portion by means of a pipe *a* leading from a cistern of water *n*. As the water flows into the butt, it displaces the oil, which passes by pipe *b* to the lower chamber of the filter which stands on the head of the butt. It thence passes through the perforated plate, a body of charcoal *c*, and a second perforated plate, to the upper chamber *f*, from whence it is discharged by the faucet. Impurities in the lower part of the filter are discharged by the faucet *k*.

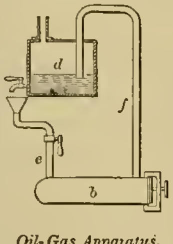
Fig. 3379.



Robinson's Oil-Filter.

Fig. 3380.





Oil-Gas Apparatus.

Oil-gas. Gas was distilled from oil by Dr. Henry in 1805; and from refuse oily and fatty matters by Taylor, and patented in 1815.

The apparatus for the distillation of oil to obtain a permanent gas consists of a furnace *a* and retort *b*, the latter being charged with coke or brick, on whose heated surfaces the oil drips continuously from a reservoir.

The retort is a cylindrical vessel with a luted cover, and the oil is supplied in graduated quantities through a pipe *c* from a copper reservoir *c*. The gas evolved passes by an eduction-pipe *f* to a cistern, where, after passing through water, it is led by a pipe to the holder. The reservoir *c* also serves to receive the oil which may condense in the gas-holder *d* above. The double walls of the gas-holder contain water to cool the gaseous products of distillation.

There are many minor variations of the apparatus, but it is a simple process, requiring an occasional change of the coke.

Oil-gild'ing. A process of gilding in which the gold-leaf is laid on a surface prepared by a *priming* of whiting and size; several coats of *clear cole*, or transparent size; and an upper surface of *oil-gold size*, made of boiled linseed-oil and ochre, laid on by a brush. See GILDING.

Oil'ing. (*Wool.*) A stage in the manufacture of wool, which is first *opened* by the *devil* or *willy*, and then *burred* in a machine to remove impurities. The *oiling* follows, to prevent the fibers from becoming felted in the subsequent *scribbling* and *carding*.

Oil-leath'er. (*Leather.*) Oil-leather is prepared by currying hides in oil. Neat's-foot oil is used, but fish-oil is more commonly employed; to this the French add potassa. It is both more economical and more effective. The hides are somewhat moist, that the oily matters may be gradually and thoroughly absorbed.

"A coating of oil is uniformly spread over the grain and flesh sides, after which the hides are hung up to dry, the direct rays of the sun or too violent a draft being guarded against. In summer time the drying is effected in 12 hours, in winter it may extend to 3 or 4 days. When dry, the hides are again fulled, oiled, and dried. This is repeated. Finally, the grain-side is cleansed by rubbing it well with a brush and weak potassa lye. The coloring of the grain or flesh side, as the case may be, follows these operations, and is effected by a dye." As, for instance, the solution of sulphate of iron, which unites with the gallic acid of the tan to produce a black dye. "After receiving one coat the leather is pommeled crosswise; another layer of blacking is applied; dried, pommeled, or stretched, according as it is deemed necessary; rubbed over with a cork pommel to give it a smooth surface, and finished by giving a light coat of oil on the hair-side." — MUSPRATT.

Oil-mill. There are several varieties of oil-mills: —

1. With cylindrical rollers rotating on parallel axes and with their peripheries in contact, or nearly so. These rollers are of cast-iron, turned truly in a lathe, and with gudgeons running in brass boxes in the cheeks of the frame. A difference of speed adds a certain grinding action to the mere forcible pressure, and may be attained in one of two ways: —

a. By giving an equal axial speed to the rollers, which have varying diameters; or

b. By driving rollers of equal diameter at varying axial speeds.

The variation in speed is best attained by an unequal number of teeth in the driving-pinions.

2. Another form of oil-mill is the ancient *Phœnician* or *Chilian mill*, which has two rollers journaled to a horizontal shaft projecting from a vertical and

rotating post, the peripheries of the rollers traversing on a flat circular bed.

This is a grinding and crushing action, inasmuch as the flat face of the stone is parallel to the axis, and the portions of the face farthest from the vertical axis of revolution tend to traverse farther than the portions nearest to the said axis, so that, a compromise being effected, one portion or the extremes of each are obliged to rub as they rotate. The same principle is involved in this that is found in the traversing of a curve by the pair of wheels of a railway car. The wheel traversing the outer rail of the curve has farther to go than the inner wheel, and the latter will compel the outer one to slip back or the outer one will slip the inner wheel forward, — if the rails be in a horizontal plane. This brings a torsion on the axle, and is a fruitful cause of accidents; but is a valuable feature in the Chilian mill, so called, as it tends to mix and macerate the material, instead of packing it into a cake. See CHILIAN MILL.

The rolling-mill is sometimes employed as a preliminary, in the case of seeds with compact and slippery rind, such as those of flax and rape. Such seeds may then be subjected to the first expression, for the first quality of *cold-drawn oil.*

The press for the expression of the oil may be worked by screw, wedge, or hydrostatic power. See HYDROSTATIC PRESS; SCREW-PRESS; WEDGE-PRESS.

The magma after the first expression may be reground in the *Chilian mill,* or subjected to vertical stamps, which mash the seeds in mortars placed beneath them. See STAMPING-MILL.

The first and second expressions of oil having been obtained cold, the magma is now subjected to heat in a pan, being constantly stirred by a machine-driven spatula. It is then ready for the third pressure, which is final, if the resulting cake is to be used for cattle-feed. If, however, the last atom of grease is to be obtained, the magma is boiled, and the result of the fourth expression is so complete that the cake has no value except as manure.

In this recitation of processes it must not be overlooked that the repetitive method is only used where the various grades are required, and the system varies with different seeds and nuts. The resulting oils derived from the pressure of different vegetable productions bear different values, and the plans adopted vary to some extent with the kind.

It is common in the case of flaxseed, which leads the list in point of importance, to grind and heat the seed and then subject it to the hydrostatic press, securing all the oil at a single or once-repeated pressure.

Castor-oil is valued more highly, and is cold drawn, or should be.

A list of the more important expressed oils is given, with some particulars as to each.

Variety.	Quality.	Specific Gravity.	Oil per cent. Ure *et al.*
Flax	Drying	0.9347	11 – 22
Poppy	D.	0.9243	56 - 63
Hemp	D	0.9276	20
Sesamum	Greasy		50
Olive	G.	0.9176	
Almond	G.	0.9180	50
Cucumber	D.	0.9231	25
Beech	G.	0.9225	16
Mustard	G.	0.9160	30
Sunflower	D.	0.9262	15
Rape	G.	0.9136	33
Castor	D.	0.9611	62
Tobacco	D.	0.9232	
Plum-kernel	G.	0.9127	33
Grape-seed	D.	0.9202	20
Cocoa-nut	G.		
Palm	G.	0.968	
Camelina	D.	0.9252	28
Cotton-seed	D.		12
Colza	G.	0.9136	40
Radish-seed	G.	0.9187	50
Apple-seed	G.		
Horse-chestnut	G.	0.927	10
Pine-top	D.	0.9285	
Walnut	D.	0.9260	60

OILS, WAX, ETC.

Common Name.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Almond	Amygdalus Communis	S Europe, etc.	One of the finest of fixed oils; used chiefly in medicine.
Argan	Argania syderoxylon	Morocco	Obtained from the kernels of the fruit; resembles olive-oil.
Beech	Fagus sylvatica	Europe	The mast affords an oil used for burning and in cooking.
Ben	Moringa pterygosperma	India and Arabia.	Oil from the seeds of the horse-radish tree. Used in perfumery and by watchmakers on account of its not readily freezing.
Birch	Betula alba	Europe	Bark affords an oil by distillation. Used in the preparation of Russia leather.
Brazil-nut	Bertholletia excelsa	Brazil	Used for burning in lamps.
Butters	....	....	Term applied to the semi-solid greasy substances that exude from trees, as shea-butter, butter and tallow tree, vegetable butter, etc. Used for cooking and burning.
Cacao	Theobroma cacao	Hot climates	The "cocoa-nibs" of the shops. Used as a beverage. Afford an oil or butter which can be used for burning.
Cameline	Camelina sativa	Europe, etc.	Oil from the seeds. Used for burning in lamps.
Candleberry	Myrica cerifera Myrica cordifolia	N. and C. Amer. Cape of G. Hope.	The berries contain a wax-like matter, which is converted into candles, producing an aromatic odor as they burn.
Candle-nut	Aleurites triloba	S. Sea Islands	Seeds contain oil. Used for food and for burning in lamps. Are strung on sticks by the natives, and so used as candles.
Carapa	Carapa guineënsis	W. Africa, etc.	Seeds afford oil used by the natives for burning and anointing. In S. France made into soap.
Cocoa	Cocos nucifera	Hot climates	The oil of the cocoa-nut is the chief material from which composite, stearine, and other candles are made. Used also in soap-making and for "railway grease."
Colza	Brassica campestris	Europe	Seeds of a variety of the cabbage tribe afford this oil. Used in lamps; largely used in lighthouses.
Cotton	Glossypium herbaceum	Hot climates	Oil used for burning.
Crab	(See Carapa.)		
Dodder	(See Cameline-oil.)		

Common Name.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Fusel	Triticum, etc	Europe, etc	Seeds produce a peculiar oil. It gives the flavor to raw whiskey and is used for making flavoring extracts. Formerly used for burning
Gingilie	(See Sesamum.)		
Ground-nut or earth-nut	Arachis hypogæa	Europe, etc	Affords oil used in cooking, burning, and for making soap.
Hazel	Corylus avellana	Europe, etc	Nuts afford oil. Sold as "nut-oil." Used by painters, perfumers, and medicinally.
Hemp-seed	Cannabis sativa	Europe, etc	Used for burning, paints, varnishes, and for soft soaps, etc.
Insect wax Japan wax Java wax	(See Wax.)		
Linseed	Linum usitatissimum	Europe, etc	Boiled with litharge produces the "boiled oil" of paints and varnishes. Used in burning, etc. The refuse of the seeds affords the oil-cake for fattening cattle.
Maize	Zea mays	Warm climates	Oil extracted from the seeds.
Mee	Bassia longifolia	Tropics	Obtained from the seeds. Used for burning, etc.
Myrica wax Myrtle wax	(See Candleberry.)		
Mustard	Sinapis alba et nigra	Europe, etc	The husks and seed afford a fixed oil.* Used for burning in lamps, etc.
Nancel	Bassia latifolia	Tropics	Oil obtained from the seeds. Used in burning, etc.
Nut-oil	(See Hazel and Walnut.)		
Olive	Olea europæa	Europe, etc	One of the purest of vegetable oils. Used in the arts and for salads. In Italy is used in lamps.
Palm	Elais guineensis	W. Africa	The fruit affords the palm-oil used in candle and soap making.
Pine	Pinus sylvestris	Europe, etc	Leaves afford an oil which can be made into soap.
Poppy	Papaver somniferum, *var.* nigrum	India, etc	Oil used extensively in the arts and for adulterating more expensive oils.
Rape	Brassica oleracea, etc	Europe, etc	Extensively used for burning in lamps. Colza is similar to it. When refined is equal to sperm-oil.
Sesamum	Sesamum indicum	India, etc	Seeds afford an oil used in India for cooking, burning, anointing, etc. Elsewhere used in lamps and for making soap.
Shea butter or oil	Bassia parkii	W. Africa	Seeds afford an oil used in Europe for candle and soap making, etc.
Souari-nut	Caryocar nuciferum, etc.	S. America	Contains a sweet oil. Much used in S. America.
Sunflower	Helianthus annuus	Europe, etc	Seed yields an oil. Used in making fancy soaps, etc.
Tallow (vegetable).	Pentadesma butyra	Sierra Leone	Tallow, a term often applied to solid fatty substances obtained from plants. That produced from the seeds of the *Stillingia sebifera* is used for candles by the Chinese.
	Stillingia sebifera	China	
	Bassia butyraceæ	N. India	
Walnut	Juglans regia, etc	Europe and America	An oil often sold as "nut-oil." Used in the arts and to adulterate other oils.
Wax (bees)			Beeswax, although not strictly a vegetable production, is primarily derived from the pollen of flowers.
Wax (insect)	Fraxinus sinensis	China	A kind of wax deposited by an insect, the *coccus pe-la*, on the leaves of this species of ash.
Wax (Japan)	Rhus succedanea	Japan	A vegetable wax afforded by the fruit of the tree. Used in candle-making.
Wax (palm)	Copernicia cerifera	Brazil	Wax obtained from the surface of the young leaves of the plant.
	Ceroxylon andicola	Andes	Wax obtained by scraping the trunk of the tree. Used with tallow to make candles.
Wheat-oil	(See Fusel-oil.)		

ESSENTIAL OILS.

Aniseed	Pimpinella anisum	Europe, etc	Seeds afford an oil used in medicine and flavoring spirits for liquors.
Bergamot	Citrus aurantium	S. Europe, etc	Rind of fruit affords an oil. Much used in perfumery, essences, etc.
Cajeput	Metaleuca cajeputi	Moluccas	A volatile oil which dissolves india-rubber.
Camphor	Camphora officinarum	China, etc	A solid essential oil. Used in medicine, etc.
Cedar	Cedrus rubra	Generally	Wood yields an essential oil. Used in perfumery, etc.
Chamomile	Anthenus nobilis	Europe	The dried flowers afford an essential oil.
Citron	Citrus medica	Europe	Fragrant oil. Used by perfumers.
Citronelle	Andropogon citratum	India, etc	Obtained from lemon-grass. Used in perfumery.
Clove	Caryophyllus aromaticus	Tropics	Fragrant oil. Used in perfumery.
Fennel	Fœniculum vulgare	Britain, etc	Used in medicine.
Grass	Andropogon (various)	India	Obtained from various Indian grasses. Used in perfumery and medicine.
Jasmine	Jasminaceæ	Asia, Europe	A perfume. Obtained from the flowers by placing them in tallow and extracting by means of alcohol the volatile principle.
Lavender	Lavendula vera et spica	Europe	Oil used largely in perfumery and medicine.
Lemon-grass	Andropogon citratum	India	A delicious essential oil.
Lemon	Citrus limonum	Warm climates	The rind affords an oil used in perfumery, flavoring, etc.
Neroli	Citrus (various)	Europe	Perfumed oil obtained from various species of the orange family. Affords the "orange-flower water" of the shops, etc.
Nutmeg	Myristica moschata	Moluccas, etc	Essential oil. Used in perfumery.
Otto or attar of rose	Rosa moschata Centifolia, Damascena	Turkey and Syria.	A fragrant oil obtained from the Eastern species of rose.
Orange	(See Bergamot, Neroli.)		
Patchouli	Pogostemon patchouli	India	Plant affords an oil. Used as a perfume.

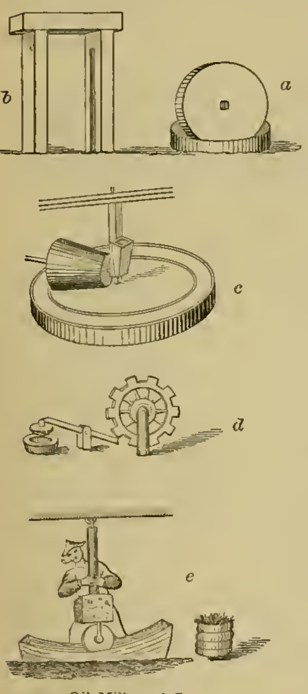
Common Name.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Peppermint-oil	Mentha piperita	Britain, etc.	Used in medicine.
Rosemary	Rosmarius officinalis	Europe, etc.	Tops of plant afford an oil. Used in perfumery, medicine, etc.
Sandal-wood or sandal-wood	Santalum	India	Yields an essential oil heavier than water. Used in perfumery.
Winter-green	Gaultheria procumbens.	N. America	The plant affords an essential oil. Used in medicine, perfumery, and for flavoring.

The most ancient oil-mills are those used for mashing the olive. They were used in Palestine at a very early date. Although Solomon, A. D. 1015, supplied Hiram with 20,000 baths of oil, in addition to the grain and wine, in return for the "timber of cedar and timber of fir," yet the Phœnicians themselves were great cultivators of the olive and traders in oil. The means they used were the mill, such as we now call the "Chilian," followed by a lever-press. The stones, bed-plates, and press-frames yet remain in the country to attest the fact.

Olives were known in ancient Egypt, and their cultivation was imported thence into Greece. Cecrops (1556 B. C.) is credited with the introduction of the tree, and Aristæus the Athenian (1450 B. C.) was deified as the inventor of expressing-machinery.

They were introduced into Italy about 562 B. C., during the reign of Servius Tullius, which was coeval with that of Nebuchadnezzar, and with the prophecies of Daniel. This was nearly 100 years before Marathon.

Fig. 3381.



Oil Mills and Presses.

The Phœnician mill is shown at *a* in the accompanying cut, which is taken from Thompson's Researches in Palestine. It is drawn from one at Em el' Awamêd. The stone wheel had an eye for the shaft, to which the draft animals were attached, and the fruit was mashed by the revolution of the stone in the basin.

The press-frame (*b*) consisted of two upright posts and a very heavy cross-piece, being evidently a *beam* or *lever* press. A beam above the platen which rested on the olive-cheese traversed in grooves on the inner faces of the posts, and was depressed by a weighted beam. This was before Archimedes and the screw.

The basin represented is 8 feet in diameter, and a stone trough in the vicinity was doubtless used to receive the oil as it flowed from the press.

The basins and posts with huge stones on top are numerous in some sections of Palestine, where the long-lived olive has rotted away and left no trace. 2,400 years have passed since these lands were fully tended; the Assyrian, Persian, Greek, Roman, Saracen, and Turk have overrun the land, and the modern Syria is now occupied by a million and a half of people divided, by race or religion, into 16 tribes, who are Ishmaelites in *deed* and many of them in *blood.*

The Spanish olive-mill (*c*) is used for crushing that fruit to obtain the oil, which stands instead of butter and lard in a land that once afforded Columella a subject for praise in the conduct and productions of the dairies of Andalusia. The Spain of to-day is not what it was in the time of Cato, nor indeed what it was under the occupancy of the Saracens. It has probably retrograded in health, wealth, morals, productiveness, and in scholastic and executive ability.

Loudon remarks, that although the olive is grown in Spain in greater perfection than in Italy, owing to some manorial rights or a system of farming the taxes, all the olives of a district are brought to one place to be ground and pressed; and as each heap has to wait its turn, the olives in many of the heaps become black and rancid.

A friend of the missionary W. M. Thompson, who farmed the district of el Mughar, near the lake of Tiberias, states that a black color does not hurt the olives as they lie in the heap. The modern Syrian plan embraces two modes of grinding the fruit and expressing the oil: —

1. The *m' ascrah*, which is worked by hand and used for grinding the early fruit before the streams are raised by the winter rains which start the water-mills. In the *m' ascrah* the fruit is ground by a revolving stone in a stone basin, much as in the ancient Phœnician method just described. It is pressed in a beam or screw press, the mass being packed into straw baskets, which are piled one above another in the press. The cheeses, after one pressure, are broken up, put in copper pans over a fire, sprinkled with water, heated, and re-pressed.

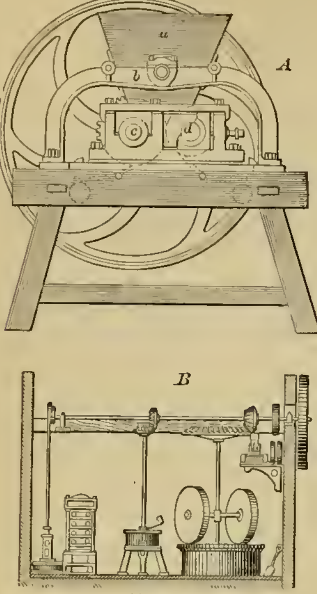
2. The *mutruf*, driven by water-power, and pounding the olives with a stamp in a heated, vertical stone cylinder. The face of the stamp is of iron cross-bars, and it is rotated as it works. The mass is taken out below, put in baskets, and pressed. The process is repeated. The details of the operation are probably almost identical with those in vogue 3,000 years ago.

In China, the pestle and mortar (*d*) are used in reducing to powder the seeds of the oil-bearing tea-plant. The meal is boiled in bags and pressed to yield the oil. The lever is tripped by the cogs of the sprocket-wheel, and falls by gravity.

e shows the press used in China in crushing the seeds of the tallow-tree. The weighted wheel is suspended by a rod from a beam, and is oscillated to and fro by the workman, traveling upon the seeds which are placed in the trough below. The oil procured from the bruised seeds by heat and pressure is added to vegetable oil and wax to the required consistence for candles.

A (Fig. 3382) illustrates a mill for crushing seeds preparatory to extracting the oil therefrom by pressure. The seeds are fed from the hopper *a* by a roller *b*, the amount being regulated by an adjustable plate, and pass between the crushing-rollers *c d*, the smaller one of which has adjustable bearings, so that the distance between them may be varied. The larger roller is driven by belt and pulley, and has a spur-gear which moves the smaller one.

Fig 3382.



Oil-Mills.

B shows a mill, heater, and press combined.

Fig. 3383 is the olive-mill of Barbary.

Fig. 3383.

Olive-Mill of Barbary.

Oil-of-brick. An empyreumatic oil used by lapidaries as a vehicle for emery, by which precious stones are sawn or cut.

The brick is soaked in oil and subjected to distillation at a high temperature.

Oil-paint'ing. The process of painting with colors held in solution by volatile or evaporable oils which, on drying, leave the pigment combined with the solid constituents of the oil, upon the surface to which it has been applied.

Linseed-oil was undoubtedly used as a medium for painting in very early times, but the term "oil-painting" has by custom become restricted to the fine arts.

The pictorial representations of the ancient Egyptians were executed upon a ground of plaster or calcareous wash; the colors, according to modern analysis, were mixed with a resinous size or animal glue, and the whole covered with a coat of varnish.

Analogous substances for holding and fixing the colors appear to have been in use down to the latter part of the thirteenth or early part of the fourteenth century.

The oldest painting in oil-colors at present known was painted in the year 1297, by Thomas de Mutina or de Mutterfdorf, in Bohemia. It is in the Imperial Gallery of Bohemia. Two other paintings are in the same collection, by Nicholas Wurmser of Strasburg, and Thierry of Prague, respectively.

These paintings antedate by many years those of Hubert and John Van Eyck of Bruges, who lived during the earlier part of the fifteenth century, and to whom the invention of oil-painting is generally ascribed.

Oil-press. A press for extracting oil from the seeds of various plants. Formerly, linseed constituted by much the largest source of supply, but within the past few years cotton-seed is largely used, it as well as linseed yielding a large proportion of oil, beside meal or cake well adapted for feeding cattle or hogs. Cotton-seed (excepting Sea Island) is preferably decorticated previous to being ground and pressed, otherwise the treatment of these and linseed is the same.

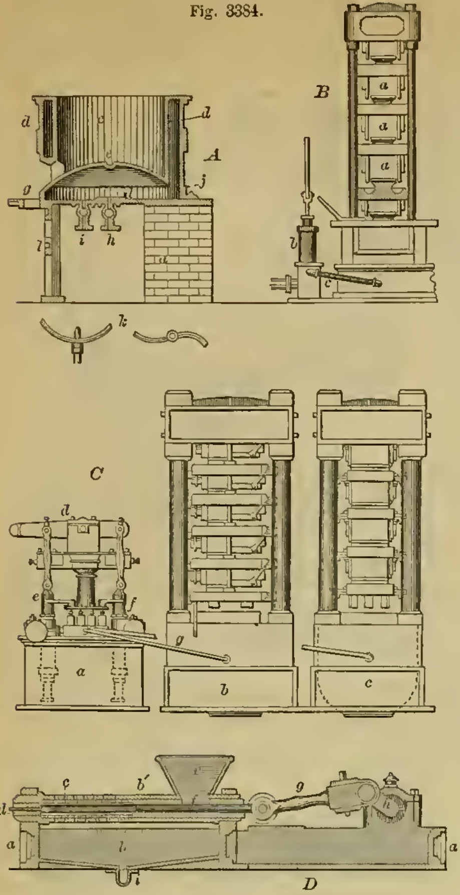
The seed is first passed between two rollers, one of which revolves more rapidly than the other, subjecting it to a drawing as well as a crushing action; from these it is transferred to the chasers, two heavy circular stones turning upon a third stone, and moistened with water to prevent the meal from adhering; when thoroughly ground it is put in a heater; of this there are several forms: that shown at *A*, Fig. 3384, consists of a cast-iron cylinder *c* supported by the brick foundation *a*, surrounded by a steam-jacket *d d*, to which steam is admitted through the pipe *h*, the water of condensation being drawn off through *i*. A charge of meal is introduced into the cylinder and agitated by a rotary stirrer stepped in the depression *c*; the steam is let on, and when a temperature of 180° to 190° Fah. is attained the gate is opened and the meal withdrawn, falling through the aperture *g* into a bag beneath; the bag being partially filled, its unfilled portion is turned over so as to close its mouth, and it is placed within a squeezer made of horsehair cord covered with leather, and having a handle attached by copper rivets. These are then introduced within the boxes *a a a* of the hydraulic press *B*, and subjected to pressure; *b* is the pump, and *c* the pipe by which its pressure is transmitted to the ram of the press.

C represents Blundell's press, *a b* a side and *c* an end elevation; *d*, the operating-lever; *e f*, plungers and pump-cylinders; *g*, pipe transmitting pressure to the ram.

D is a plunger-press, to be presently described.

The product of oil is about 2 gallons from a bushel of linseed, or 56 pounds of hulled cotton-seed; that

Fig. 3384.



Oil-Heater, Presser, and Hydrostatic-Press Pump.

from Sea Island seed, which does not require hulling, is about 90 gallons from each 100 bushels.

"The oil-press was invented by Aristæus, the Athenian"; so says Pliny. To find the date at which he flourished, we must consult the marriage register. He was a son of Apollo, but married a daughter of Cadmus about 1450 B. C., let us say. He found time between his spells of running after Eurydice to instruct men in the culture of the olive and of bees. This was about the time of Joshua. Archæologists have shown it to be probable that the Phœnicians practiced both the arts before Aristæus destroyed the harmony in the household of Orpheus.

The oil-press used by the Phœnicians in the time of Solomon, and substantially in use at the present day in Syria and Palestine, consists of two posts and a very heavy lintel. The press is illustrated in OIL-MILLS (which see) in connection with the basin and revolving stone by which the fruit is ground. The crushed fruit in straw baskets was (and is) placed on a bed-piece, the platen adjusted, an upper beam laid upon the platen, its ends traversing in grooves on the inner faces of the posts as it was pressed down by a lever above. This accounts for the lintel being so heavy, as it was required to resist the upward thrust of the lever. The screw-press was then unknown.

The olive is a native of Asia, from which it has been transported to Africa and Southern Europe.

The wedge-press, which is sometimes used for expressing linseed-oil from the hot magma, is a somewhat crude but powerful press. The bags of ground seed are placed in bags between followers, which are driven toward each other by wedges driven in above and below.

The hydraulic press does not differ substantially from that employed for other purposes, and is described under HYDROSTATIC PRESS (which see).

In the English practice, the flaxseed is crushed between rollers, then ground beneath an edge-stone, heated, filled into bags, and then pressed in a wedge-press or a hydraulic press.

The castor-oil plant (*Ricinus communis*) was well known to the Egyptians, and is called *silli-cyprium* by Herodotus, and *kiki* by the inhabitants of Egypt. The oil was then extracted by pressure or by boiling, and used for anointing. It was probably Jonah's plant, *kikion*, being mistranslated *gourd*. Herodotus and Pliny claimed that it smelt badly, but had its uses medicinally.

Bessemer and Heywood's machine (*D*, Fig. 3384) for expressing oil from seeds (English) consists of a bed-plate or framing *a a*, cast in one piece and having a receptacle *b* for receiving the expressed oil. The frame supports a gun-metal cylinder *b′*, within which is fitted a tube *c*, having a spiral exterior perforated groove, and lined with an open-ended bag of coarse fabric containing a cylinder of wire gauze or perforated metal. The cylinder *b* is contracted at *d*, so as to support the interior tube against longitudinal pressure, and prevent the rapid escape of the pressed seed. The seeds are placed in the hopper *c*, and as the plunger *f* is drawn back by the connecting-rod *g* on the crank-arm *h*, a portion falls into the tube, and on its return movement is forced into the bag before described, where the seeds are crushed, a portion of the cake thus formed being at the same time expelled through the contracted end of the tube. The expressed oil passes through the openings in the inner and outer cylinders, whence it is withdrawn by the pipe *i*.

Oil-pump. A pump to raise oil from a can or reservoir and discharge it on to a journal.

Oil-re-fin′ing Ap′pa-ra′tus. The apparatus employed for separating the various ingredients contained in crude petroleum in the process of obtaining kerosene consist of an iron still having a wrought-iron worm-pipe, which is submerged in a tank containing cold water. The still having been filled with crude oil, a fire lighted beneath it causes the oil to boil, and drives off the more volatile vapors which at ordinary temperatures pass over without being condensed. By surrounding the coil with ice or by compressing these gases by means of an air-pump, they may be condensed into the form of very volatile liquids, termed *rhigolene* and *chymogene*.

After these have been eliminated, the vapors begin to condense in the coil, the resulting oil being received in a tank at its farther end. That first formed has a gravity of about 95° Beaumé, but the product becomes heavier as the process proceeds. It is usually customary to direct the stream into one tank until the gravity reaches from 65° to 59° B., forming crude naphtha, when it is diverted into the kerosene tank, into which it is allowed to flow until a gravity of about 38° B. is reached, or the oil becomes of a yellow color. This second fraction is the burning-oil, which requires a farther purification to fit it for use. The stream is next directed into the paraffine oil-tanks, and allowed to run until nothing remains in the still except coke. When, however, very large stills of 1,000 barrels capacity or upward are employed, the distillation is stopped when the residuum has attained a tarry consistence, the remaining oil being extracted in smaller stills.

By slow distillation in high stills, the production of the heavier oils may be avoided, they being "cracked" into lighter oils, so that only crude naphtha, kerosene, and coke result.

The burning-oil is purified by the addition of about two per cent of sulphuric acid to improve the color and deodorize it. The acid is poured into the oil, and the liquid thoroughly agitated and then allowed to stand, when a dark tarry residuum separates. This is removed, and the clear oil is then agitated with water and afterward with caustic soda or ammonia. This neutralizes any remaining traces of acid, and is removed by water. In some instances it is then heated to expel a small proportion of naphtha or benzine which it may contain, or is redistilled.

The crude naphtha is redistilled for gasoline, benzine, or refined naphtha, or is poured into the oil-wells, nominally for the purpose of cleaning them. In some instances it is used for adulterating the crude oil sold to the refiner.

In the details of the process of refining, manufacturers somewhat differ. Some blow steam through the crude oil, thus taking off the naphtha previous to distillation. In other instances, the heavier portions of the distillate are separated, forming safer oils than those in ordinary use. Thus, "astral oil," averaging 49° B., flashes at 125° of Fahrenheit's scale, and "mineral sperm," having a gravity of 36° B., only yields inflammable vapor at temperatures above 262°.

Oil which flashes at or above 100° F. is considered safe for ordinary use, but the temptation to allow the heavier portion of the crude naphtha, an article which commands a much lower price than oil, to flow into the tank designed for the latter is so great that many kinds of oil in the market are very dangerous, their vapors exploding at a much lower point.

Instead of continuing the flow of naphtha into its proper tank until a gravity of 58° or 59° B. is attained, it is diverted into the burning-oil reservoir while yet as light as 63° to 65°.

Dr. White of New Orleans found that one per cent of naphtha added to an oil which flashed at 133° Fah. caused it to flash at . . . . 103°

2 per cent	92°
5 per cent	83°
10 per cent	59°
20 per cent	40°

Ordinary kerosene, having a gravity of 47° B., flashes at 86° Fah. An oil which will not flash below 100° may be made by running off the naphtha to 58° B., and exposing the oil in shallow tanks to the sun or a strong light for a day or two.

The average yield of crude Pennsylvania oil is stated to be: —

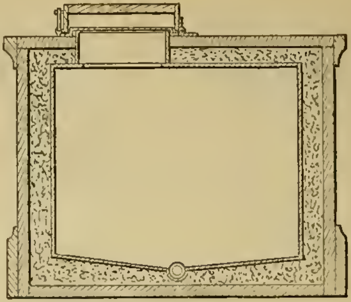
Gasolene	1½
Refined naphtha	10
Benzine	4
Refined petroleum or kerosene .	55
Lubricating oil	17½
Paraffine	2
Loss, gas, and coke	10
	100

By *cracking* it can be made to yield, —

Crude naphtha	20
Burning oil	66
Coke and loss	14
	100

Oil-safe. A storage-vessel for oil, protected from access of fire, and measurably from the heat of the surrounding atmosphere. It consists of a vessel of sheet-metal with soldered joints in a box of wood with an intervening material which is a poor conductor of heat. Oil is poured in at the top and discharged by pipe and faucet at the bottom.

Fig. 3385.



Oil-Safe.

Oil-skin. Cloth treated with oil to make it water and perspiration proof.

Oil-still. A still for hydrocarbons, notably petroleum. See PETROLEUM-STILL.

Oil-stone. A slab of fine-grained stone, set in a wooden block and provided with a wooden cover, used for imparting a keen edge to tools: it is so called because oil is used for lubricating its rubbing surface. See WHETSTONE. See list under GRINDING AND POLISHING.

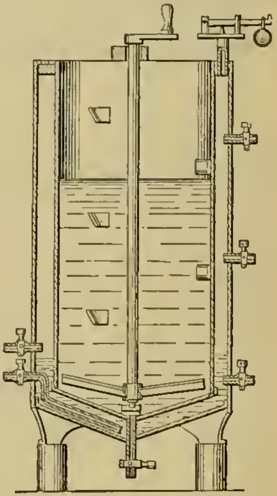
Oil-tank. A large vessel for holding oil for —

1. Treatment.
2. Storage.
3. Transportation.

1. Tanks for treatment are usually large reservoirs or vats. Two illustrations may be given.

In Fig. 3386, the oil or fat is placed in the inner tank, which has a vertical shaft having radial stirrers and a discharge-pipe at its lower conical end. It is surrounded by a water or steam chamber, by which the oil or fat is heated to 90° or 100° Fah., respectively, and yeast, 3 parts, added to 40 parts of the grease. The whole is stirred while warm, and then left to ferment, when sediment is drawn off at the bottom. The tank may be used in the manufacture of stearine. See also LARD-TANK.

Fig. 3386.

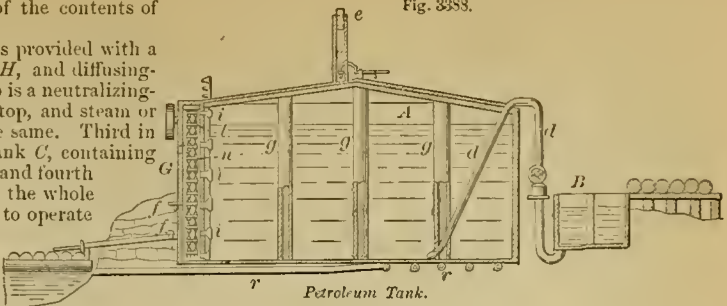


Oil-Purifying Tank.

Fig. 3387 shows an arrangement of tanks for carrying out successively the operations of oxidizing, neutralizing, steaming and heating for evaporation, oils to be purified; and of special devices to be employed in connection with one or more of the tanks for the addition of oxidizing and neutralizing chemicals to the oils, for stirring and agitating the same, and for indicating the condition of the contents of the several tanks.

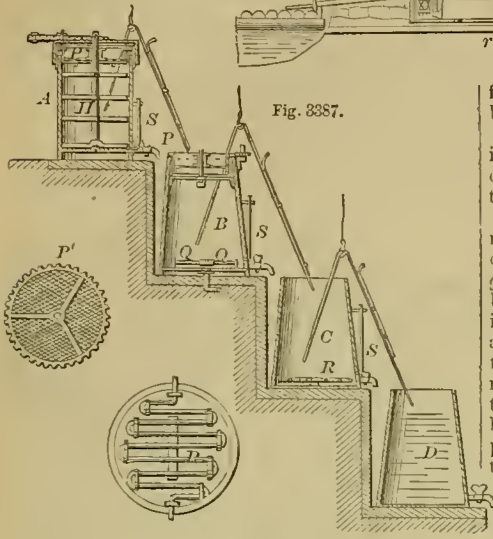
The oxidizing-tank *A* is provided with a detachable stirring-shaft *H*, and diffusing-sieve *P*. On the next step is a neutralizing-tank *B* with sieve *P'* at top, and steam or hot-air pipes *Q* within the same. Third in the series is a steaming-tank *C*, containing suitable steam-jet pipes *R*, and fourth is an evaporating-tank *D*, the whole being adapted and made to operate consecutively upon the same body of oil as it flows from one to another in the series.

Fig. 3388.



Petroleum Tank.

Fig. 3387.



Tanks for the Purification of Oil.

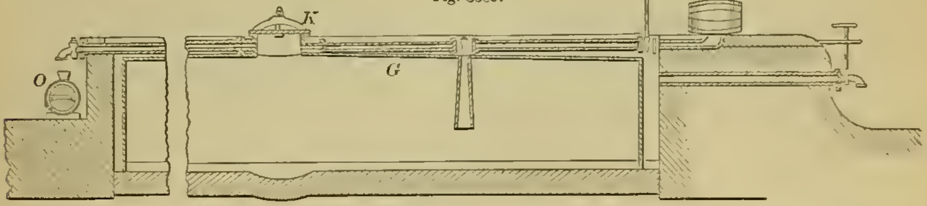
Each vat has its gage-glass *S*, and the discharge from each tank of the upper three to the one next beneath it is by siphon.

2. *Tanks for storage* are usually on a large scale, in obedience to the law of economy of material in construction, being much less per cubic foot of contents for large vessels than for small.

Fig. 3388 is a petroleum tank, shown as upon a river-bank. The tank *A* is of metal, is hermetically closed, and its roof is supported by hollow columns *g g*. Above is an escape where volatile gases are burnt as at a gas-burner. *B* is the receiving-tank into which the barrels of oil from the well are emptied, and from which the oil flows into the tank *A* through the siphon *d*. *G* is the delivering-chamber with a number of valves *i i* at different hights leading from the tank *A*, so that oil of different gravities may be drawn from different altitudes. The entrance-pipe *d* delivers the fresh oil into the bottom of the tank in contact with the heavier stratum of oil, depositing the paraffine at the bottom. *r* is a heating coil, for use if necessary. *f f* are delivering faucets to the pipe which leads to the barrels in the boat alongside the river-bank.

Fig. 3389 shows a form of submerged tank, the iron oil-chamber being placed in a pit with water around and above it. The oil is introduced and discharged by pipes. The induction and overflow of the water is also by pipes. *K* is the man-hole cover. Water enters below the oil in the tank, the level being evidenced by a gage.

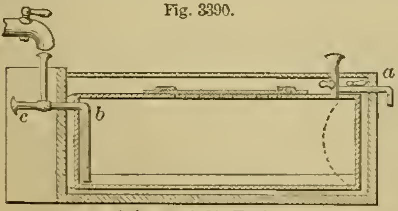
Fig. 3389.



Submerged Oil-Tank.

In Fig. 3390, the water in the submerged tank is displaced by oil introduced from above; the stratum of water escapes by rising through a pipe *b* and overflowing. Oil is discharged at *a* by admitting water.

Fig. 3390.



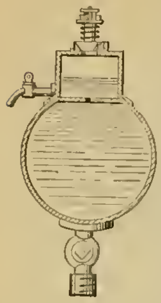
Submerged Oil-Tank.

3. *Tanks for transportation* are made of a size to form a load for a platform, on which they remain, being filled and discharged by pipes and hose (see Oil-car); or are of such a size that they may be swung or rolled on to the car. The latter includes boiler-iron barrels, and those of wood, pitched or otherwise treated to render them impervious to oil.

Church's petroleum tank (Fig. 3391) has upon its top a chamber with a safety-valve to enable it to be kept full without endangering it when the contents expand or contract by changes of temperature.

In Fig. 3392 the tank has an air-chamber in any convenient part provided with a safety-valve. A bent tube extends from the petroleum-tank into the air-chamber, the ends terminating a short distance

Fig. 3391.



Church's Oil-Tank.

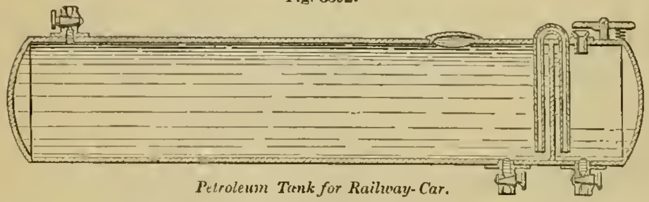
above the bottom of the tank and air-chamber. The tank is filled with petroleum, and enough is placed in the air-chamber to cover the end of the bent pipe under all circumstances of expansion and contraction, so as to prevent the accession of air to the main chamber.

As the petroleum expands it flows into the air-chamber, condensing the air; as contraction of its bulk occurs it flows back to the main reservoir.

In Fig. 3393, the safety-chamber is introduced to afford a space into which the oil may expand, and from which it returns when contracting. The chamber is detachable and capable of introduction into the tank or barrel at the ordinary opening for filling.

Other forms of tanks for transportation are built of metal, inside box-cars, with devices for staying, filling, emptying, etc.

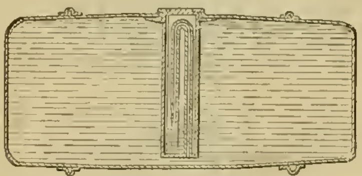
Fig. 3392.



Petroleum Tank for Railway-Car.

Much ingenuity has been expended in making barrels of wood or of metal for shipping petroleum and coal-oil.

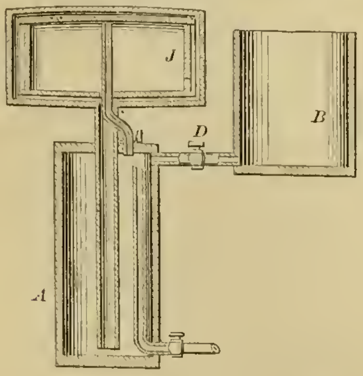
Fig. 3393.



Knight's Oil-Tank.

Day and Chapman's metallic barrel is inclosed in one of wood.

Fig. 3394.



Apparatus for applying Solutions to Oil-Barrels.

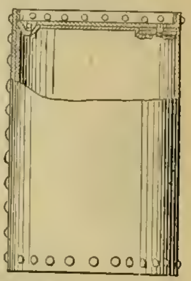
Fig. 3394 shows an apparatus for applying solutions to oil-barrels to render them impervious to oil. The barrel *J* is placed in the upper chamber and the lid closed tightly. The solution from vat *B* is allowed to flow into *A*, and the faucet *D* is then closed. Steam is then admitted from the pipe entering the bottom of the closed vessel *A*, and, collecting in the top of the vessel, forces the liquid into the chamber in which the cask *J* is placed. When the cask is saturated, the steam is shut off and allowed to flow by faucet *D* into chamber *B*; the liquid sinks from the upper chamber, the lid is lifted, and the cask removed.

Barnum and McNoah's metallic barrel (Fig. 3395) is coated on both sides with lead, and the joints made by riveting and soldering.

There are many patents for compositions, modes, and machinery for thus impregnating, and for coating barrels for this purpose.

Oil-test. For ascertaining the degree of heat at which the hydrocarbon vapors of petroleum are liable to explode.

Fig. 3395.



Metallic Barrel.

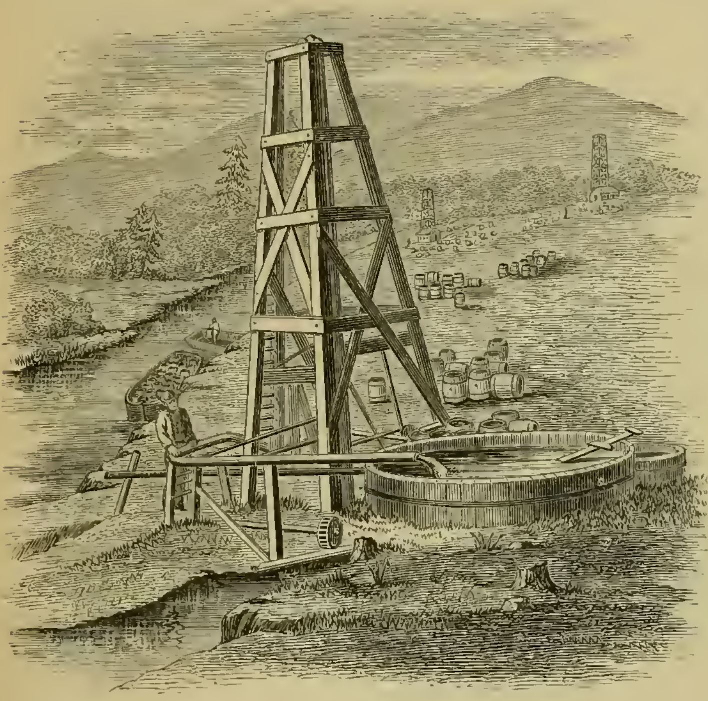
That legally employed in Great Britain consists in heating the oil in a porcelain vessel surrounded by a hot-water bath. A wire is placed ¼ inch above the rim of the vessel, and when a thermometer whose bulb is submerged 1½ inches below the surface of the oil indicates the desired heat, say, 90°, a small flame is passed quickly along the wire over the surface of the oil; if no flash is produced, the heat is continued and the test applied at every 3° above this until the flashing-point is reached. The operation is then repeated with a fresh sample of oil, fresh water being used in the outer vessel, the source of heat being removed when a temperature approaching that obtained in the first experiment has been reached. A *fire-test*. See PETROLEUM-TESTER.

Oil-well. The first borings for oil were made at Titusville, Pa., 1859, by Mr. E. L. Drake. Previous to this the petroleum was collected by blankets on the surface of springs and bottled for medicinal use. Nothing was then known of its use for lighting or lubricating. Mr. Drake had great difficulty in obtaining competent drillers, so absurd was deemed the project of searching for a basin of oil beneath the surface. He then gave out that he was boring for a salt-well. He originated the practice of driving a tube to the rock, instead of excavating and cribbing. He drove a tube 32 feet, and then bored 37½ feet. He tubed the well, and obtained by hand-pump 25 barrels per day for two years. It was difficult then to find use for so much. The first refiners were McKeown and Kier of Pittsburgh.

Oil-wells are of various depths, but the mode of sinking them is substantially similar. They vary in depth from 100 to 1,100 feet. After a spot is decided upon, a derrick is built, having four diverging posts planted upon a base of about 12 feet square, and having a hight of 40 feet. So great interest has been felt in the subject, and so frequently has the matter been described in the magazines and journals of the day, that we do not deem it advisable to afford much space to the description of the *modus operandi.* We give a condensation of the description given by a writer in "Harper's Magazine."

The engine-house being erected and the necessary machinery all ready therein, sections of iron pipe, 6 inches in diameter, are driven into the ground by means of a pile-driver until the first layer of rock is reached, which, in most cases, is found at a depth of 35 or 40 feet below the surface of the ground. Great care is taken that this iron pipe is driven plumb. After the rock is reached and the earth within the pipe is removed, a block and tackle is rigged at the top of the derrick, and the drilling-tools, weighing in some cases 900 pounds, are hoisted up and dropped into the driving-pipe down to the rock. A temper-screw is then attached to the top of the drill, by means of a rope, and made fast to the end of a walking-beam, which is a heavy horizontal piece of timber, vibrating on its axis and supported by a Samson-post. The other end of the walking-beam connects with the driving-pulley by means of a crank. The engine drives the pulley, the end of the walking-beam rises and falls, giving the vertical motion to the drill-rod and drill. At intervals, during the process of drilling, a tool called a *reamer* is inserted into the well, its duty being to bring the bore to the proper size and shape. A sand-pump is a metallic tube, from 5 to 10 feet in length, and having a valve in the bottom, opening upwardly. (See SAND-PUMP.) This sand-pump is lowered into the well at intervals, and when it reaches the bottom the valve opens and admits the borings; when the pump is raised, the valve closes and the contents are brought to the surface. After the bore is thus cleaned, the drill is again inserted and the drilling is continued.

Fig. 3396.



Oil-Flowing Well.

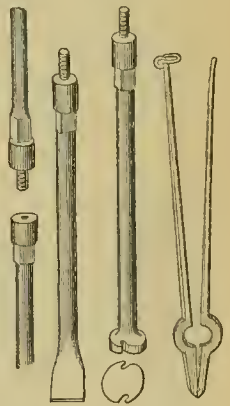
In boring a well, a correct journal is kept, showing the different kinds of rock and earth passed through, and the exact points where water-courses, gas, or shows of oil are found.

If a large vein of oil be struck, the well is immediately tubed with 2 or 2½ inch pipe, put together in sections with couplings. The water from veins and from the surface is prevented from running down the well, outside the pipe, by means of a leathern bag filled with flaxseed; the swelling of the seed completely closes all communication between the top and bottom of the well outside the tubing.

If the vein of oil struck prove to be large, and the pressure of gas is sufficient, the oil will flow out without the aid of a pump; but in most cases a pump is required, in which case a copper working-barrel is placed at the bottom of the well and attached to the lower section of the tubing, with a valve at the bottom. The upper valve is connected with a sucker-rod, the end of which is attached to the end of the walking-beam.

The tanks or tubs to receive the oil are mostly made of wooden staves, but sometimes of boiler-iron, and are placed at some distance from the well; they are connected with it by means of iron pipes attached to the spout of the pump.

Fig. 3397.



Drilling-Tools.

It is almost impossible to give the exact cost of sinking and completing a well. Prices vary in different localities, and the cost of drilling ranges from $2 to $3.50 per foot. It may be estimated at an average of $5,500. The tools have been incidentally referred to, and are shown in the accompanying cut. The drill-stem consists of sections of iron rod connected by screw-couplings.

The ordinary drill has a chisel face, but a great deal of ingenuity has been expended on this part of the apparatus. Several varieties are cited under the captions ARTESIAN-WELL; ROCK-DRILL; WELL-BORING, etc.

The reamer is introduced into the bore to *true* it; the drill fails to make a smooth hole, and the reamer is about circular in its form, giving a perfect shape, and fitting the bore to receive the tube.

The pipe-tongs is adapted to grasp the drill-rod or tube while a new hitch is being taken in withdrawing or introducing either.

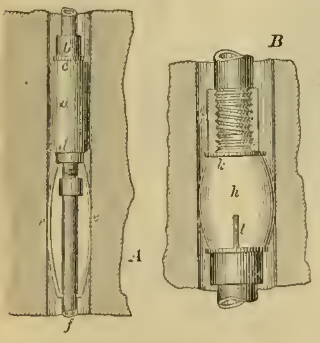
The presence of oil in springs has been noticed from time immemorial, and the rock-oil, Seneca oil, or whatever custom or charlatans have called it, has been famous either as having a sacred character or association, as in the famous wells of the Caspian, or as a liniment. Bitumen, asphate, bituminous shales and rocks, are found in many parts of the world, and the references to the subject are found scattered in the writings of Herodotus, Pliny, and very many others of the writers of antiquity.

"It is said that on digging near the river Ochus [in Bactria] a spring of oil was discovered. It is probable that as certain nitrous, astringent, bituminous, and sulphurous fluids permeate the earth, greasy fluids may be found, but the rarity of their occurrence makes their existence almost doubtful." — STRABO, A. D. 16.

See PETROLEUM.

Oil-well Pack′ing. The usual method of packing oil-wells has been by a *seed-bag*, so called, consisting of a leathern bag filled with flaxseed and placed around the tube, to fill the space between the latter and the sides of the well. The office of the seed-bag is to prevent the water which percolates through upper strata from reaching the bottom of the well, where it would float the oil, and require to be pumped out before the oil would sink to a point where the end of the tube could reach it. It has a farther office in some wells, where a heavy pressure of gas is present, as the said pressure would elevate the oil, perhaps to the surface, were not a way of escape found around the tube, between it and the wall of the well. The seed, becoming saturated with water, swells and forcibly presses the leathern bag against the well-tube and the wall, and the device has proved very effective. It is, however, almost impossible to withdraw it, for the purposes of removing the tubing. The practice has been to "spear" the bag, to allow its contents to escape and permit the leather bag to collapse; but this operation has proved tedious and uncertain, owing to the small limits of the working space and the distance from the surface of the ground.

Fig. 3398.



Oil-Well Packing.

In *A* (Fig. 3398) *a* is an elastic substance surrounding the main tubing, *b* is the ordinary coupling, resting upon the washer *c*, their surfaces ground together and made water-tight; *d* is a loose nut, running upon a screw-thread cut on the main tubing. *e e* are elliptic springs, dovetailed or otherwise fastened to the sides of the loose nut *d*, and partially clasping the tubing at *f*, also pressing the walls of the well at *g*, thereby holding the loose nut firmly and preventing its rotation.

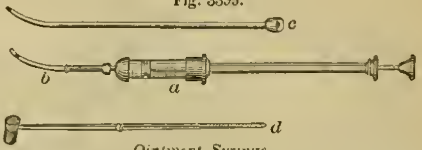
By rotating the tubing from the top of the well while suspended in the tackle, the loose nut *d* is drawn up, expanding the packing and effectually filling the bore of the well.

By rotating the tubing in the other direction, the nut descends and loosens the packing, thereby freeing the tube and allowing it to be withdrawn, if necessary.

Another form is shown at *B*. A cylinder *h* of any elastic substance not affected by oil is placed between two washers about the well-tube. The cylinder is slightly smaller than the bore of the well, and is easily let down therein; but on reaching its position it is compressed by screwing the tube itself down into a long coupling: this action forces the washer *k* against the packing, and squeezes it out so as to fill the passage completely. The packing rests at the bottom on a fixed washer, and has also four ribs *l* to hold it from turning while the tube is screwed up. It will be seen that the thread is not exposed at any point.

Oint′ment-syr′inge. (*Surgical.*) One employed to apply caustic, etc., in the form of ointment, to deep-seated places. The syringe *a* is shown with two silver flexible tubes, one *b* for the uterus and the other *c* for the male urethra. The instrument forms a *porte-caustic*.

Fig. 3399.

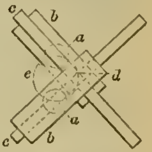


Ointment-Syringe.

d is a platinum spoon for melting caustic.

Old′ham's Coup′ling. A sliding coupling for parallel shafts, invented by Oldham. *a a* are the axes of two shafts; *b b*, two cross-heads on their ends; *c c*, bars sliding in grooves in the cross-heads: the bars are fixed together at their midlengths so as to form a cross, the middle point *d* of which revolves upon the dotted circle *e* described on the line of centers, so that its axis of rotation at any instant is at a point in that circle diametrically opposite to *d*. See TRAMMEL.

Fig. 3400.



Oldham's Coupling.

Old-sand. (*Founding.*) The sand forming the floor of the molding-shop to the depth of two or three feet, and filling the deep pits under the cranes. It is generally quite black, is weak and friable, and unfit for the face of any mold. On the other hand, its porous character makes it well suited for filling the flasks over the *facing-sand*.

O′le-ine. The fluid portion of fats and oils after the stearine or more solid portion has been removed.

O′le-o-mar′ga-rin. A substitute for butter. It is prepared by chopping clean animal fat fine, and boiling it; when cool it is churned with pure fresh milk, washed, worked over, salted, and packed for market. It is claimed that this article is scarcely distinguishable from pure butter, and that in consequence of its superior keeping properties it is peculiarly adapted for exportation to warm climates.

O′le-om′e-ter. A species of hydrometer adapted for determining the relative densities of oils.

One form of oleometer, invented by Professor Palmieri of Naples, consists of an electrical apparatus of great delicacy, the object of which is to detect the admixture of other oils with that of the pure olive. The instrument is founded on the fact of the variability in the powers of conduction possessed by the various oils, olive being lowest in the scale. The wires of a battery are brought to a small elongated vessel containing the oil to be examined, and, an electrometer being attached, the degree of conductivity can be read off on a scale. The instrument, it is said, can detect any of the usual adulterants with the utmost nicety. It has also been applied to the detection of woolen or cotton fibers in silk fabrics.

Ol'ive. An escutcheon attached to the strap of a traveling bag or satchel and perforated for the passage of the swiveled stud or button.

Ol'i-ver. A forge-hammer whose handle is attached to an axle and which is worked by a treadle and spring.

It is usually a small lift-hammer, worked by the foot. The hammer-head is about 2½ inches square and 10 inches long, with a swage-tool having a conical crease attached to it, and a corresponding swage is fixed in a square cast-iron anvil-block, about 12 inches square and 6 deep, with one or two round holes for punching, etc. The hammer-handle is about 2 to 2½ feet long, and mounted in a cross-spindle nearly as long, supported in a wooden frame between end-screws, to adjust the groove in the hammer-face to that in the anvil-block. A short arm, 5 or 6 inches long, is attached to the right end of the hammer-axis; and from this arm proceeds a rod to a spring-pole overhead, and also a chain to a treadle a little above the floor of the smithy.

Om-brom'e-ter. A RAIN-GAGE (which see).

Om'ni-bus. 1. (*Glass-making.*) A sheet-iron cover for articles in a *leer* or annealing-arch, in order to protect them from drafts of air.

2. (*Vehicle.*) A large four-wheeled vehicle to carry passengers; the seats being usually arranged on each side, the passengers facing, and the door at the rear.

Established in Paris by a decree of Louis XIV., 1662, and made to hold eight persons. Re-established, 1819. In England in 1829. Amsterdam, 1839.

Om'ni-graph. A PANTOGRAPH (which see).

On'a-ger. An ancient military engine for hurling stones out of a cup-shaped receptacle.

Ooze. A solution of tannin obtained by infusing or boiling oak-bark, sumac, catechu, or other tannin-yielding vegetable.

There are many ways of extracting the ooze: —

1. By cold water.

2. By hot water, steam being conducted to the vats.

3. By boiling, the spent or weak liquor from the pits being employed.

4. By hydrostatic pressure; the ground bark is placed in a strongly bound vessel with a perforated false bottom; a column of water 20 or 30 feet high rests upon the bark and forces the water to filter through the mass.

O'pal-ine. A semi-translucent glass, also known as *fusible porcelain* or *milk-glass.* It is a glass whitened by the addition of phosphate of lime, peroxide of tin, or other ingredients.

O-pal'o-type. (*Photography.*) A picture on milky glass.

O-paque'-disk Re-volv'er. (*Optics.*) A stage disk mounted on a universal joint beneath the object-glass of a microscope, and intended to expose an object at various angles.

Op'ei-o-scope. An instrument for exhibiting the pulsations of sound. It consists of a tube from 1 to 2 inches in diameter, over one end of which is secured a thin membranous substance having a small mirror at its center. When a musical note is emitted into the open end of the tube, which is held so that the beam of light from the mirror may fall upon a white wall or screen, the image will vibrate, the vibrations differing for each tone. By a slight movement of the tube a series of sinuous lines is produced, forming either simple or compound waves according as the note is simple or compound.

O'pen-er. A machine for opening cotton taken from the bales in which it has been closely compacted. Is usually a box or casing with inwardly projecting blunt teeth, and with a screen-like bottom. A drum provided with blunt pins rotates within this casing, opens the cotton, and dirt falls through the grating. See OPENING-MACHINE.

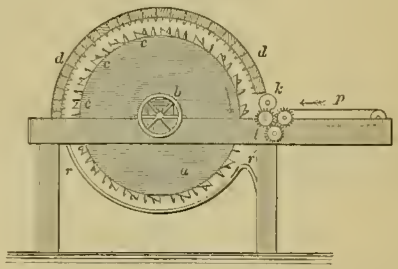
O'pen-ing-bit. A *broach* or *reamer.* A tapering tool with angular sides for widening an aperture.

O'pen-ing-knife. A blunt strong-bladed knife for opening oyster and fruit cans.

O'pen-ing-ma-chine'. A machine for loosening the tussocks of cotton as it comes from the bale, so that the offal and dust may be removed and the fibers parted. The machine has several forms, known as *willy, willower, devil, wolf, beating-machine, cotton-cleaner;* and when associated with a blast of air, as *blowing-machine, scutcher, blower,* and *spreader.*

It consists of a wooden drum *a*, having rows of iron spikes alternating on its circumference with upright iron ridges *c c c*, which prevent the cotton from passing through the machine too rapidly. The top of the drum is covered with a wooden lid *d d*, consisting of *lags* of wood curved to the shape of the drum, and having similar spikes and ridges.

Fig. 3401.



Opening-Machine.

These lags are capable of being singly moved for the purpose of cleaning or repairing. The lower part of the drum is covered in with the brass wire-gauze *r*, which has an opening at *r'*, through which the cleaned cotton is removed, the dust and impurities falling through the gauze.

The machine is fed from the *feed-cloth p*, upon which the cotton is spread out by hand, and from which it is taken by the grooved nipping-rollers *k l*. The drum is driven by the pulley *b* at the rate of 400 to 450 revolutions per minute. The machine can prepare 1,000 to 1,200 pounds of cotton in a day.

O'pen Link. See OPEN RING.

Open Ring. (*Agriculture.*) A link with one side open, the ends lapping past each other, but not in contact.

Used for coupling the single-trees to the double-tree, and for analogous purposes in agriculture.

Also called *lap-ring*, as the ends lap over each other.

O'pen-sand Mold'ing. (*Founding.*) Heavy beams, foundations, and bed-plates are sometimes molded in the floor of the foundry, without any cope or top part. They are generally filled direct from the furnace. As such castings are never very sound, it is a method not often employed of late years.

Op'e-ra-glass. A binocular telescope of the kind invented by Galileo, and with which that philosopher first observed the planetary disks and Jupiter's four moons.

This has a plano-concave or double-concave eye-glass, so that the image is not inverted and little light is lost, thus securing great distinctness. See LENS.

The object-glasses are now made achromatic, and are adjusted simultaneously to the same focus by a milled-headed screw between the two tubes. These are usually made of hard rubber, ivory, papier-maché, or mother-of-pearl, so as to present an ornamental appearance, the use of the instrument being, in consequence of its limited magnifying power and narrow field, principally confined to the interior of buildings.

A larger and superior glass of similar appearance is used in military field service. (See FIELD-GLASS.) It is sometimes provided with a diagonal object-glass having a mirror within the tube at an angle of 45° with its axis, so as to show objects without apparently being directed toward them.

Op'e-ra-hat. A folding hat of felt, silk, or fur.

The *crush;* to fold flatly under the arm.

The *cocked;* the brim cocked up against the side-crown.

See G. Lloyd, English patent 4,900, 1834.
J. T. Tyler, 12,442, 1849.
Gibus, French patent, Fig. 17, Plate 22, Brevets d'Inventions, Vol. III. Loi de '44.

Op'e-ram'e-ter. An attachment to a machine to indicate the number of rotations of a shaft. It consists of a train of gear-wheels and pinions inclosed in a box and connected to or moved by the rotating shaft. A finger on the dial-plate indicates the count.

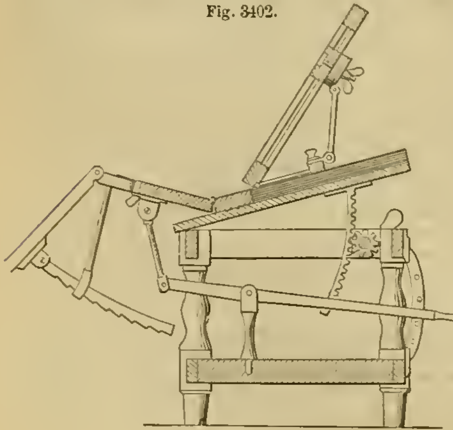
Operameters are used to count the revolutions of a shaft, axle, or wheel, the strokes of a piston, the copies from a printing-press, lengths of sheets from a Foundrinier or other paper-making machine or cloth measuring or printing machine.

A common form is the counter of a printing-press, which has a wheel for units, one for hundreds, and another for thousands. As the *fly* deposits a printed sheet, the unit-wheel moves forward one tooth. The complete revolution of this wheel moves the one of next higher order one tooth, and so on.

The accurate registration of the revolutions of a propeller or paddle-wheel is a matter of much importance to navigators, and many forms of operameters have been tried for this purpose. See REGISTER; ARITHMOMETER; SPEED-GAGE.

Op'er-at'ing-ta'ble. (*Surgical.*) One on which the patient is placed to expose prominently the portion to be operated upon. In the example, the table, back, thigh, and leg supports have individual vertical adjustments to support the patient in any position. The leg pieces have also a lateral adjustment to spread them apart for examinations and amputations, operations on the genitals, in lithotomy, applications of the speculum, etc.

Fig. 3402.



Operating-Table.

Oph'i-cleide. (*Music.*) A wind-instrument of metal, with keys and valves, and made *en suite;* that is, of various sizes and compass. (See HORN, *j*, Fig. 2563.) It is the largest brass wind-instrument of the trumpet species, and forms the bass to that class of instruments. Its compass is 3 octaves.

Ophicleides are the altos and basses of the bugle.

The *bass* ophicleide is written on the F-clef, and its compass is three octaves and one note. They are in two keys, C and B ♭.

The *alto* ophicleides are in F and E ♭; their compass is the same as the bass; they are written on the F-clef, like horns.

The *double-bass* ophicleides are in F and E ♭, a fifth below the bass ophicleides in C and B ♭.

The *bombardon* is a low-pitched instrument without keys and with three cylinders. It differs but little from the ophicleide.

Oph'thal-mo-di-as-tim'e-ter. (*Optics.*) An instrument contrived by Landsberg, a Hanoverian optician, and thus named by him, for adjusting the optical axes of lenses to the axis of vision. It consists of two tubes with adjustable plane glasses, each divided by a central line. On looking through this instrument at a mirror, each eye views its own image, and the glasses are adjusted until the line on the glass as viewed in the mirror is caused to bisect the pupil of the eye. — "Poggendorf Annalen," Vol. CX. p. 435.

Oph'thal-mom'e-ter. 1. (*Surgical.*) An instrument of the nature of compasses for measuring the capacity of the chambers of the eye in anatomical experiments.

2. (*Optics.*) An instrument invented by Helmholtz for ascertaining the true distance at which an object shall be viewed for the accommodation of each eye. It consists of two planes of glass at right angles to each other, and a sight-tube through which they and an object beyond them are viewed. By rotating the glasses on their common axis until the two images formed by reflection from their back surfaces coincide, the proper point of vision is ascertained. — "Poggendorf Ann.," Vol. CXI. p. 415.

Oph-thal'mo-scope. An instrument for inspecting the interior of the eye, invented by Professor H. Helmholtz, and described by him in 1851. He attributed the difficulty experienced in viewing images formed on the retina to the fact that the refractive humors of the eye cause it to be focused at the precise point *c* where the object forming the image is placed. In order to obviate the difficulty thus arising he employed a piece of plate-glass as a mirror, by which the rays from the object are at once both reflected and transmitted.

In the cut, *a* represents a candle, the rays of light from which, falling on the inclined reflector *b*, are thrown through the pupil of the patient's eye *c*, whose retina reflects the image back in the direction whence it was received; the transparent glass plate permitting it to be viewed by the eye *d* of the observer.

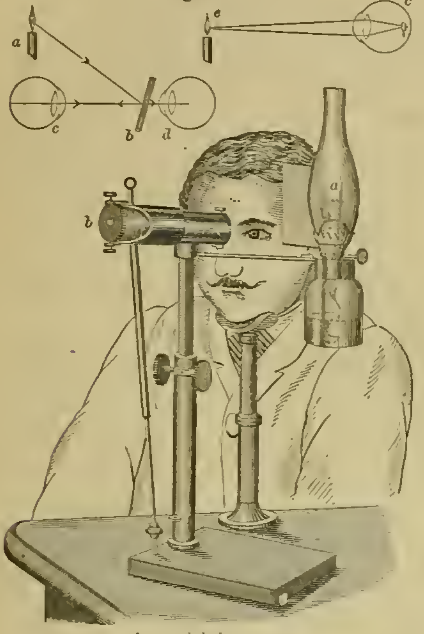
By this means the background of the eye is illuminated, enabling the observation of its delicate blood-vessels and tissues.

A great number of forms of this instrument are constructed. That of Dr. Liebrich is probably the simplest. It consists of a concave circular mirror of about 1½ inches diameter and from 6 to 12 inches focus, having a central perforation, behind which is arranged a lens through which the eye, illuminated by the rays from a lamp reflected into it by a mirror, is viewed.

An instrument on the same principle, enabling a person to examine the interior of his own eye, is called an auto-ophthalmoscope. It is shown in the lower portion of the figure.

Dr. Knapp's instrument consists of two centrally perforated plates, connected by a handle, and having between them two disks each with a series of perforations near its periphery in which lenses are inserted, those in the one being convex and in the other concave, so as to form a varied series of magnifiers by turning the disk so as to bring different ones into coincidence over the central opening in the case. One side of the case has an annular concave mirror which reflects light into the eye while it is being examined by a magnifier or the naked eye, through the central opening. One of the openings in each disk is left unfilled, so that only a single lens, or no lens at all, may be used.

Fig. 3403.



Auto-ophthalmascope.

Oph-thal'mo-state. An instrument for holding the eye in a fixed position to facilitate operations. Such are the ophthalmostate of Jäger, the fine many-pointed forceps of Graife, etc. They have specific names, such as *fixation-forceps*, *iris-hook*, etc. *Ophthalmostatum.*

Oph'thal-mox-ys'trum. (*Surgical.*) A small brush with barbs like an ear of barley, to scarify the eyelids in cases of ophthalmia.

Op'si-om'e-ter. An instrument for measuring the limits of distinct vision in different individuals, for determining the focal length of lenses suited for remedying imperfect vision.

Lehot's device consists of a white thread placed on a narrow rule covered with black velvet, and having an arrangement for indicating the points at which the thread begins and ceases to be distinctly seen when held in a certain position with respect to the eye. See also OPTOMETER.

Op'ti-cal In'stru-ments. The first ascertained optical fact was probably the propagation of light in straight lines.

> Alhazen the Saracen, about A. D. 1100, was the first to determine that the retina is the seat of vision, and that light comes from external objects to the eye. Before his time it had been uniformly taught that rays issued from the eye and impinged upon objects. Euclid treated the subject on that principle.
>
> Alhazen also explained the reason that "we see single when we use both eyes, because of the formation of visual images on symmetrical portions of the two retinas." — DRAPER.

He also wrote on the reflection and refraction of light. Knowing that the air increased in density toward the surface of the earth, he determined that the path of a ray of light through the atmosphere would be curvilinear, and the apparent position of the heavenly bodies an illusion. He also determined the hight of the atmosphere to be nearly 58½ miles. There were philosophers before Torricelli and Galileo.

The discovery of the lens is lost in antiquity, but in its early uses it was a microscope. (See LENS.) For telescopic purposes, a combination of lenses is required, — an objective and an eye-glass. This was invented about 1608 by Lippersheim and by Galileo. The latter turned it on the moon, and saw the shadows of the lunar mountains; on Jupiter, and discovered his satellites; on Saturn, and saw his bulging sides. He supposed the planet to be triple, as his telescope was not of sufficient power to define the ring. He afterward saw the phases of Venus and the spots on the sun. The reflecting telescope was invented in several forms, known as the Gregorian, Newtonian, etc. Then Newton made his discoveries in the reflection, refraction, inflections, and colors of light. Achromatism was discovered by Dolland; afterward polarization of light by double refraction; a century later polarization by reflection, by single refraction; depolarization, and many beautiful phenomena were observed, such as the irised rings, bright and black crosses in crystals, unannealed and compressed glass; then came the discovery that the colors of soap-bubbles were due to the thickness of the film, and this led to ascertaining the length of waves of light. The undulatory theory was suggested in 1664, and was held in abeyance by the supremacy of Newton's preferred material theory; the eye came to be considered as a camera, as described by Da Vinci; later we have reached the kaleidoscope the stereoscope, the photographic camera and processes, the compound and achromatic microscope, which is now working a revolution in anatomy and physiology. See under the following heads: —

Achromatic condenser.
Adapter.
Alidade.
Altarimeter.
Altazimuth instrument.
Altimeter.
Altiscope.
Altitude instrument.
Amici's prism.
Analyzer.
Animalcule cage.
Aperture.
Apomecometer.
Aquatic box.
Astigmatism apparatus.
Binocle.
Binocular glass.
Binocular microscope.
Binocular telescope.
Black-ground illuminator.
Burning glass or mirror.
Camera-lucida.
Camera-obscura.
Camera-photograph.
Camera-solar.
Catadioptric apparatus.
Catopter.
Catoptric cistula.
Catoptric dial.
Cloth-prover.
Collimator.
Compound microscope.
Compressorium.
Condenser.
Condensing-lens.
Dark-well.
Diagonal eye-piece.
Diamond-microscope.
Diaphragm.
Diaphragm-plate.
Diatom-prism.
Dichroscope.
Dioptra.
Dioptric light.
Dipleidoscope.
Dipping-tube.
Dissecting-microscope.
Double-bodied microscope.
Doublet.
Draw-tube.

Dynactinometer.
Dynameter.
Engiscope.
Erecting eye-piece.
Erecting-prism.
Erector.
Eye-glass.
Eye-rim.
Field-glass.
Finder.
Fishing-tube.
Florascope.
Folder.
Frog-plate.
Goggles.
Graphic microscope.
Growing-slide.
Hand-magnifier
Heliometer.
Helioscope.
Heliostat.
Heliotrope.
Horizon. Artificial
Horizon-glass.
Illuminator.
Index-glass.
Indicator.
Iris-diaphragm.
Jointed microscope.
Kinescope.
Lens.
Level.
Lieberkuhns.
Linen-prover.
Live-box.
Live-trap.
Lorgnette.
Lucernal microscope.
Lunette.
Magnifying-glass.
Megameter.
Megascope.
Meridian-circle.
Micrometer.
Microscope.
Microspectroscope.
Mirror.
Moderator.
Monocular microscope.
Multiplying-glass.
Nautical indicator.
Negative eye-piece.
Nobert's test-plate.
Nose-piece.
Object-finder.
Octant.
Opaque-disk revolver.
Opera-glass.
Opsiometer.

Optigraph.
Optometer.
Oxy-hydrogen microscope.
Parabolic illuminator.
Parabolic reflector.
Perspective-glass.
Polariscope.
Polarizer.
Polarizing-apparatus.
Polemoscope.
Positive eye-piece.
Prism.
Pseudoscope.
Quadrant.
Race-glass.
Ramsden's eye-piece.
Reading-glass.
Reflecting-circle.
Reflector.
Refracting-circle.
Repeating-circle.
'Scope.
Scotoscope.
Sector.
Sextant.
Side-reflector.
Slide.
Solar camera.
Solar eye-piece.
Solar microscope.
Spectroscope.
Spectacle-gage.
Spectacles.
Speculum.
Spherical mirror.
Spider-line.
Spot-lens.
Spy-glass.
Stage.
Stage-micrometer.
Stage-plate.
Stereoscope.
Striæ-detector.
Submarine telescope.
Teinoscope.
Teleiconograph.
Telemeter.
Telescope.
Terrestrial eye-piece.
Terrestrial refracting-telescope.
Theodolite.
Tourmaline.
Transit.
Triplet.
Universal instrument.
Vandkikkat.
Watchmaker's-glass.
White-cloud.
Zoophyte-trough.

Op′ti-cal Square. A reflecting instrument used by surveyors and others for laying off lines at right angles to each other. It consists of a box containing two plane mirrors, set at an angle of 45° with each other, so that the image of an object reflected from one mirror to the other will form an angle of 90° with its true position, indicating the correct direction in which a perpendicular offset to the main line shall be measured. See also SURVEYING-CROSS.

Fig. 3404.

Optical Square.

Op′ti-cal Tel′e-graph. 1. A semaphoric telegraph. One whose signals are formed by altering the relative position of its indicators or by differing combinations of colors.

2. An electric telegraph of the needle or pointer class. See SEMAPHORE; ELECTRIC TELEGRAPH.

Op′ti-cal Toys, Scenes, and Ef′fects. See under the following heads: —

Anorthoscope.
Astromara.
Camera-lucida.
Camera-obscura.
Chart.
Chromascope.
Chromatrope.
Cosmorama.
Cosmosphere.
Diorama.
Dissected map.

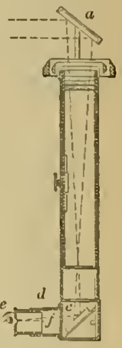
Dissolving-views.
Enorthoscope.
Georama.
Globe.
Horoscope.
Kaleidoscope.
Logotrope.
Magic lantern.
Map.
Marinorama.
Metamorphoscope.

Myriorama.
Myrioscope.
Orrery.
Panorama.
Panstereorama.
Phantascope.
Phantasmagoria.
Phenakistoscope.
Phosphoroscope.
Planetarium.
Planisphere.
Plot.
Pseudoscope.

Ribbon-map.
Section.
Sciopticon.
Stereomonoscope.
Stereoscope.
Stereopticon.
Stroboscope.
Tellurian.
Terrasphere.
Terrestrial globe.
Thaumatrope.
Zoetrope.

Op′ti-graph. (*Optics.*) A form of camera used for the purpose of copying landscapes. The rays from the object to be drawn are reflected from the plane-mirror *a* through the object-glass of the instrument to the speculum *c*, and thence through the eye-glass *d* to the eye at *e*. At *f* is a piece of parallel faced glass with a small dot on its center exactly in the focus of the eye-glass *d*.

Fig. 3405.



Optigraph.

For use, the drawing-board to which the telescope is attached is clamped to a table, so that the surface of the mirror *a* may be nearly parallel to the object, and the pencil placed on any part of the paper where it is desired to commence.

The eye is then placed at the aperture of the eye-tube, and the mirror so inclined as to bring the small dot on *f* on some particular part of the image of the object, and the telescope adjusted to distinct vision. By moving the hand holding the pencil, the dot seen in the field of the telescope is passed over the outlines of the object, which are at the same time traced on the paper by the pencil.

The drawing may be made larger or smaller by varying the distance of the telescope from the paper.

Op-tom′e-ter. An instrument for trying the length of vision in adapting spectacles to the eye.

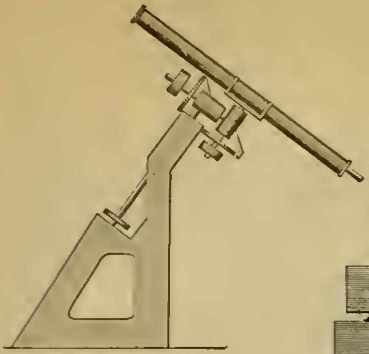
It consists of a rule to which a sliding upright is attached. This contains the test type, and is first held as near as possible to the cornea and afterward gradually removed until the nearest point of distinct vision is found. In another form, the rule is divided by a longitudinal line, which is viewed through two of several adjacent slits on the slider, when at the proper distance from the eye the line appears to form two intersecting lines. The distance of the apparent point of intersection is marked, indicating the focal distance required for the lens. See also OPSIOMETER.

O′pus. A reticulated masonry. See MASONRY.

Or′a-to-ry. (*Architecture.*) A room in a private house set apart for prayer. It differs from a chapel in not containing an altar, nor can mass be celebrated in it. — CANON.

Or′bit-sweep′er. Invented by Airy, to follow the inclined path of a comet or planet. It resembles a German equatorial, the polar axis of which is of greater length than usual, and which works for some distance at its upper end in a tubular bearing. The declination, or cross-axis, carries at one end a counterbalance, and at the other, not, as in the regular equatorial, a telescope, but a small trunk in which a second and smaller cross-axis turns; to one end of this is attached a counterbalance, and to the other end the telescope. By giving a proper position in rotation to the first cross-axis, any inclination of the second cross-axis to an astronomical meridian may be obtained, and the inclination of the circle in which the telescope will sweep will correspond and may be made to coincide with the definite line on the celes-

Fig. 3406.



Orbit-Sweeper.

tial sphere in which the comet is to be sought. — G. Chambers.

Or'der. (*Architecture.*) The different modes of architectural treatment adopted by the ancients in constructing their public edifices and buildings of the higher class are denominated orders. They are usually separated into five, principally distinguished from each other by the proportions of their columns and the kind of capitals employed, but also by the relative proportions and decorative parts of their entablatures, as well as other minor features. They are known as the Doric, Ionic, Corinthian, Tuscan, and Composite.

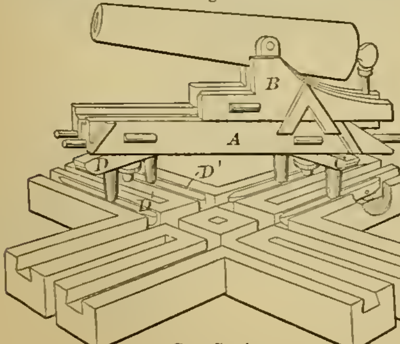
The Tuscan, so called, would, however, seem to be but a debased form of Doric, while the difference between the Corinthian and Composite is but slight, and not in favor of the latter, the copy.

They may be divided into three classes, according to their capitals; those of the Doric and Tuscan consisting simply of an echinus and abacus, the shaft of the Doric column being fluted and having no base, while that of the Tuscan is plain and provided with a base. The capital of the Ionic is distinguished by its volutes, the shaft is fluted and has a base. The Corinthian and Composite capitals are of the foliaged class, having volutes at the angles of the abacus, those of the Composite being the larger, leading to some change in the foliation; the shaft of each is fluted and has a base.

Ord'nance. A class of fire-arms too large to be fired from the person. See Cannon; Mortar; Battery-gun; Howitzer; etc. See list under Weapons.

When hawks were supplanted by fire-arms, the names of the birds of prey were transferred to the new weapons.

Fig. 3407.

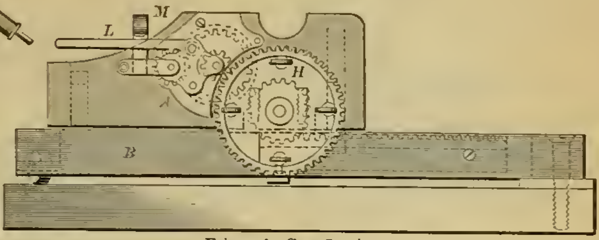


Gun-Carriage.

Mosquet, a sparrow-hawk, became mousquet.
Fançon, a hawk, was a heavy piece of ordnance.
Terzuolo (Ital.), a hawk, was a small pistol, etc.

Fig. 3407 shows a form of timber carriage by which a gun may be trained to all points of the compass, without being pivoted or placed on a circular track. The foundation, or chassis, is composed of timbers framed together in the form of a cross, and having grooves *D' D'* cut in their upper surface. In these grooves the legs of bolsters *C D* run on casters, or slide on greased runners. The bolsters support the bed *A*, on which the carriage *B* slides out and in. The plan of mounting is adapted for use in earthworks and extemporized fortifications.

Fig. 3408.



Ericsson's Gun-Carriage.

Ericsson's gun-carriage, Fig. 3408, is for working guns on shipboard in rough weather, and is designed to check the movement of the carriage instantly, either in its recoil, or when swayed by the motion of the ship. *A* is the gun-carriage, and *B*, a slide-frame on which the carriage runs. *H* is a wheel with cogs on its periphery, which runs the gun out and in by means of gears worked by lever *L*. *M* is a nipper on the side of the carriage, which serves to lock the lever *L* and stop the motion of the gun in case of a lurch of the ship.

Several devices are in use to take up the recoil of guns, by rubber or spiral metallic springs, compressed air, etc.

Some of the gun-carriages devised by Captain Ericsson, and in use on the monitors, are so easy of operation that in case of necessity one man can manipulate a gun weighing 25 tons. See Turret.

Stevens's mode of operating heavy guns, designed to obtain security for the gunners while loading, is by elevating the breech and depressing the muzzle, until the piece stands at an angle of 30°, or thereabouts. The charge is then inserted through a hole in the deck, if on shipboard, or from below the top of the parapet, if mounted in a fortification *en barbette*. For heavy guns the rammer is worked by steam-power.

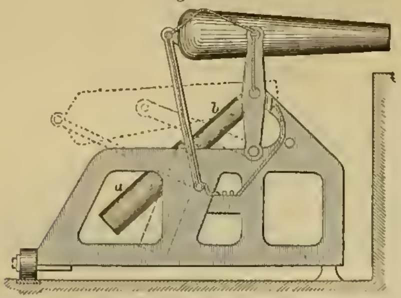
This plan of loading was tried on the "Naugatuck," a small iron-clad presented by Mr. Stevens to the United States government. The Parrott gun mounted on this vessel burst while she was engaged with the Confederate forts on James River. The disaster was supposed by some to be the result of the manner of loading, as affording the shot a chance to slip forward after being driven *home*.

Eads's system of working barbette-guns consists in removing the piece bodily below the parapet while loading, and only elevating it to position at the moment of firing.

Fig. 3409 shows a carriage for operating a gun in this manner. The recoil of the gun when fired compresses air in cylinder *a* by the pressure of piston *b*. When the piece is loaded, a valve is opened which allows the restoration of the gun by the expansion of the air.

Steam or water pressure may be substituted for that of compressed air. The carriage is trained horizontally in the usual manner, whether the gun be in a raised or depressed position.

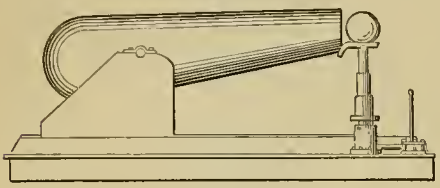
Fig. 3409.



Eads's Gun-Carriage.

Fig. 3410 is a plan of elevating heavy shot to the gun-muzzle. The ball is placed in a cradle upon a telescopic stem, which is extended by internal steam-pressure from below. As it rises, the yoke on the cradle catches below the muzzle of the gun, the front stop is depressed, the pivoted cradle tilted, and the ball rolls into the bore of the gun.

Fig. 3410.

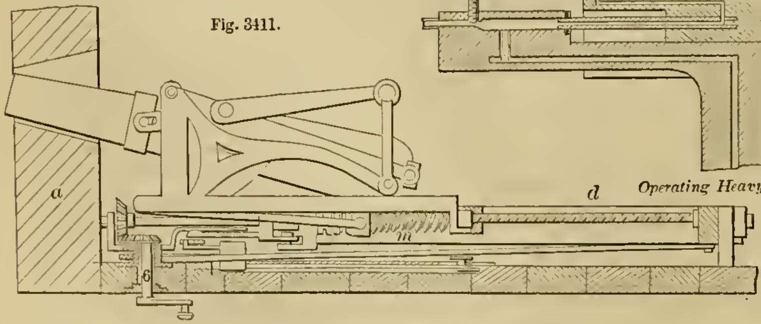


Ball-Elevator.

Fig. 3411 is a plan for operating guns, in which the piece may swing about the muzzle, as a pivot, when the gun is in battery, so that a port-hole about the size of the muzzle may be sufficient.

In the figure, the chassis and carriage are moved by revolution of the crank-shaft 6. To elevate or depress the breech, the hollow screw-collar *m* on the shaft *d* is thrown into gear, and by lever connection the breech is swung upward. The collar *m* is left out of gear, and the chassis and carriage swung sidewise, still retaining the muzzle as a pivotal point.

Fig. 3411.

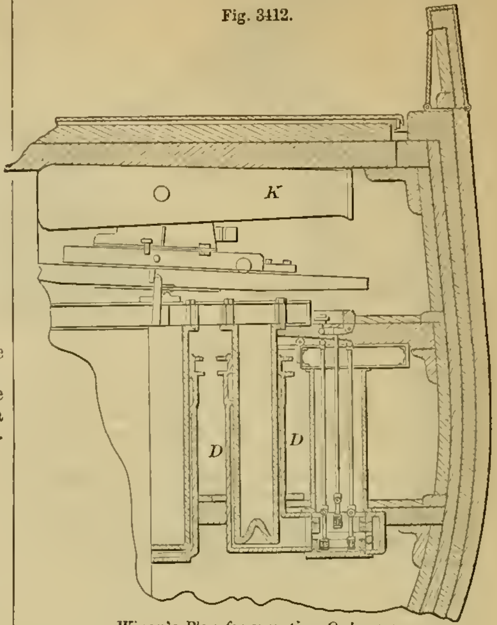


Eads's Ordnance-Operator (Minimum Port-Hole).

a is the shield through which the port-hole is made.

Winan's mode of loading guns on gunboats is illustrated in Fig. 3412. The gun-carriage is formed in two parts, the upper section swiveling upon the lower sections, and is supported on an adjustable chassis, the whole being raised and lowered by steam-power, and also supported on hydrostatic cylinders *D D*, which control the descent of the platform and its carriage. Sliding hatchways are opened and closed by the raising and lowering of the gun-platform. The vessel has no port-holes, and the gun *K* is lifted above the bulwarks when it is to be fired.

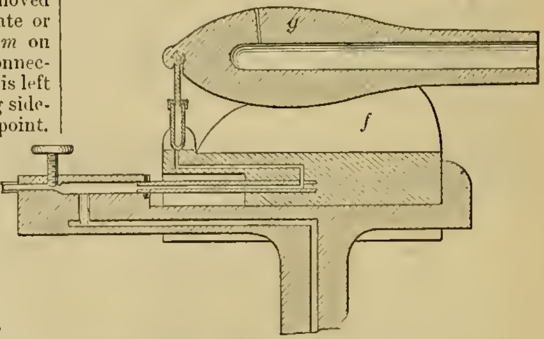
Fig. 3412.



Winan's Plan for operating Ordnance.

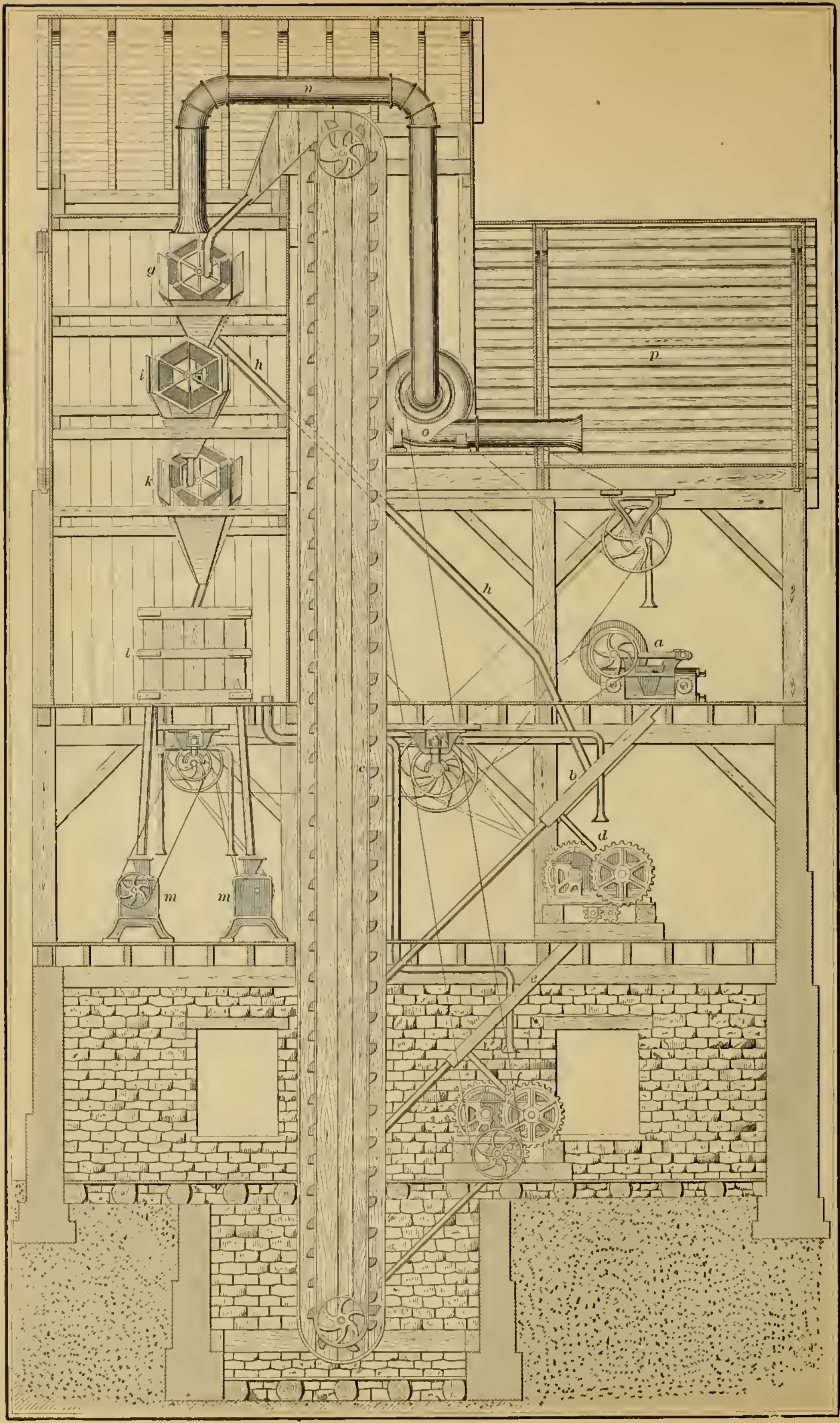
Moncrieff's counterpoise-carriage elevates the gun above its parapet by the weight of the front part of the cheeks. The upper and forward part of the carriage is made very heavy, and rocks in its seat when the gun recoils. See GUN-CARRIAGE.

Fig. 3413.



Operating Heavy Guns.

Fig. 3413 shows a mode of operating heavy guns, invented by Mr. Perley of New York. The weight



MILL FOR GRINDING AND CONCENTRATING ORE BY THE DRY PROCESS.

PLATE XXXIV. *See page 1567.*

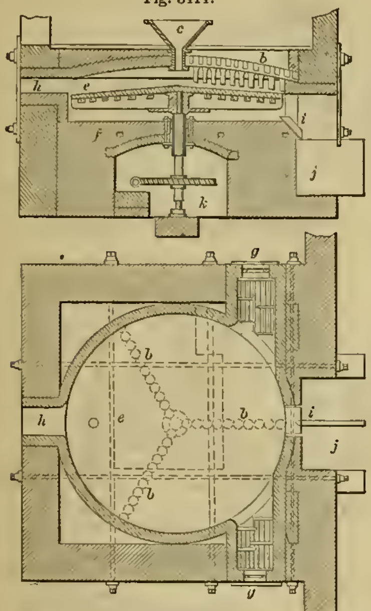
of gun *g* and carriage *f* is borne by a hydraulic piston, working in a cylinder below. The recoil of carriage *f* expels water from the water-chamber at the rear, and when water is forced back into this chamber by the pumps, the gun is simultaneously run forward and the breech raised to its proper position for firing.

Ore–ap′pa-ra′tus. (*Metallurgy.*) The methods of treating ores are described under various heads, which are assembled under METALLURGY; FURNACE; MILL (which see). The methods are *dry, wet, hot,* etc. Otherwise classed, they may be *crushers, grinders, stamps, mills,* etc. Or they may be *sorters,* which act by wet or dry processes to save the more valuable from the coarser particles; such are *washers, jiggers, cradles, concentrators, separators.* Acting by heat, they may be *blast, smelting, calcining, desulphurizing, oxidizing, reducing, roasting* furnaces. Using quicksilver, they may be *pans, barrels, amalgamators, arrastras,* etc. See under these heads and the lists quoted above.

Ore–cal′cin-ing Fur′nace. A *roasting* furnace for ores. One in which ore is reduced to a friable state; the heat at the same time, as with some iron ores with argentiferous pyrites and many others, driving off certain volatile matters, such as sulphur, carbon, arsenic, phosphorus, antimony, etc.

An *oxidizing* furnace, which reduces the metal in the ore to a metallic calx.

Fig. 3414.



Revolving-Calciner.

Calcining or roasting furnaces are of various kinds: reverberatory, revolving on horizontal or vertical axes. The furnace shown in Fig. 3414 is used at Constante, Spain, for the roasting of the argentiferous ore, which consists principally of antimonial sulphides of silver disseminated in gangues consisting chiefly of sulphate of baryta, and in combination with arsenic, iron pyrites, galena, and sulphide of copper. The hearth or table *c* is 14 feet in diameter, and makes four revolutions per hour, in which time the furnace consumes about 130 pounds of pine wood. *c* is the hopper through which the charge of ore and salt is fed. *b*, agitator-frames built into the masonry of the arch. The hearth *c* has a slightly conical surface, and is made of fire-brick set on end on a cast-iron shell. The bed *f* is also of refractory clay. The furnaces *g g* are on each side, and the products of combustion, after traversing the flue, pass by the duct *h* to the chimney. After calcination, the ores pass by the spout *i* to the chamber *j*. The stem of the hearth is stepped in a block on the floor of the crypt *k*, being revolved by the wheel and worm. See ROASTING-FURNACE; SILVER-MILL.

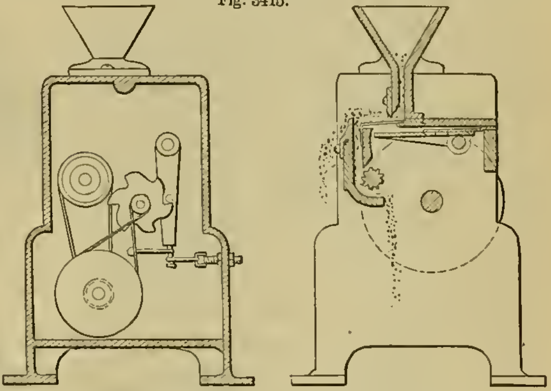
Ore–con′cen-tra′tor. (*Mining.*) A device to sort ores according to richness, or to separate the metallic portions of powdered ores from the gangue.

The processes are two, the *dry* and the *wet.*

The *dry* is illustrated by Krom's. (See CONCENTRATOR.) In this the powdered ore in a thin stratum is exposed in falling to a sheet of air in motion; this blows the particles to a greater or less distance, according to their comparative richness, the quantity of metal in each determining the relative weight. Heavy particles fall down in opposition to the blast; portions less weighty are driven somewhat out of their course and fall over a division board; light parts are blown away as dust. Screens aid in separating.

This device is shown in Fig. 3415, as also in Plate XXXIV. As each projection on the trip-wheel comes in contact with the pin, the lever is thrown back and the bellows carried down. The pin being passed, the rubber spring connecting the lever with another fixed pin carries back the lever and bellows, repeating the operation for every tooth on the wheel.

Fig. 3415.



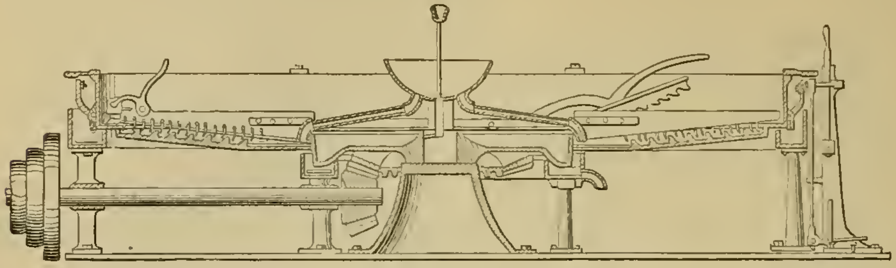
Ore-Concentrator.

Plate XXXIV. represents a mill arranged for crushing and concentrating ores by Krom's dry process. The mill is preferably built on a hillside or steep slope, so that the ore may be delivered directly into the third story, where it is fed to the jaw-crusher *a*, by which it is broken into small fragments, and falls on to an inclined screen *b*, where that portion which has been crushed sufficiently fine is separated and conveyed by a chute to the elevator *c*; the coarser portion goes to the first pair of crushing-rolls *d*, where it is farther broken up, and, falling on a second screen *e*, the finer parts are carried through another chute to the elevator, the coarser pieces being transferred to the second crushing-rolls *f*, which complete the crushing, and deliver all the remainder to the elevator.

In this way the portions which have been broken sufficiently small are not subjected to the farther action of the rollers, the formation of an excess of fine stuff is prevented, and a less amount, corresponding to the lesser capacity of each pair of rolls, which successively increase in fineness, remains to be treated.

The whole mass of broken ore is conveyed by the elevator to the upper floor of the building and delivered by the chute to the first screen *g*, where such as is still too coarse is conveyed by the pipe *h* back to the rolls to be recrushed, and that which passes the meshes of this screen falls into the second screen *i*; the pieces which fail to pass through the larger end of this screen constitute the first or coarsest grade of ore for concentration, which flows into one of the bins *l*, three in number, on the third floor. The second grade is obtained from the end of the third screen *k*, while that which passes through its meshes constitutes the third or finest grade; each of these flows to its appropriate bin, whence it is delivered to separators *m*, one for each grade, on the floor below.

Fig. 3416.



Rotary Ore-Concentrator.

The concentrated ore and tailings from the separators are conducted by separate passages to the floor below, the former being received in bags or bins and the latter in cars preparatory to removal.

The dust made in crushing and separating is conducted through pipes leading to the screening-chamber, into the top of which enters the large pipe *n* of the exhaust-fan *o*, which causes a gentle draft from all parts of the building, so that the dust arising from the crushing as well as the screening is all ultimately conveyed to the settling-chamber *p*. The design is only to remove the flowing dust, leaving the heavier particles, which may be susceptible of farther concentration, behind. In the case, however, of gold and silver, the fine dust in the chamber may be preserved for future treatment if of sufficient value; otherwise it may be conducted directly out of the building.

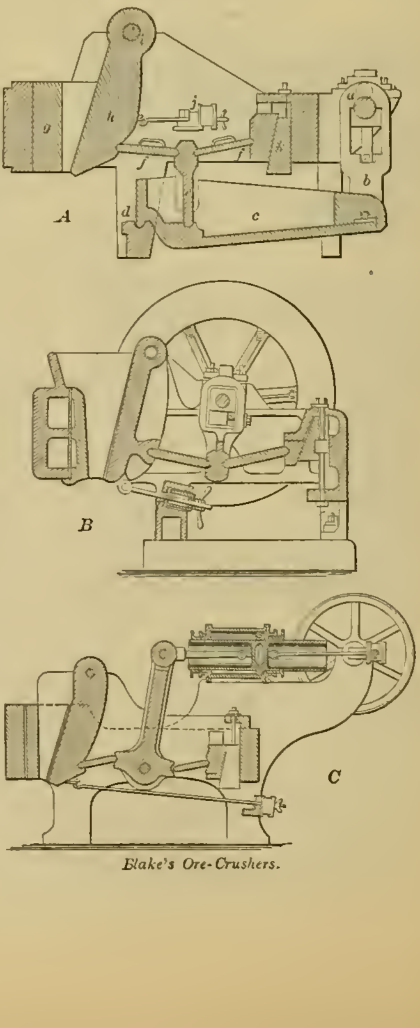
Fig. 3416 is an illustration of the *wet process* of concentrator. The circular, concave, grooved disk has a continuous rotary motion. The ore and water are received at the center and carried by centrifugal force to the periphery of the disk, the heavier particles settling in the riffles. The débris is separated by the current and constant agitation, is carried out by the sluice transversely across the disk to the center, and is discharged through openings into the stationary circular sluice below; the sulphurets are discharged by a plow at the periphery of the disk into another stationary circular sluice below.

In Varney's apparatus, the pulp is passed from the hopper to the pan, which is horizontally oscillated by a cam and recoil spring. By the inclination of the disk forming the floor of the pan, the motion, and the flow of the water, the lighter and heavier particles are assembled on the respective sides of the radial strips which divide the disk into sectional compartments. The trough beyond the periphery of the disk is divided in line with the strips, and has openings on each side of the divisions, which conduct the respective qualities, thus sorted by their relative gravities, by separate channels to their distinct receptacles, the lighter being discharged centrally to the waste-pipe, and the heavier particles of ore being collected in a circular series of boxes placed one below each discharge.

Other varieties might be cited.

Ore-crush'er. A mill for breaking ores into small pieces for farther treatment. Usually a preliminary breaking preparatory to *stamping*.

Fig. 3417.



Blake's Ore-Crushers.

Fig. 3417 shows three forms of the Blake ore and stone crusher. In each figure the parts are represented in position as they would be seen by removing one side of the frame *A*. *a* is the crank, *b* is a pitman or connecting rod which operates the lever *c*. This lever has its fulcrum on the frame at *d*. Upon the lever stands a vertical piece *e*, against the top of which the toggles *f f* have their bearings, forming an elbow or toggle-joint. *g* is the fixed jaw against which the stones are crushed. This is bedded in zinc against the end of the frame. *h* is the movable jaw, pivoted at *i* and swinging back and forth by every revolution of the crank. *j* is a rubber spring which opens the jaw, and *k* is a wedge which regulates the degree of closure of the jaw.

The jaws are generally set about 1½ inches apart at the bottom, and the vibration of the moving jaw amounts to about one fourth of an inch at the bottom, being, of course, much less toward the pivot. The full power of the engine is exerted to move the jaw through a very small space when the stone is large, and the force is exerted through a larger space as the pieces grow less in size.

B shows a form of the machine without the lever, the rod on the eccentric shaft being connected directly to the toggle-levers. This is the form of machine most in use in Europe.

C is a machine which has a steam-engine mounted on the frame. A piston-rod from the trunk-cylinder connects with the long arm of a rocking lever which is pivoted between the toggles.

Where large fragments of ore are to be crushed, as often happens in mining, a large crusher is sometimes introduced to break the rock into pieces of moderate size, which are then fed to smaller machines to complete the work. Crushers of this class are used in the Lake Superior copper-mines, and at Freiburg, Saxony.

The jaws of Blake's crushers are usually faced with case-hardened blocks of iron, which can be turned over when worn, and cheaply replaced when this is necessary. The jaws usually have coarse vertical furrows, the elevation on one opposite the depressions of the other, to prevent the passage of long, slim pieces of rock; but plain jaws may be used. See also ORE-MILL.

Ore-fur'nace. (*Metallurgy.*) A furnace for operating upon ores. The term is general, but the actual furnaces have specific names and various constructions, according to the metal, its gangue, the condition, etc. *Blast, calcining, desulphurizing, reducing, roasting, subliming* furnaces may be mentioned, but a list is given under FURNACE (which see). See also METALLURGY.

Ore-hearth. (*Metallurgy.*) A form of reducing-furnace which is without a dome, and known also as a *forge*. See lists under FURNACE; METALLURGY.

Or'e-ide. A factitious gold. See OROIDE. See also ALLOYS.

Ore-mill. A machine for grinding ore, in order that by comminution the metallic portion may be separated from the gangue.

The plate on the next page shows several typical forms of *ore-mills*, known by various technical names, such as *grinders, disintegrators, crushers, stamps*, etc. Other forms not represented, or not as fully shown as desirable in this plate, may be found under the previous figure, the "Blake" crusher, and also under the heads of AMALGAMATOR, ARRASTRA, CHILIAN-MILL, PAN, STAMP, etc.

In Plate XXXV., next page, *A* is a form of mill known as the "Chilian." It rotates on its own axis, and also revolves around the central post, treading upon and grinding the ore in its path. See also CHILIAN-MILL.

B is a form of pulverizer, in which a pestle rolls on its axis and travels in a circular bed whose cross-section approaches the form of the rounded surface of the pestle.

C is a battery of two stamps, operated in the present example by cranks, pneumatic springs in the cylinders above the stamps giving a certain quality to the blow and recoil.

D is a form of crusher in which a heavy roller with circumferential grooves rotates and rolls in a rotating cylinder, the interior of which has corresponding interlocking ridges.

E has an eccentric toothed roller which has a reciprocating rotation.

F has two conical-faced disks, keyed to inclined shafts, having powerful set screws to adjust the width of space between the disks. The ore or stone is fed into a chute, and, falling between the inclined disks, is subjected to pressure as it passes into the gradually contracting space, and is thus crushed.

G has a concentric roller with teeth of varying sizes as the throat narrows, to bite upon the ore, which is gradually comminuted between the jaws as the roller is rocked.

H is a form like some kinds of grinding-mills for stock, excepting that the core and shell revolve in the same direction at different speeds.

I has a series of revolving cylinders with perforations and with interior corrugations: in the middle one of the series are balls. The material is fed through the trunnions and discharged through the holes in the cylinders.

J has a rocking bed and a heavy roller.

In *K* the ore enters the revolving cylinder from the hopper. The heavy inner cylinder rolls in and crushes the ore against the bottom of the outer one, which contains mercury. The discharge-cylinder is attached to the outer cylinder so as to catch any particles of metal that may pass over its edge. A current of water may flow through the apparatus.

L is a Whelpley and Storer's mill. It has a series of beaters *m m* which revolve in a casing and dash to pieces the blocks of copper ore which are placed in the hopper *o* and fed by the corrugated roller. A suction draft from the fan *n* removes the stuff when it is beaten into dust.

M has a wheel with hammers revolving a case with interior corrugations. A fan on the disk face of the wheel drives out the powdered ore.

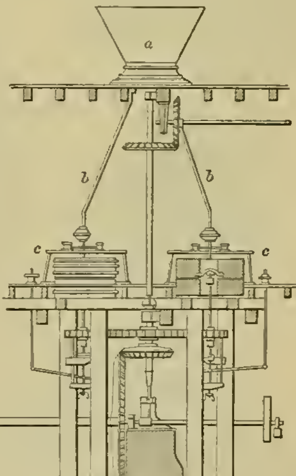
N is Howell and Hannay's machine for crushing quartz, bones, etc., by the percussive force of the rotating projector or by the impingement of the material against the inside of the case.

O is a form of the "Blake" crusher, in which the lower end of the moving jaw rests against the anti-friction roller, and its upper end receives motion by a cam turning in the rectangular opening. The concave faces of the jaws are thus made to roll together with a slight but powerful movement. See also Fig. 3417.

For list of machines and appliances in this line, see METALLURGY; MILLS.

The horizontal mill for grinding silver ores at Constante, Spain, is shown in Fig. 3418. The figure shows two mills, one in section; each has buhr stones, and is fed from a hopper *a* with ore ground so as to pass through a sieve of a gage of 100 openings to the square inch. Pipes *b b* lead the ore to the stones *c c*, which revolve in casings. The runners are suspended by balance-rynds upon the cock-heads of spindles, as in grain-mills, and are driven by a system of gearing below, which needs no particular description.

Fig. 3418.



Horizontal Ore-Mill (Constante, Spain).

Fig. 3419 is also a horizontal mill having a pair

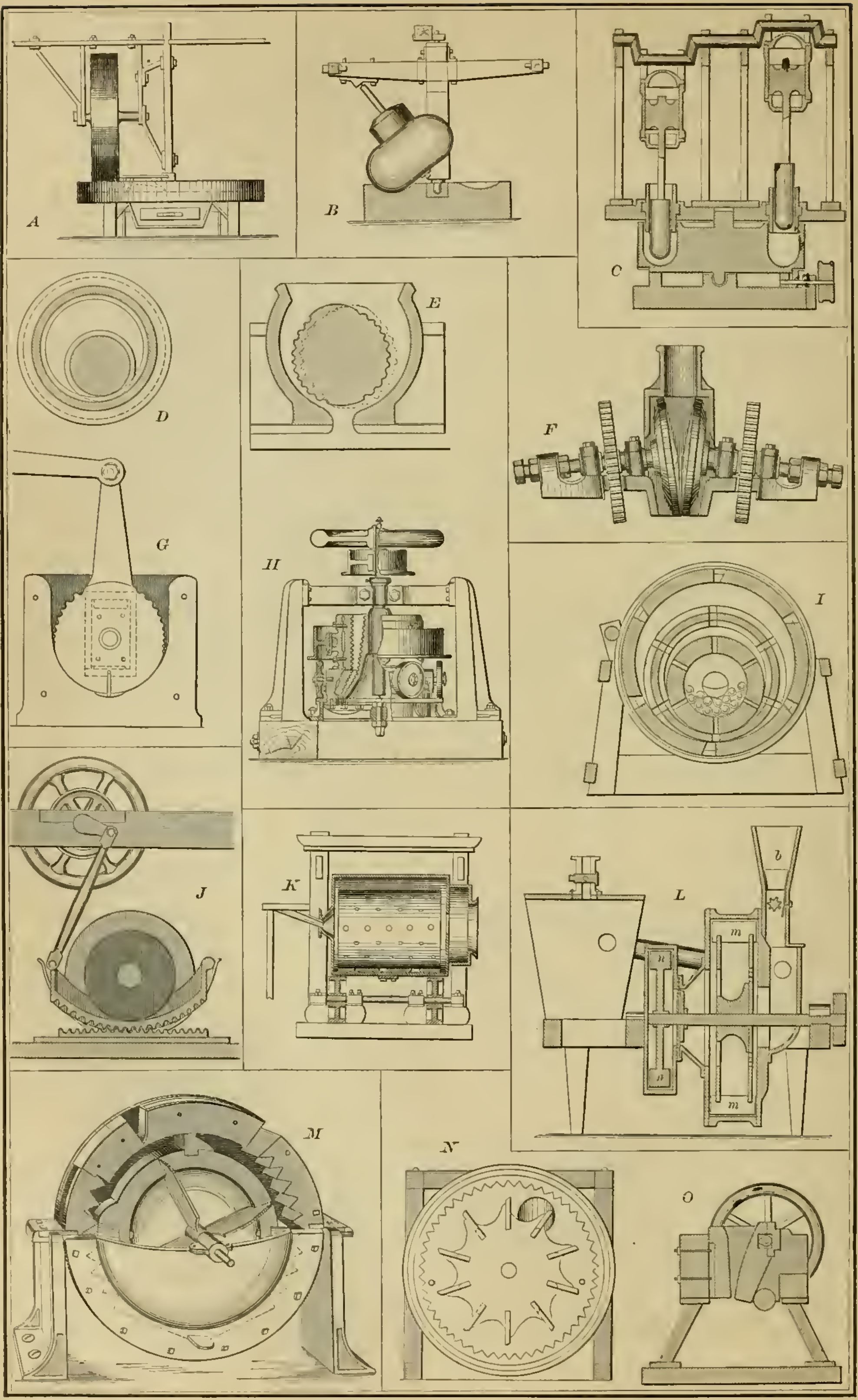
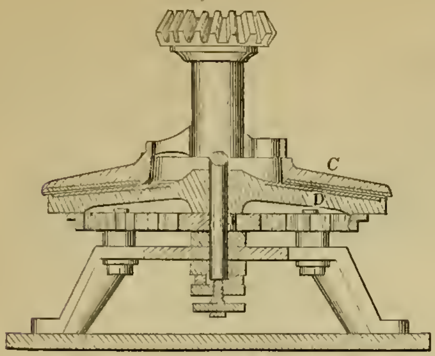


PLATE XXXV. ORE-MILLS OF VARIOUS KINDS.

See page 1569.

Fig. 3419.



Ore-Grinding Mill.

of slightly conical disks *C D* revolving in opposite directions.

Pliny says that "the ore is first broken up and washed, then roasted and ground to a fine powder." This was placed in a reducing-furnace to expel volatile metals, and the remainder was again ground and farther reduced in crucibles. He speaks also of breaking-machines used for crushing the silex as being shod with pieces of iron weighing 150 pounds. These were probably iron-shod stamps. See Gold.

> "Whate'er is excellent in art proceeds
> From labor and endurance: deep the oak
> Must sink in stubborn earth its roots obscure,
> That hopes to lift its branches to the skies:
> Gold cannot gold appear, until man's toil
> Discloses wide the mountain's hidden ribs,
> And digs the dusky ore, and breaks and grinds
> Its gritty parts, and laves in limpid streams,
> With oft-repeated toil, and oft in fire
> The metal purifies: with the fatigue,
> And tedious process of its painful works,
> The lusty sicken, and the feeble die."
>
> Dyer, *The Fleece*, 1757.

Ore-roast'ing Fur'nace. (*Metallurgy.*) One for heating powdered ores to drive off sulphur, arsenic, and other ingredients amenable to this treatment, and prepare the mineral for farther operations, by which the metallic portions are separated from the gangue.

Roasting-furnaces are of various kinds, some adapted to special metals. See Copper Furnace; Roasting-furnace, etc., and list under Furnace.

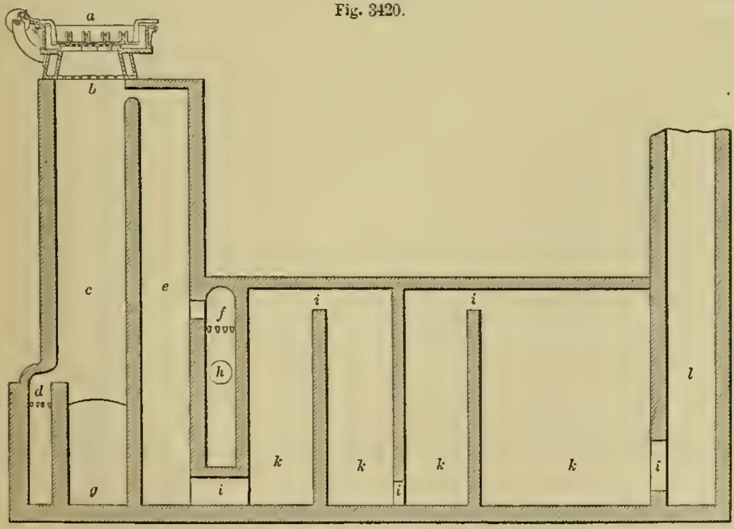
Others are known by their peculiar purpose, as *desulphurizing*, *calcining*, *oxidizing*, *reducing* furnaces, etc.

Others are known by their construction, as *reverberatory*, *horizontal*, *rotary*, *shaft* furnaces, etc.

The above are considered under their respective heads.

Fig. 3420 is a view of the Stetefeldt ore-roasting furnace, so much used in the silver districts, and shown under Silver Mill in its relation and position to the *crusher*, *stamps*, and *amalgamator*. It is of the class known as a *shaft-furnace*, in which the finely powdered ore is mixed with certain chemical re-agents and dropped into the flame, which passes up the chimney. In the case, for instance, of operating upon the sulphides of silver mined in Utah, the ore which has been broken in the *crusher*, and reduced to powder by the stamps, is mixed in the latter with a certain percentage of salt, and then conveyed to the top of the furnace, where it is distributed by the feeder *a* in a shower of fine dust by the sieve *b*; falling down the shaft *c*, it is exposed to the full effect of the flames and heat rising from the furnace *d*, for which the shaft *c* forms a chimney. A double decomposition takes place in the shaft, the chlorine leaving the sodium and entering into combination with the silver to form chloride of silver, while the sulphur parts company with the silver and unites with the soda to form sulphate of soda, which is readily dissolved and runs away in the tailings. The heat of furnace *d* passes up the shaft *c* by way of an arch into descending flue *e*, where any metallic dust which is carried over is subjected to the action of the flame from the second furnace *f*; *h* is the air-opening for the supply of air to furnace *f*. The chambers *k k k*, connected by arches *i i i*, are for the collection of metallic dust, and are cleaned out from time to time. *l* is the chimney. The main body of the ore from the feeder *a* collects at the bottom of the shaft *c*, where it remains in a hot bed, and is removed at intervals to the damping-floor and the amalgamator. See Silver-mill.

Fig. 3420.

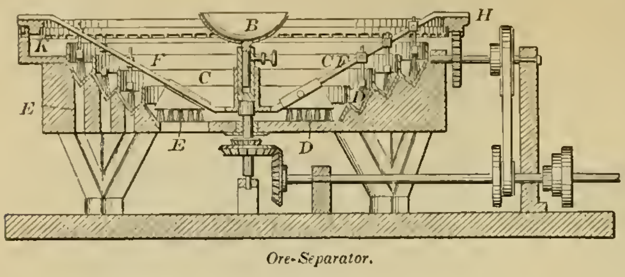


Stetefeldt Furnace.

Ore-sep'a-ra'tor. A general term which includes machines of various kinds for separating metallic ores from the gangue, after pulverization. They may be classed into wet and dry. Of the former are the *washers*, *frames*, *cradles*, *jigging-machines*, etc. Of the latter are *ore-concentrators*, etc. See also list under Metallurgy.

In Fig. 3421, the crushed material descending in regulated quantities from a vertical spout impinges on the rapidly rotating disk *B*, from which it is thrown off by centrifugal force, being at the same time sorted according to size and gravity,

Fig. 3421.

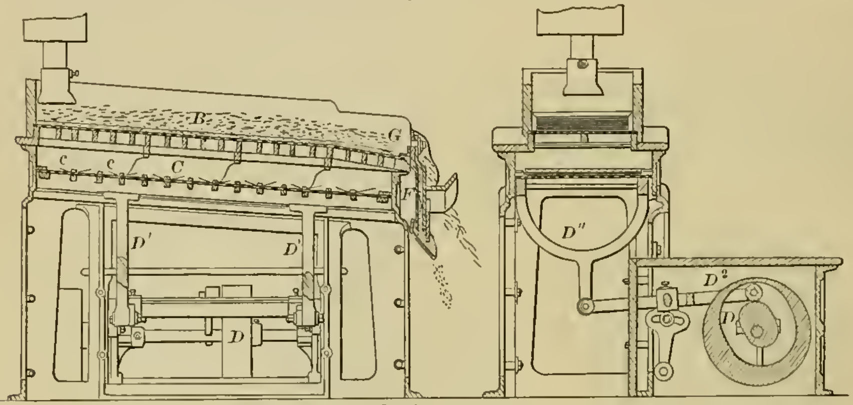


Ore-Separator.

the lighter portions falling farther from, and the heavier nearer to, the disk ; the different sizes are received in the various grooves $C'\ C$ of the circular trough, and are swept into their appropriate chutes by brushes $D\ D\ E$ attached to arms $F\ F$, which are fastened to a circular toothed rack $K'\ H$ rotated by a pinion driven by belt connection with the main shaft.

In Fig. 3422, the broken ore descends from a spout on to the inclined sieve B, through the meshes of which an upward current of air is passed from the bellows C. This is operated by the cam-wheel D, yokes $D'\ D'\ D''$, and levers D^2 ; these latter are adjustable on the wheel to regulate the working of the bellows, which is provided with valves $c\ c$, the openings of which may be varied to control the force of the blast, which requires to be stronger near the lower end, where the coarser particles collect. The various sizes are discharged through different chutes $F\ G$.

Fig. 3422.



Ore-Separator.

Ore-smelt'ing Fur'nace. One for reducing metal from its ores. See Blast-furnace ; Iron ; Smelting-furnace. See also lists under Furnace ; Metallurgy.

Ore-stamp. A means of crushing ore by shod beams vertically reciprocated. See Stamp-mill.

Ore-wash'er. (*Metallurgy.*) A means of separating metal from ore after the latter has been reduced to powder. The slimes or metallic mud are agitated in *jiggers*, flowed over *frames* or *riffles*, exposed to a stream of water in *concentrators*, or otherwise treated with water so as to float off the lighter and less valuable portions, leaving the metal behind. See list of machines and processes under Metallurgy.

Gold is separated from broken quartz or from sand by similar methods. See Gold-washer ; Gold-mining.

Or'gan. (*Music.*) A musical instrument in which the notes are produced by pipes of different lengths, shapes, and materials, supplied with air by bellows and operated by keys which admit or cut off the supply.

The dimension of the instrument is designated by the number of feet of length that its largest pipe measures, forming the lowest note of the key-board. Thus, we speak of an organ of 32, 16, or 8 feet. An instrument which possesses *open flutes* of 32, 16, 8, and 4 feet, and a *principal* an octave above the latter, has a compass of 8 octaves. See Musical Instruments, Fig. 3263.

Large organs sometimes have five key-boards, one above another.

The first, nearest to the organist, is that of the *choir* organ.

The second, that of the *great* organ.

The third, the *bombarde* key-board.

The fourth, the *recitative* key-board.

The fifth, the *echo* key-board.

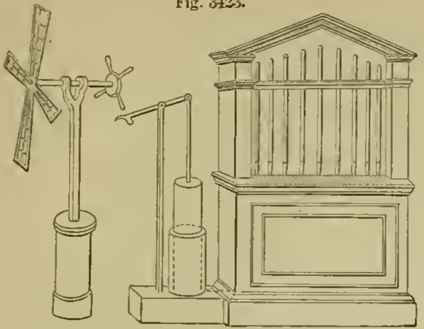
Below these is the *pedal key-board*, played by the feet. The music of the organ is sometimes written on three lines, the two upper ones for the hands and the under one for the pedal key-board.

The *organ* of Jubal (Gen. iv. 21), 3875 B. C., may be supposed to have been a mouth-organ or Pandean pipes. His name is associated with the invention of the harp and the organ, — stringed and wind instruments, — and the same connection of musical instruments is maintained in the Book of Job and the Psalms. In the latter case, the trumpet, harp (*of two kinds*), timbrel (*tambourine*), organ, and cymbal are referred to. The Greek word ὀργάνον, from which our word "organ" is derived, denoted an instrument of any kind, but was more particularly applied to musical instruments. According to Vitruvius, *organum* was a term applied to any instrument requiring skill in its use, while the *machina* merely required animal force for its operation.

The mouth-organ, or Pandean pipes, was expanded into an instrument resembling the bagpipes, in which the air for supplying the pipes producing the musical tones was blown by the performer.

In the "Spiritalia" of Hero of Alexandria, who flourished 150 B. C., we find a description of an organ blown by the agency of a wind-mill which works the piston of the air-pump. Its invention is, perhaps, to be credited to Ctesibus of Alexandria, though it is likely that it was the result of the gradual improvement by various parties through the centuries. The reconstruction of it given in Fig. 3423 is by Woodcroft, from the text of the "Spiritalia." The descriptions of it by Athenæus, Vitruvius, and Claudian render it certain that the pipes were musical, and blown by the force of water, instead of expansible air-bellows.

Fig. 3423.



An Organ blown by Wind-Power, 150 *B. C.*

Athenæus thus describes it : —

"And Alcides said: 'But this engine, the hydraulic organ, whether you choose to class it among stringed instruments or among wind instruments, is the invention of a fellow-countryman of mine, an Alexandrian, a barber by trade, and his name is Ctesibus.'

"And Aristocles reports this in his book on 'Choruses,' saying: 'The question is asked, whether the hydraulic organ is a stringed or a wind instrument. Now, Aristoxenus did not feel sure on this point; but it is said that Plato showed a certain notion of the invention, making a nightly clock like the hydraulic organ, being very like an enormous hour-glass, which, indeed, it resembles. It cannot, therefore, be considered a stringed instrument, and one to be played by touching. But perhaps it may be called a wind instrument, because the organ is inflated by the water; for the pipes are plunged down into the water, and when the water is agitated by a youth, as the axles penetrate through the whole organ, the pipes are inflated and emit a gentle and agreeable sound. And this organ is like a round altar, and they say was invented by Ctesibus the barber, who dwelt at that time in the territory of Aspendor, in the reign of the second Ptolemy, surnamed Euergetes, and they say that he was a very eminent man, and learnt a good deal from his wife Thais. Trypho, in his dissertation upon flutes and organs, says that Ctesibus, the mechanician, wrote a book about the hydraulic.' " — From the "Deipnosophists," by Athenæus, A. D. 220.

A fuller description of an organ of this kind may be found in Vitruvius. An organ with pipes of varying length, and apparently about 10 feet high, is shown on a coin of the gentle Emperor Nero. He was much addicted to music, and is supposed to have also soothed his mind by the bagpipes. A Greek epigram in the Anthologia, attributed to the Emperor Julian, A. D. 364, has the following description: "I see reeds of a new species, the growth of another and a brazen soil, agitated by a blast rushing from a leathern cavern beneath their roots and producing melodious sounds, as the keys dance under the skillful fingering of a robust performer." The origin of the bellows organ would thus seem to have been known to the Greeks of the Eastern Empire.

Fig. 3424 shows several old methods adopted for supplying wind to the organ; the arrangement of the keys and the manner of manipulating them are also illustrated.

A is a representation by Father Kircher of a very primitive form of Hebrew organ, the "Macraphe d'Aruchin." In this, as in other of the earlier organs, a leathern bag served the purpose of the wind-chest.

B is copied from the sculptures on an obelisk at Constantinople, erected by Theodosius, who died A. D. 395.

C is a pneumatic organ of the tenth century; it is taken from an ancient psalter in the library of Trinity College, Cambridge.

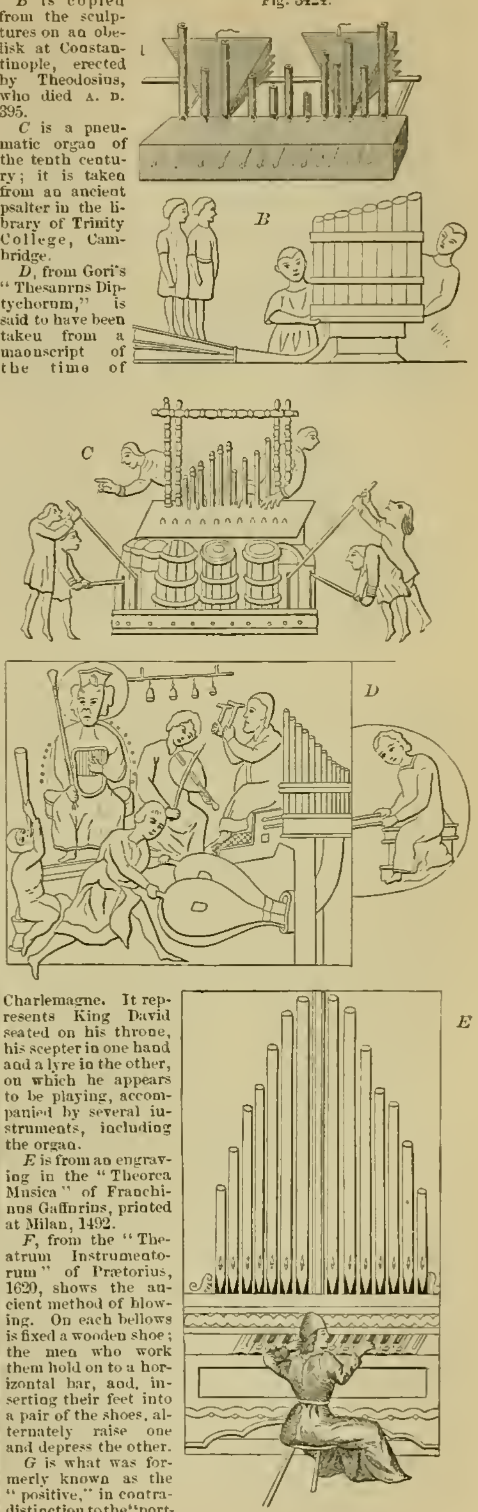
D, from Gori's "Thesaurus Diptychorum," is said to have been taken from a manuscript of the time of Charlemagne. It represents King David seated on his throne, his scepter in one hand and a lyre in the other, on which he appears to be playing, accompanied by several instruments, including the organ.

E is from an engraving in the "Theorea Musica" of Franchinus Gaffurius, printed at Milan, 1492.

F, from the "Theatrum Instrumentorum" of Prætorius, 1620, shows the ancient method of blowing. On each bellows is fixed a wooden shoe; the men who work them hold on to a horizontal bar, and, inserting their feet into a pair of the shoes, alternately raise one and depress the other.

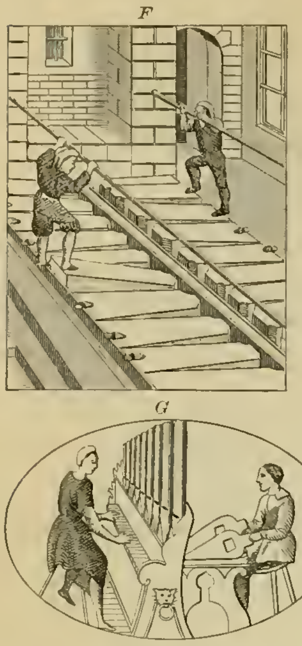
G is what was formerly known as the "positive," in contradistinction to the "portative" organ. The lat-

Fig. 3424.



Old-Time Organs.

Fig. 3425.



Old-Time Organs.

ter, as its name implies, was portable, being carried in processions by one person and played by another; it was also called the "regal" or "rigol." The former was fixed in position, and, when carried in a procession, it and its stand were placed on a car. An organ of this kind was afterward placed before the great organ in churches, the two constituting a single instrument, the "positive" being the origin of what has since been designated the *choir* organ.

The organ is said to have been applied to religious services in churches in 657, and first used in the Western churches in 658 by Pope Vitalianus; though they were, according to Julianus, a Spanish bishop, commonly used in Spain 200 years previous to this date.

In 757, the Emperor Constantine IV. presented an organ to King Pepin of France; and one, the work of a Saracen artist, was presented to his son Charlemagne by Haroun al Raschid; and, in 812, Louis le Débonnair built one on the Greek model at Aquisgrana, the modern Aix-la-Chapelle.

Several German organs were placed in Italian churches by John VIII., 872–882.

About 951, the abbey of Malmesbury and the cathedral of Winchester in England were provided with organs. At this time and for two centuries later, the compass was small, usually from 9 to 11 notes, the brass pipes harsh in tone and the machinery clumsy; the keys being 4 or 5 inches broad, and struck by the fist.

Gerbert of Auvergne, in his school at Rheims, had an organ played by steam. He was afterward made Pope by the Emperor Otho III., assuming the name of Sylvester II. He and his patron were poisoned by Italian intriguers about 1002. Gerbert introduced the Arabic numerals into Europe.

The organ of Winchester, probably placed there by St. Dunstan, had 26 pairs of bellows, 400 pipes, and required 70 men to work it.

The *key-board* is distinctly described at the close of the eleventh century. At this time a number of small bellows, 20 or more, were used, worked by men who held to a horizontal rail and operated the bellows with their feet, as at *F*, Fig. 3425. It is said that half-notes were invented at Venice in the twelfth century, but the earliest authentic example of their introduction was in the Halberstadt organ, built about 1360. The invention of the pedal is claimed for Bernhard, a German organist to the doge of Venice, 1470–80. He probably made some improvement in that appendage, but it appears to have been in use nearly a century previous.

The organ of Nuremberg had pipes from 16 to 32 feet long, A. D. 1468.

In 1596, the organ of Breslau had most of the now known stops.

It would seem that up to the fifteenth century organs were generally constructed by the monks, but about this period organ-builders by profession were to be found both in England and on the Continent. The earliest recorded in England was William Wotton, who, in 1587, agreed to make a pair of organs for Merton College, Oxford, for the sum of £28.

The German and Dutch builders appear to have taken the lead, and we find that, notwithstanding the strenuous opposition of Zuinglius and some of the early reformers, the German churches were, during the sixteenth century, generally provided with organs. During this century, the German builders introduced the *register* and the stopped pipe. The key-board also was extended to four octaves.

England, also, was well provided with artists of this class, and possessed some fine instruments.

In 1634, we are informed that the organ in the cathedral of Durham cost £1,000. Those of York, Litchfield, Hereford, Bristol, and other cathedral towns were also noted.

During the civil war, the Puritans, particularly the parliamentary soldiers, destroyed many fine organs, breaking them in pieces and selling the pipes for old metal. Few or none being built during this period, the art became almost forgotten in England, so that Pepys records, under date of July 8, 1660: "To White-Hall Chapel, where I got in with ease by going before the Lord Chancellor with Mr. Kipps. Here I heard very good musique, the first time that I ever remember to have heard the *organs* and singing men in surplices in my life."

The class of native organ-builders having become almost extinct, inducements were offered to foreigners to settle in England. Prominent among these was Schmidt, generally known as Father Smith, who built the instrument referred to by Pepys. Among the instruments of this period was the organ of St. Paul's Cathedral, noted as being the source of much tribulation to Sir Christopher Wren, who considered that the harmony of his designs was spoiled by the "box of whistles." This instrument was nearly 30 feet high, 18 wide, and 8 deep.

About 1680, the *barrel-organ* used by itinerant musicians was introduced.

The early builders were fond of employing *outré* materials in their organs, and of decorating them with precious metals and stones, or with grotesque carvings; animals, birds, and angelic figures moved by mechanism were also introduced, the latter playing on the trumpet or beating big drums.

The old organ at Lynn, in Norfolk, had a figure of King David playing on the harp and larger than life, cut from the solid wood; likewise several moving figures, which beat time, etc.

We are told that the Emperor Theophilus, 829–41, had "two great gilded organs, embellished with precious stones and golden trees, on which a variety of little birds sat and sung, the wind being conveyed to them by concealed tubes."

The Duke of Mantua had an organ in which the pipes and other parts were made of alabaster. A pair of organs at Venice were made all of glass, and of the eight in the convent of the Escurial, near Madrid, one is said to be made of solid silver.

The devices required in order to make a pipe sound or *speak* are: the bellows, for supplying condensed air; a channel, for conducting it to the pipe; a valve or other contrivance, for admitting and cutting it off; and a lever, for opening and closing the valve.

The pipes are of two descriptions: the *mouth* or *flute* pipe (technically called *flue*-pipe) and the *reed*-pipe, which are each farther divided into several varieties.

Mouth-pipes, so called from having a mouth and lips similar to those of the flageolet, are either of wood or metal. The latter are those observable at the front of the organ case, and are cylindrical in cross section. The wooden pipes are rectangular in section, the sides being in the proportion of 5 to 4; the interior is usually sized with glue. The upper end is open, or is closed by a tompion made air-tight by a leather covering. The other end is closed by a block to which three of the sides are glued, a narrow aperture being formed between the block and the front side, by beveling this side so as to have its sharp edge on the interior: this is called the *upper lip* or *wind-cutter*.

Another block is arranged so as to leave a narrow space between it and the block. The hollow cylinder, through which air from the bellows is supplied, is let into this block.

A mahogany cap, hollowed out on the inner side so as to leave the aperture free, is fastened to the front of the pipe below the mouth. The aperture between the cap and the block, called the *plate-of-wind*, admits the compressed air from the bellows in a thin stream, which, being forced against the mouthpiece or wind-cutter, produces a musical note determined in pitch by the length of the column of air set in motion. In order to *voice* the pipe, — that is, improve the tone, — the edge of the block opposite the upper lip is slightly pared away and serrated so as to divide the plate of wind and direct it against the inner edge of the lip.

The pitch of a note depends on the length of the pipe (see PIPE), while the tone or *timbre* depends on its diameter, its shape, or on the kind of wood employed: that yielded by pipes of hard woods, as mahogany, being more clear, while the softer woods yield a mellower sound.

The *chimney-top* pipe has a small open tube in the top-plate for the purpose of sharpening the note: a similar effect is sometimes produced by a hole in the tompion.

Metallic mouth-pipes are made conical at their lower termination, and where this cone and the cylindrical portion unite is an aperture occupied by a thick plate of soft metal, called the *languette*, nearly closing the tube, but leaving a small opening for the wind-plate, formed with the upper lip.

The thickness of the stream of air admitted to the pipe may be diminished by turning down a projecting exterior lip on the plate.

The *reed-pipe* is closed near the bottom by a solid plug, having apertures for the passage of the reed and its adjusting wire. The *reed* is a cylindrical or slightly tapering tube of brass, having a narrow longitudinal slit in front, covered by a thin plate of metal called the *tongue*, which is made fast to the reed at its upper part, but is free at the lower end The back part of the reed is cut off slanting at its lower termination, over which a piece of metal is soldered.

The *pitch* of the reed-pipe depends on the length of the tongue, which is adjusted by means of the *tuning-wire* above mentioned; the *quality* of tone depends on the pipe.

In the free reed of Grenié, invented many years ago, the tongue, instead of battering against the side of the reed, vibrates within the opening, producing a more uniform, sweet, and harmonious tone.

It also admits of the musical effects called *crescendo* and *diminuendo*, by varying the pressure of the air. The air escapes through tubes in the form of an inverted cone, whose upper portion is hemispherical and slit.

A *stop* consists of a series of pipes agreeing in quality of tone, or timbre, but differing in pitch. When any particular stop is drawn the keys will play on the corresponding set of pipes.

The stops are designated by figures or by words intended to be descriptive of the quality of sound, as *flute*, *oboe*, *vox humana*, etc. See STOP

Two or more key-boards are required to enable the performer to produce all the notes in an organ of more than one stop.

In a large organ the different series of stops are so arranged as to form three or four separate instruments, each having its own set of keys, wind-trunk, wind-chest, sound-board, etc. These have been distinguished by different names, as the *great-organ*, the *choir-organ*, and the *swell;* also the *pedal-organ*, or *foot-keys*, which act on the larger pipes.

Couplers are also brought into action at will, which connect the keys on different banks so as to make them act together when one is played. The effects are also varied by *tremulo* and *swell*, which give respectively quavering and rising and falling force of sound.

The feet of the pipes are inserted in the *upper* or *stock* boards, above the bearers and supported on *racks*, — thin boards mounted on pillars.

The pipes of the larger stops, however, take up so much space that they cannot be placed immediately over their proper groove, but they may be placed in any convenient position, even outside of the case, and air conveyed to them by means of grooves cut in the upper boards and covered with parchment, forming closed channels.

The key movement, in its simplest form, comprises: the *key*, a pivoted lever, which, being pressed down at one end causes the other end to raise the *sticker*, a small wooden rod depending from the end of a second lever above, which is thus depressed at its opposite end, drawing down the *pull-wire* and opening the *valve*.

This arrangement is, however, only applicable in case each key is opposite its own proper valve, a condition which can only apply in few instances. This difficulty is remedied by introducing a series of rollers above the secondary levers, whose ends are connected by wires with arms on the sides of the rollers; the other ends of these, on the same side, have also arms to which the wires controlling the valves are attached.

The foregoing description will give an idea of the general principles governing the construction of organs, though there are many mechanical details and improvements introduced into modern construction to which we have not space to refer.

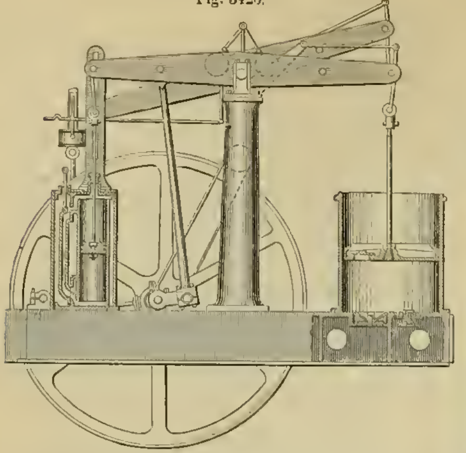
The *bellows* communicate with the *wind-chests*, which act as reservoirs and distribute the air to the different *pipes*, as the finger or foot *keys* are pressed down. The pressure of air is regulated by a weight on the upper part of the reservoir, usually about 15 pounds to the square foot. The different parts of the organ are now commonly supplied with air under different pressures, separate bellows being used for each pressure.

The *wind-chest* is an air-tight box communicating above with the *sound-board*, an oblong frame or box of wood divided by parallel strips into channels or compartments completely separated from each other. Holes corresponding with the number of ranks of pipes are bored through the upper part of the sound-board into each channel. Its lower side is covered with parchment or leather, except on that part where the channels communicate with the wind-chest and are closed by clack-valves opened by means of *pull-down* wires operated by lever connection with the keys and brought back by a spring. On the upper side of the sound-board, at right angles to these channels, a set of grooves, corresponding in number to the number of stops, is formed by screwing down thin pieces of hard wood, termed *bearers*. These communicate through holes with each of the channels below, and each has a register or slide, a little thinner than the bearers, but exactly fitting the groove in length and width. The slides are pierced with holes corresponding in number and size with those of the sound-board, so that by drawing out or pushing in any particular slide, it is caused to open or close the holes in the sound-board, and supply or cut off the air from the range of pipes above it.

In organs of the largest class as formerly constructed the operation of the keys was a work requiring, in addition to musical skill, a large amount of hard bodily labor. It is said that the performer on the great Haarlem organ was obliged to strip preparatory to commencing his work, and retired covered with perspiration at the end of the hour's performance. This is one of the largest instruments in Europe, having 60 stops and 8,000 pipes. One at Seville has 5,300 pipes. The expenditure of wind varying greatly, according to the series of notes produced, the tension of the air supply was very different at different times, causing a variation in the purity of the tone and difficulty in opening the valves when under high pressure. These difficulties were remedied by the *pneumatic* lever of Barker, in which small subsidiary bellows operated by the movement of the key are employed to depress the wires by which the valves are opened.

Where an extraordinarily large supply of air is required, it may be furnished by blowers or bellows operated by hydraulic or steam power. Fig. 3426 illustrates the blowing-engine employed for the great organ at the Hall of Arts, South Kensington, London, England. It is a vertical beam-engine, having two steam cylinders of 7 inches diameter and 24 inches stroke, and two blowing cylinders of 24 inches diameter and 24 inches stroke. Its principal duty is to compress and attenuate air for blowing and for mechanical purposes, such as opening and closing the stops. The valves of the blowing cylinder are of india-rubber. The upward stroke exhausts the air from vacuum receivers, to which it is connected by zinc piping, and the down stroke exhausts the pressure receivers to which it is similarly connected. In addition to the ordinary governor, it has two throttle-valves connected respectively with the pressure and vacuum receivers, so that when the former is filled with air at 1½ pounds pressure above, and the latter with air at 1½ pounds pressure below, that of the atmosphere, both throttles are closed and the engine stops, thus regulating the supply according to the ever-varying requirements of the organ.

Fig. 3426.



Blowing-Engine for the Organ Royal Albert, Hall of Arts and Sciences, South Kensington, London.

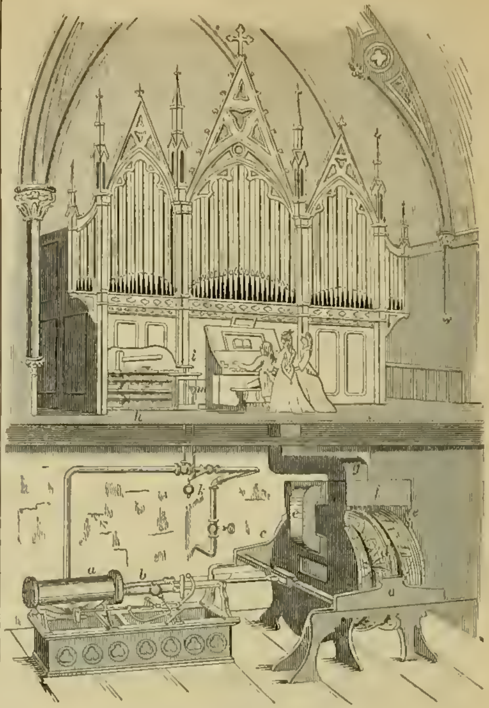
A horizontal engine of 13-horse power, driving a crank to which six large bellows are connected, furnishes compressed air to the reservoirs which supply the pipes.

This giant organ is 60 feet wide and 70 feet high; the four center pipes, which are over 40 feet long, weighing nearly a ton each. The instrument was erected by Mr. H. Willis, and, according to the "English Mechanic," is the finest in the world, having five claviers (four manuals, extending from C C to C in altissimo, and one pedal from C C C to G). The pedal-organ consists of 21 stops; the first manual clavier, or choir-organ, including the echo-organ, comprises 20 stops, all the pipes in which are of metal. The second clavier, or great-organ, contains 25 stops, only two of which have wooden pipes in the bass notes. The third clavier, or swell-organ, comprises 25 stops, and these are all, with the exception of the basses of two stops, of metal. The fourth clavier, or solo-organ, has 20 stops, making in all 111 stops; then there are 14 couplers and 32 combinations. The total number of pipes is close upon 9,000, and these range from 30 inches diameter down to the size of a straw, and from 40 feet in length down to 6 inches.

Fig. 3427 illustrates an organ provided with the hydraulic blowing apparatus designed by G. W. Lascell, Brooklyn, N. Y. *a* is the cylinder, the piston-rod of which *b* is attached to the cross-head of a reciprocating frame *c*, by which the movable diaphragm *d* of the double-acting bellows is operated, alternately forcing the air through the pipes *e e* into the wind-chest *f*, from which it is distributed by the trunk *g* to the organ bellows *h*. The wheel *i* is connected with a wire that controls the lever *k* of the governing valve of the water-supply pipe. As the bellows *h* becomes inflated, the block on its upper lid strikes against the lever *m*, closing partially or entirely the valve, and automatically regulating the supply of air to the demand. By means of a hand-wheel *i*, which can be conveniently reached by the organist, a valve *k* is opened or closed for admitting or cutting off the water supply. In this engine the crank is dispensed with, and the valve-gear so arranged as to prevent stoppage on the dead centers.

A number of reed instruments are called organs, being on the accordeon or melodeon principle, free reeds played by keys in one or more banks. Such are known as cabinet, parlor, and small choir organs.

Fig. 3427.



Lascell's Organ-Blowing Apparatus (Dr. Partridge's Church, Brooklyn, N. Y.).

Pipe organs are also made of a cabinet size. The *hand* or barrel organ is also a pipe organ in which the keys are moved by pins (staples) on a barrel moved by a crank, the arrangement of the pins being on a similar principle to that of a musical-box.

The *electric* organ is one in which the valves admitting air to the pipes are opened and closed by electro-magnetic action. The general arrangement is as follows: —

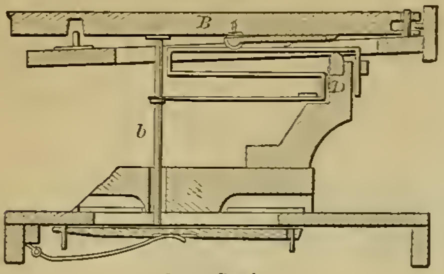
Each key has a separate insulated wire, the circuit through which is closed by depressing the key, causing a communicator to dip into a minute cup of mercury, the current thus established exciting a small electro-magnet that attracts a pallet or keeper, by which the valve is opened and remains so until the finger is withdrawn from the key, causing the pipe to *speak*. The battery employed is composed of glass vessels containing sulphate of mercury arranged on the upper surface of the bellows; when these rise, plates of zinc, each placed between two plates of gas-retort graphite, dip into the solution. No action is therefore exerted except at this time, and thus waste of battery power is avoided.

The arrangement admits of the key-board being placed in any convenient position, and at any distance from the instrument; the touch required for operating the keys is also much lighter than is required for an ordinary instrument.

Or′gan–coup′ler. (*Music.*) A device for connecting two sets of keys in an organ, so that by operating a lever or pedal each key when struck sounds the octave as well as its own note.

In Fig. 3428 the coupler is a bent wire, having a collar at one end which slips over the tracker-pin *b* that connects the key *B* and its valve. By a movement of the lever *D* the coupler may be caused to

Fig. 3428.



Organ-Coupler.

sound a note an octave higher than that of the key *B*, or may be thrown out of adjustment, so that only the note proper to that key will be produced.

Or′gan-die. (*Fabric.*) Fine Swiss figured muslin for ladies' summer wear.

Or′gan-har-mon′i-con. (*Music.*) A large *harmonium* or cabinet organ.

Or′gan-loft. (*Building.*) That part of a church designed for receiving the organ and its appurtenances. Usually an end gallery is chosen for this purpose. In ancient buildings it was customary to place it at one side of the choir, usually the north.

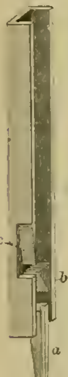
Or′gan-pipe. (*Music.*) A tube in which air is vibrated to produce a musical sound.

The organ-pipe is of two kinds : —

1. The *flute* or *mouth* pipe.
2. The *reed* pipe. See PIPE.

"The vibrating body in the organ-pipe is not the pipe, but the air contained in it. An agitation produced in the air at one end of the pipe is communicated to the other end, and reflected backwards and forwards from end to end, producing isochronous (or equal-timed) impulses, the frequency of which depends entirely on the *length* of the pipe. Hence, all organ-pipes of the same length yield the same note as to *pitch*, its quality only being affected by the form or material of the pipe. It will thus be at once perceived that the lowest C (the waves of which are 64 feet long) requires a pipe of 32 feet to produce it; and that all notes, from this to the shrillest whistle, are easily calculated, by dividing 550 feet by the length of the pipe." — TOMLINSON.

Fig. 3429.



Organ-Pipe.

Fig. 3429 illustrates an organ-pipe of the *mouth* or *flute* kind. On opening the proper valve by depressing its key, the compressed air from the wind-chest passes through the tube *a* into the chamber *b*, and is directed with some force through a narrow slit against the sharp edge *c*, formed by beveling one of the sides of the pipe.

In the *reed*-pipe the vibration of the air is caused by a metallic tongue affixed or inserted in the *reed*, a tube having a slit throughout its length, and fixed within the pipe.

Or′gan-zine. *a.* A silk thread made of several *singles*, *thrown* together. *Thrown-silk.*

b. Silk fabric made of such thread.

A *single* is a reel thread twisted. Several singles are twisted together in a direction the reverse of that of the singles, making *thrown-silk*. The *single* receives a twist to the left, is *doubled*, — that is, united with others, — and the combined threads are twisted to the right. *Organzine* is therefore *double-twisted thrown-singles.*

Orgues. 1. (*Fortification.*) Timbers shod with iron so suspended as to be dropped upon an enemy passing through a breach or gateway.

2. An arrangement of a number of parallel musket-barrels, so placed as to be fired simultaneously by a train of powder. Such was the weapon of Fieschi who fired at Louis Philippe, and it may be held to be the predecessor of the MITRAILLEUR (which see).

O′ri-el. 1. The bow-window of English domestic architecture. Sometimes it is of two stories. Sometimes it does not reach the ground, but is supported by corbels.

2. A recess within a building, as a window-way, closet, or chamber.

O′ri-en-ta′tion. The placing with an eastern aspect or presentation. From Lat. *oriens; Sc. sol*, rising.

(*Surveying.*) The determination of the east point in taking bearings.

(*Architecture.*) The placing of a church so that its chancel is toward the east.

O′ri-ent-a′tor. (*Surveying.*) An instrument used in regulating the ground plan of a church, so as to present the chancel to the east.

O-ril′lon. 1. (*Fortification.*) A curved projection formed by the face of a bastion overlapping the end of the flank, intended to protect the latter from oblique fire.

2. An earthen mound faced with brick.

Or′leans Cloth. (*Fabric.*) A ladies' dress-goods, having a cotton chain and woolen filling. It has a self color and highly finished surface.

Or′lo. (*Music.*) A Spanish wind-instrument.

Or′lop. (*Shipwrighting.*) *Orlop-deck, orlop-beams*, are, respectively, the lowest deck of a ship, or beams occupying the corresponding position. The deck is below the water-line, and may be occupied by the magazine, cock-pit, and for stores.

Or′mo-lu′. (*Alloy.*) *a.* A brass used for cheap jewelry. Copper, 48 ; zinc, 52.

b. Bronze or copper gilt also goes by this name. See ALLOY.

Or′mo-lu′-var′nish. An imitation gold varnish.

O′ro-ide. (*Alloy.*) An alloy resembling gold in appearance. One formula for its production is, —

Copper	100
Zinc or tin	17
Magnesia	6
Sal-ammonia	3.6
Quicklime	.12
Tartar of commerce	9

The other ingredients are added in small quantities to the fused copper and stirred in ; the zinc last. Fusion is then maintained for about 35 minutes, when the dross is skimmed off, leaving the alloy fit for use. It is largely employed in the manufacture of cheap watch-cases.

Another formula is, –

Copper	79.9
Zinc	13.05
Nickel	6.09
Iron	.28
Tin	.09

The latter two are, perhaps, merely accidental ingredients. See ALLOY.

Or′phe-on. (*Music.*) A musical instrument of the melodeon order.

Or′re-ry. A planetary machine to illustrate and explain the motions of the heavenly bodies. Its invention appears to have been coëval with the construction of the clepsydra and other horological automata. It was so called from the Earl of Orrery, who bore the expense of one constructed in 1715 by Rowley, after a pattern devised by the clockmaker George Graham. See PLANETARIUM ; TELLURIAN.

The heliocentric theory was held by the ancient Egyptians, and taught by them to Pythagoras. The theory did not flourish in Greece. Plato mentions it. A few scholars, like Nicolas (probably of Laodicea, fourth century A. D.), entertained it during the vast intervening period, and it was eventually revived by Copernicus.

When the Spaniards conquered Peru, they found the natives in possession of the true theory, considering the sun the center of our system.

The Chinese annals state that Tsi-ang-nung, in the reign of Shu-en-ti (126 – 145 A. D.), made an orrery to represent the apparent motion of the heavenly bodies round the earth, the instrument being kept in motion by the dropping of water from a clepsydra. There is a reference also to a similar instrument in the third century.

A planetarium is described in a letter from Angelo Politiano to his friend Francesco Casa, as seen by the former at Florence in the fifteenth century. The inventor was one Lorenzo of Florence, and the apparatus was constructed to illustrate the Ptolemaic theory of the heavens. The various parts were moved by trains of cog-wheels. Life of A. Politiano, published by Cadell and Davis, London, about 1800.

A planetary clock was made by Finee, 1553, and a planetarium by De Rheita in 1650.

Or'se-dew. Leaf metal of bronze. Dutch metal.

Or'tho-graph. A drawing representing a structure in *elevation*, external or internal. The internal *orthograph* is usually termed a vertical section or *sciagraph.*

The ground plan is the *ichnograph.*

The view of the whole building, the *scenograph.*

Or-tho-scop'ic Lens. (*Optics.*) An arrangement of two achromatic compound lenses, separated by an interval.

Or-tho-pæ'dic Ap-pa-ra'tus. (*Surgical.*) A device to correct the deformities of children, such as curved spine, club-foot, etc. See CLUB-FOOT APPARATUS.

Os'cil-lat-ing-cyl'in-der Steam-en'gine. (*Steam.*) A simple form of engine, in which the cylinder rocks on trunnions and the piston-rod connects directly to the crank. It was invented by James Watt, and was brought into use by Maudslay. Watt's model, made at Soho in 1763, was exhibited at the London Exhibition of 1851.

Witty of Hull patented the oscillating cylinder in England in 1813. English patent, June 5.

Goldsworth Gurney was in some way associated with the improvement of it, and has been credited with the invention.

It was introduced by those two famous makers of marine and river engines, Maudslay and Field and Penn and Sons.

This engine has a cylinder mounted on gudgeons or trunnions, generally near the middle of its length, on which it is capable of swaying to and fro through a small arc, so as to enable the piston-rod to follow the movements of the crank, to which it is directly attached without the intervention of a connecting-rod. This construction is economical of space and weight.

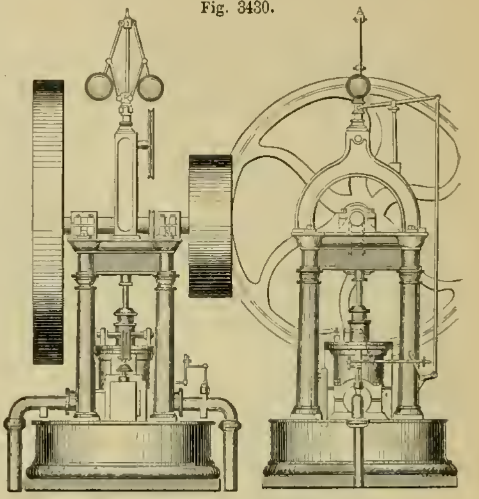
The trunnions are hollow, and are connected by steam-tight joints, one with a steam-pipe leading from the boiler, the other with an exhaust-pipe leading to the condenser.

The *valve-chest* oscillates with the cylinder.

Various arrangements are used to adapt the valve gearing to the oscillating motion of the cylinder and valve-chest. One of the simplest is to communicate motion from the eccentric to a sliding rod, on which is a *cross-head* of the form of an arc of a circle described about the axis of the trunnions, when the valve is in its middle position and having in it a slot of the same figure; in that slot is a slider attached to the end of a lever arm projecting from a rocking-shaft attached to the cylinder; another arm projecting from that shaft moves the slide-valve rod.

Another form of valve common in engines of this class is the trunnion-valve either of a disk form or having the shape of a frustum of a cone, in either case one portion of the valve having a rotary reciprocation derived from the oscillations of the cylinder.

Fig. 3430.



Oscillating-Cylinder Steam-Engine.

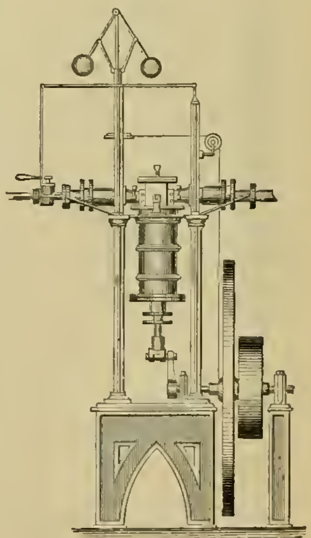
Fig. 3430 is an engine of this character for land use. The power may be communicated by a leather band over a pulley fixed on the axle of the fly-wheel, or by means of a spur-wheel and pinion. The steam is admitted through the hollow axle on one side, and withdrawn through a similar hollow axle at the opposite side of the cylinder.

The figure gives side and front elevations, respectively. The top works are supported by a four-column frame.

Fig. 3431 is another form of oscillating-cylinder steam-engine, known as Joyce's pendulous high-pressure engine. The cylinder is inverted and oscillates on its trunnions after the manner of a pendulum. The piston-rod is connected directly to the crank. See also OSCILLATING-PISTON STEAM-ENGINE.

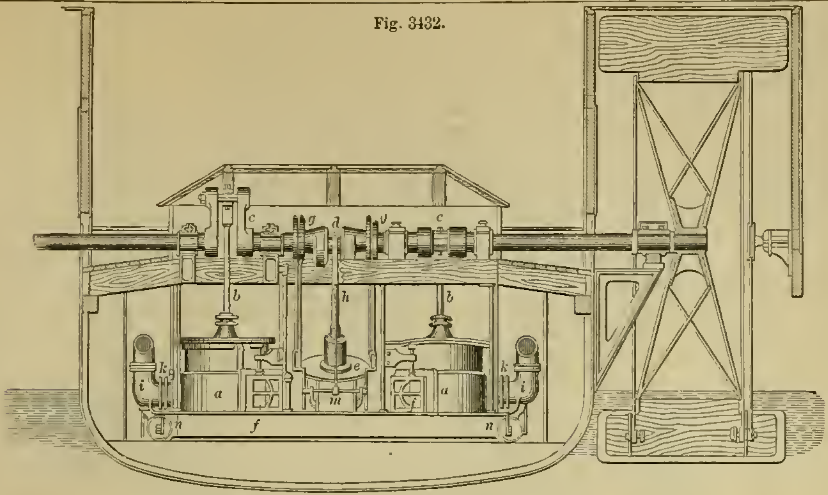
Fig. 3432 is a transverse view of a low-draft river steamboat with a pair of oscillating engines and feath-

Fig. 3431.



Oscillating-Cylinder Steam-Engine.

Fig. 3432.



Oscillating Engine on Low-Draft River Steamer (Thames).

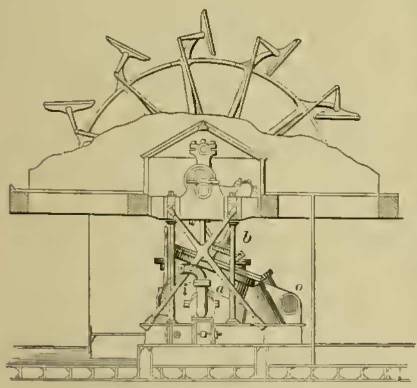
ering paddle-wheels. Fig. 3433 is a side view, showing one cylinder inclined, and the upper portion of the wheel with its floats in their changeable positions. The engines are coupled by an intermediate shaft having a crank which operates one or more air-pumps.

a a are the steam-cylinders; *b b*, the piston-rods, connected immediately with the cranks *c c*; *d*, a crank in the intermediate shaft, working the piston-bucket of the air-pump *e*; *f f* are slide-valves regulating the admission of steam to the cylinders; *g g*, double eccentrics on the intermediate shaft, operating the valves *f f*, enabling a link motion to be employed.

h is a handle by which the engines may be stopped, started, or reversed.

i i are steam-pipes leading to the trunnions *k k*, on which and on other trunnions connected with the pipe *m* the cylinders oscillate; *n n* are pumps, the pistons of which are attached to the trunnions and worked by the oscillations of the cylinders; *o*, the waste-water pipe from the condenser.

Fig. 3433.



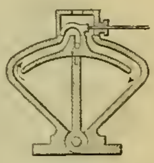
River Steamer Engine (Side View).

Os'cil-lat-ing-pis'ton Steam-en'gine. A form of steam-engine in which the piston oscillates in a sector-shaped chamber. By means of a slide or other valve the steam is admitted to alternate sides of the piston, which imparts a rotary reciprocation to the rock-shaft.

The engine (Fig. 3435) has a piston planted on an axis and has an oscillation in a vertical plane.

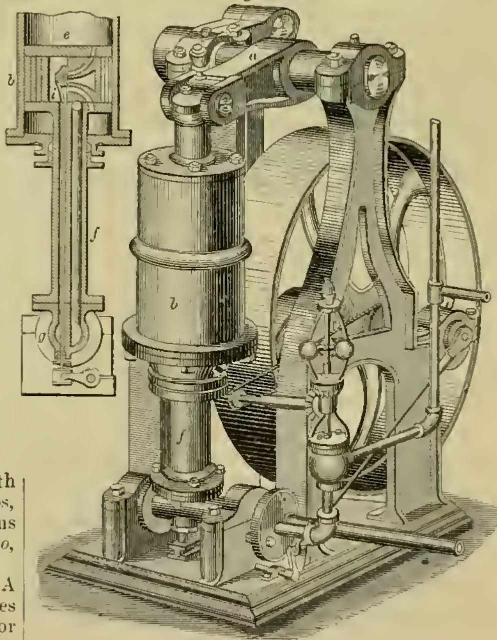
The cylinder *b* is attached to the walking-beam *a*, which oscillates on a rock-shaft, and whose other arm is connected by a pitman with the fly-wheel crank. The piston is at the upper end of a hollow rod *f*, which also oscillates on a hollow rock-shaft *g* divided into two compartments. The piston is hollow, forming a steam-chamber, within which is a slide-valve *i*; it has also

Fig. 3434.



Oscillating-Piston Engine.

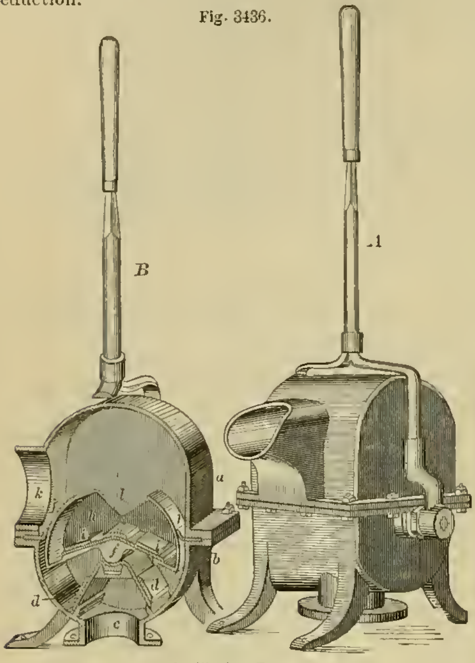
Fig. 3435.



Oscillating-Piston Engine

suitable inlet passages and an exhaust passage. Steam is admitted through one of the induction-passages of the rock-shaft *g* and piston-rod *f*, alternately above and below the piston by means of the slide-valve *i*, operated by a rod extending through the induction-passage of the piston-rod and reciprocated by a small rock-shaft connected with the crank-shaft; this causes the reciprocation of the cylinder, while the piston oscillates upon the rock-shaft *g*. The other passages of the piston-rod and rock-shaft serve for eduction.

Fig. 3436.



Oscillating Pump.

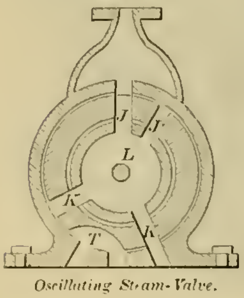
Os'cil-lat-ing Pump. The pump, Fig. 3436, is made in two sections *a b*, flanged and bolted together. The induction-chamber *c* has upwardly opening valves, through which water is drawn by oscillating the handles *A B*, causing corresponding oscillation of the shell *j j*, which turns upon *f* as a center, and is divided by radial plates provided with upwardly opening valves *d i* into chambers into which the water is successively admitted at each oscillation and discharged through the eduction-opening *k*.

Os'cil-lat-ing Pump-spear. (*Nautical.*) A revolving arrangement like a winch, for working a pump-rod.

Os'cil-lat-ing Valve. 1. (*Steam.*) A valve which reciprocates on a pivot, as the disk and trunnion valves of oscillating-cylinder steam-engines.

In Fig. 3437 steam is admitted to the center *L* of the hollow valve, through passages *J J*, communicating with the steam-chest; *K K* are induction-openings to the steam-cylinder; *T*, eduction-port.

Fig. 3437.

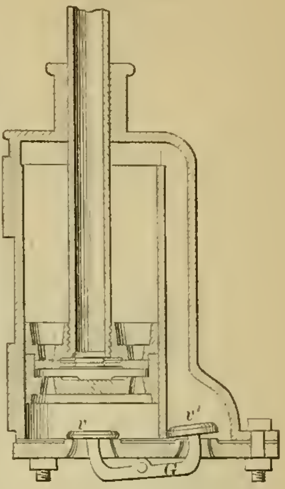


Oscillating Steam-Valve.

Oscillating steam-engines frequently have oscillating valves working in their trunnions. Others are oscillated by bar or crank connection to a fixed object while the cylinder vibrates.

2. A pump-valve which reciprocates on a pivot. In the example, the valves *v* and *v'* are attached to a lever *G*, and batter upon their seats alternately.

Fig. 3438



Oscillating Pump-Valve.

O'si-er-peel'er. (*Agriculture.*) The process of peeling osiers by a cleft stick is shown at Kourna, Thebes. The uses of the osier among the ancient Egyptians were constant and various. Baskets were even more common then than now, as the products of the field, the net, and the hook were generally carried by men. The wheeled vehicles in Egypt were few and not capacious.

Machines for peeling osiers proceed in various ways. In Colby's, the osier wands are carried between vulcanized rubber rollers which press, rub, and wring the bark from the wood. A serrated metallic roller acts in connection with an elastic or yielding roller, both having an end chase or lateral reciprocation to rub off the bark of the wand. A rack or comb catches and removes the bark.

Easterbrook's has a pair of rollers, respectively convex and concave, which give a slipping pressure upon three sides of the wand and loosen the bark; a pair of wire brushes next come into play, and then rollers discharge it from the machine.

Other forms have rollers having various angular presentations to a disk against which they press the wand. Another has jaws to drag the willow past V-edges. Another rubs the willow between a wheel and a traveling belt.

Os'le-on-i'ron. (*Metallurgy.*) Bars specially made for the manufacture of wire.

Os'mi-um. Equivalent, 99.6; Symbol, *Os.*; specific gravity, 21.4; nearly infusible. A rare metal, sometimes found in a native alloy with iridium, and forming the hardest alloy known.

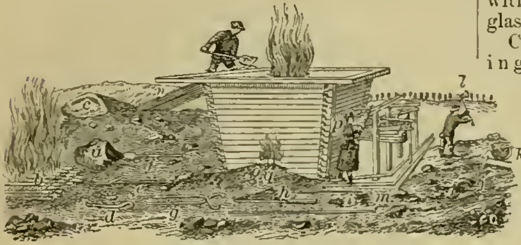
Os-mom'e-ter. An apparatus for exhibiting the force of osmotic action, by which liquids are impelled through a moist membrane, illustrating the phenomena of *endosmose* and *exosmose*. The device consists of a porous vessel or sac containing a saline solution and plunged in pure water.

The more rapid flow through the porous septum or wall is from the thinner fluid to the saline solution, and is termed *endosmose*. A slower current sets in the other direction, and is called *exosmose*. The result is a blending and ultimate uniformity of quality.

Os'mund Fur'nace. (*Metallurgy.*) A furnace formerly employed in Sweden and still employed to some extent in Finland for reducing bog-iron ore. This ore, consisting essentially of hydrated sesquioxide of iron, is extracted from the bottoms of lakes and rivers. It occurs in grains, cakes, or amorphous masses, generally of a somewhat loose and friable texture, different varieties yielding from 25 to 50 per cent of pure iron.

The illustration is taken from a cut in Swedenborg's work on iron. *a* is a heap of the ore not calcined; *b*, a heap undergoing calcination on wood; *c*, calcined ore; *d*, borer employed in searching for ores; *e*, charcoal rake; *f*, iron shovel; *g*, tongs for withdrawing the bloom from the furnace; *h*, cinder hook, also used in taking out the bloom; *i*, bar for cleaning the cinder hole and tuyere hole; *j*, sledge used for hammering the bloom when taken out; *k*, lump of iron, *blästra*, or *osmund*, partly divided; *l*, hatchet; *m*, treadles for working the bellows; *n*, inclined plane for conveying ores to the top of the furnace; *o*, tap hole for cinders; *p*, tuyere; *q*, wood shovel for charging the furnace with ore. The female in the figure is engaged in spinning with the distaff and operating the treadles of the bellows at the same time. The furnace has a rectangular cavity at the bottom, into which the reduced iron was received, and which is provided with an opening near *q*, through which the bloom is extracted. During the operation of smelting this is built up temporarily with stones. The inner lining is of refractory stone, and between this and the outer wooden casing is a filling of earth. The iron produced may be forged, but is usually of a mixed character, requiring to be remelted to render it malleable.

Fig. 3439.



Osmund-Furnace.

A furnace of this kind yielded about 1½ tons of iron weekly, of which from 33 to 50 per cent was lost in working it up into an *osmund* or bloom. In Finland, as has been observed, this primitive contrivance still maintains its ground beside the high-blast furnace, seeming to be well adapted for producing a good quality of iron from the peculiar ore employed. It formerly afforded lucrative employment to the Swedish peasant during the winter season. When the farm labors of the year were over, he went into the woods for some weeks with his wife and family, with whose aid he extracted the iron, which was sold for a small amount of ready money at some market town.

Os'na-burg. (*Fabric.*) A kind of coarse linen, made of flax and tow, originally imported from Osnaburg, Germany.

Os-te'o-tome. (*Surgical.*) An instrument to cut a bone; specifically, one to cut the bones of the fetal cranium when it is necessary to much reduce it to facilitate delivery.

Ot-a-cous'tic. (*Surgical.*) An instrument to improve the sense of hearing.

O'tho-scope. (*Surgical.*) An instrument invented in 1851 by Czermak, for holding water round the eye to enable the interior to be seen. It has the effect of preventing the cornea acting as a convex refracting surface. It is a little reservoir of glass, having three sides, and when placed against the cheek and nose and filled from above with water, the eye can be kept open in it under the water. It is superseded by Helmholz's OPHTHALMOSCOPE (which see).

O'to-phone. An ear-trumpet.

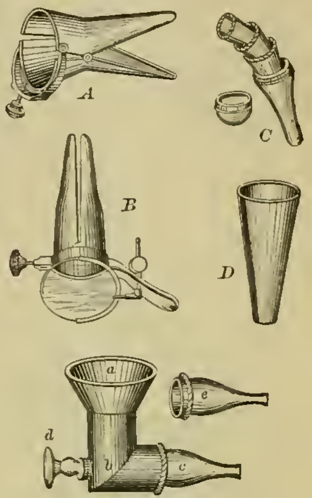
O'to-scope. (*Surgical.*) *a.* An instrument for viewing the interior of the ear. *Otoscopium.*

To this class belong the different patterns of ear-speculums (*C D*), funnel-shaped, of high polish inside, through which light is reflected by means of a concave mirror; and the bivalve speculum *A*, which admits of expansion of the meatus auditorius, etc.

Simrock's otoscope (*B*) is a funnel-shaped bivalvular instrument with magnifying-glass.

Clark's reflecting otoscope (lower figure) consists of an angular tube, one extremity of which is expanded to receive the rays of light from the window, a gas-jet, or lamp, while the other is prepared for the adaptation of specula of various sizes.

Fig. 3440.



Otoscopes.

The light enters at the flaring extremity, and is reflected from the surface of a polished steel mirror, which is placed transversely across the angle *b*, and is thrown upon the tympanum through the speculum *c*. A small tube proceeds from the eye-piece *d*, and, transfixing the mirror, extends just into the speculum *c*. At the extremity of this tube, a carefully ground lens is introduced, which greatly magnifies the objects which are seen through the speculum. The smaller speculum *e* can be adjusted in place of the one upon the instrument when required.

b. An instrument enabling the examiner to detect the sound of air passing through the tympanitic cavity in certain morbid conditions. An *ear-explorer.*

The *otoscope* of Toynbee is an elastic tube with ivory extremities, one to fit the operator's, the other the patient's, ear. Air being blown into the eustachean canal, you determine with it whether the tympanum be sound or perforated.

Ouch. Formerly *ouche*: see King James's translation of the Bible, Exodus xxviii. 11: —

> "Engrave the two stones [onyx] with the names of the children of Israel; thou shalt make them to be set in *ouches* of gold."

Also in Exodus xxxix. 18: —

> "And the two ends of the two wreathen chains they fastened in the two *ouches* and put them on the shoulders of the ephod, upon the forefront of it." — BISHOP'S "Bible," 1568.

The collet of a jewel.

The part of a setting which grasps the stone. The *bezel.*

An ornamental collar of gold.

From the word *ouche* comes *brooch*, the modern name of the ornamental dress-clasp. This was formerly a clasp or button, and by the addition of a *broach* — a pin — (Fr. *broche*), received its present form.

Out′burst-bank. (*Hydraulic Engineering.*) The middle portion, as to elevation, of a sea embankment. The lower portion is the footing, and has a base of 5 to a hight of 1. The *outburst* has a base of 2 to 1 of hight, and is crowned with the *swash-bank*, which has the same proportions and a level on top of 4 to 5 feet under ordinary circumstances, where it is not to be used as a road.

Out′crop. (*Mining Engineering.*) The emergence of a stratum or seam at the surface. *Basset.*

Out′er Form. (*Printing.*) The form commencing with the first page of the sheet. It is usually worked off last.

Out′fall. (*Hydraulic Engineering.*) The point of discharge for, or the embouchure of a drain, culvert, or sewer.

Out′haul. (*Nautical.*) A rope used to extend the clew of a boom-sail.

Out′keep-er. (*Surveying.*) A small dial-plate having an index turned by a milled head underneath, used with the surveyor's compass to keep tally in chaining.

The dial is figured from 0 to 16, the index being moved one notch for every chain run.

Out′rig-ger. 1. (*Nautical.*) *a.* A spar for extending a sail or rope beyond the points of attachment furnished by the hull.

b. A boom rigged out from a vessel to secure boats to when the vessel is at anchor.

c. A floating timber attached by spars to the hull and floating parallel therewith. Used with crank or narrow boats to support them upright in the water under a press of canvas which would otherwise upset them. Principally used with the *proas* of the Malays and Ladrones. The lesser or leeward boat of the double canoe of the Pacific-Islanders is called a *hamma.*

d. A spar projecting over the stern of a boat for assistance in hauling out the *clew.*

e. A light boat for matches.

2. (*Gearing.*) A wheel or pulley outside the frame to receive a belt or other driving connection.

3. Of a crane; the *jib.*

4. The cat-head.

5. (*Building.*) A beam projecting outwardly from a wall to support a hoisting tackle.

Out′side Car. (*Vehicle.*) An Irish jaunting-car in which the passengers in two rows sit back to back, with their feet on boards outside of the wheels. The *inside* variety is shown under CAR.

Out-sid′er. (*Locksmithing.*) A pair of nippers with semi-tubular jaws, adapted to enter a keyhole and grasp the pin of a key, so as to turn it and unlock the door from the outside.

Out′side Bel′ly-band. (*Harness.*) An extra belly-band used on single harness, to prevent the thills rising too high.

Out′works. (*Fortification.*) Works included in the defense of a place, but outside the *parapet. Detached* works are beyond the *glacis.*

Ou-vreaux′. (*Glass.*) The *peep-holes* of a plate-glass furnace.

O′val Chuck. A chuck invented by Sharp, for oval or elliptic turning. See CHUCK.

O′val Com′pass. A compass for describing ovals. See ELLIPSOGRAPH.

O′val File. A file whose cross-section is elliptical or oval. Used sometimes as a *gulleting* file. Called by the French *limes à double dos.*

Ov′en. A chamber in which objects are baked by artificial heat.

The division may be made into these kinds: —

1. *Domestic.*
2. *Baker's.*
3. *Metallurgic.*
4. *Glass-annealing.*
5. *For clay and ceramic ware.*

The oven of the Society-Islanders is a pit in the ground paved with large stones, over which a fire is lighted. When the stones are hot enough, the embers are removed, the stones covered with green cocoa-nut leaves, the dressed pig wrapped in plantain-leaves, placed in the hole, and covered with hot embers, on which are placed bread-fruit and yams wrapped in plantain-leaves. Captain Cook said it was the best mode of cooking he ever saw. It is a pity that he was afterward subjected to it. He was sent by the English government to the South Seas to observe a transit of Venus, and was killed and eaten by the natives of Owhyhee, February 14, 1779.

The early Egyptian oven was a crock sunk in the ground and heated by a fire built inside. To the sides of the crock wet lumps of dough were attached and baked by the heat. It explains how the frogs with which Egypt was plagued came into the *ovens.* The cannibals of the Feejee Islands make a hole in the ground, and place therein the meat (*bakolo*, long pig, as they called a human carcass) and heated stones, covering all with leaves. The Rocky Mountain Indians collect the grasshoppers in pits, and there cook them with heated stones. These are primitive ovens, and with certain variations may be found among most barbarous nations and among some who have retained primitive customs.

1. The domestic ovens are of three kinds: —

a. Stove ovens.

b. Dutch ovens, so called.

c. Out-ovens, heated by fuel. These resemble the baker's ovens.

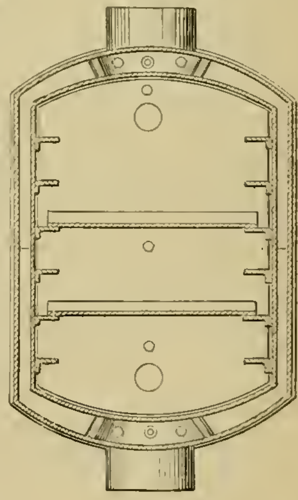
a. Stove ovens are usually a part of the stove, and vary in their position with the shape and capacity of the stove. Several forms are shown under COOKING-STOVE, p. 615.

The oven of the range is alongside the fire-chamber, as in Fig. 1435, p. 614. See also RANGE.

The *elevated oven* is a chamber surrounded by a spreading or enlargement of the flue, as in Fig. 3441. See also Fig. 1439, p. 615.

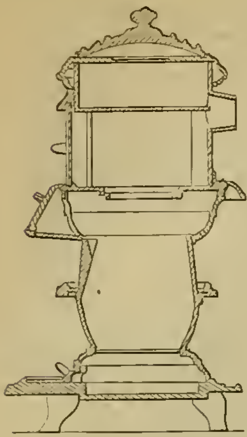
Another form is an oven combined with a heating stove, some varieties of which are known as "parlor cooks." Fig. 3442 is an instance, in which the cast-iron fire-chamber is surmounted by a cap, and the latter by a cylindrical casing containing an oven encompassed by the caloric current. It combines in small compass heating and cooking arrangements.

Fig. 3441.



Elevated Oven.

Fig. 3442.



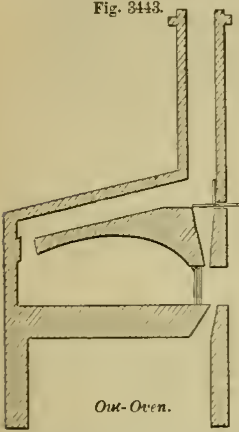
Heating Stove with Oven.

b. The *Dutch oven*, so called, is of two kinds. One is a *skillet* or *baking-pot*, used in cooking by wood coals on the hearth, the iron pot being set upon a bed of hot coals and others piled on to its lid.

The other form is a sheet-metal affair placed in front of a fire in a grate, so as to cook by radiation from the open fire, the closed back of the chamber keeping in the heat. See Fig. 1809, p. 765.

c. The *out-oven*, as it is called, was commoner aforetime than now. It is so called because built out of doors; not a *house-oven*. It has a domed chamber, is built of brick, and is heated by means of light wood or sticks burned inside. The bricks having been well heated by the fire inside, the ashes and embers are raked out, the floor swept, and the batch of dough loaves introduced by a *peel*, which is a flat wooden shovel with a long handle. The door is then closed. The result is very satisfactory when good material meets with good management. The illustration shows a form with a front, back flues, damper, a rake-hole for the embers, and an ash-pit beneath.

Fig. 3443.



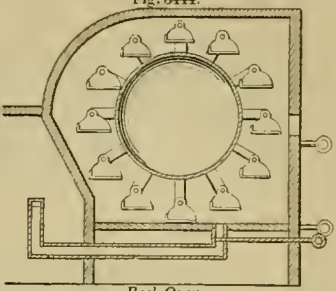
Out-Oven.

Loaves found in a Pompeian bakery indicate that the name of the meal, wheat, rye, beans, etc., was stamped on bread. Among the recent discoveries in a baker's oven, so hermetically sealed, says Marc Monnier, that not a particle of volcanic ashes had entered, there were eighty-one loaves, whole, hard, and black, found just as they had been placed on the 23d of November, A. D. 79. Enchanted with the discovery, Fiorelli himself climbed into the oven and took out the precious relics with his own hands. Most of them weigh about a pound, are round, depressed in the center, and divided into eight lobes. Loaves precisely like them are still made in Sicily.

2. The *baker's oven*. *a.* Until lately, and even now in many places, this was but an extension of the one last described; the additional capacity enabling it to act upon a larger quantity, and the larger size requiring greater skill in the building and the mode of conducting and using the heat economically. Some ovens of this kind are heated by steam.

b. The *reel-oven*. This has a series of pans or trays suspended from the periphery of a skeleton cylinder, or, as it were, from the spokes of two wheels keyed on to the same shaft. The pans are preserved in a horizontal position by means of suspending each from a point above its center of gravity (Ball, September 23, 1856; McKenzie, May 1, 1860; Coburn, January 30, 1872); by a suspended weight beneath the pan (Ball, July 19, 1870); by radius rods like those of a feathering paddle-wheel (McKenzie, June 6, 1871).

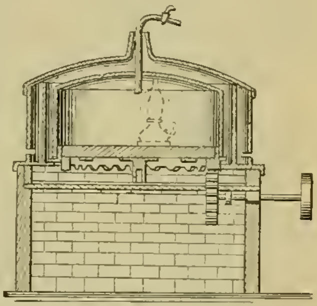
Fig. 3444.



Reel-Oven.

The reel-oven is shown in Fig. 3444. The rate of revolution is such that a loaf is baked during one revolution. As a pan comes opposite the mouth of the oven, the baked loaf is taken off and a loaf of dough placed upon it. The pans are hung to radial arms projecting from a rotating drum which reflects heat upon the top of the matters contained in the pans. Flues within the oven have dampers by which the escape of heat to the chimney may be permitted. The work is thus continuous, the door being closed in the intervals of taking off the bread and putting on the dough as the pans arrive in succession opposite to the doorway. The reel is turned by a wheel on the axis which extends outside the wall of the oven.

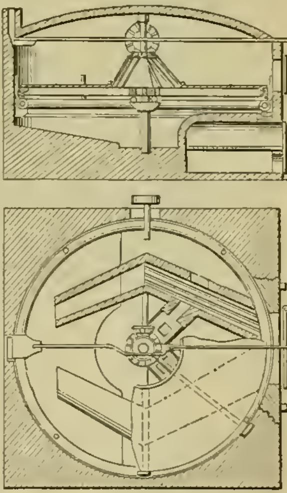
Fig. 3445.



Rotary-Hearth Bake-Oven.

c. The *traveling-apron* oven is another form of continuously working oven. In Crumbie's oven, April 9, 1872, shelves are suspended from a series of traveling axles, which are connected by an endless chain of bars and caused to travel in an elliptical path, presenting the shelves consecutively at the oven door, as described just above. An endless-apron oven was patented by Deneale in 1806.

Fig. 3446.



Rotary Oven.

d. An *endless chain* with suspended trays, traveling in a tall vertical flue, is shown in Jennison's patent, February 1, 1859.

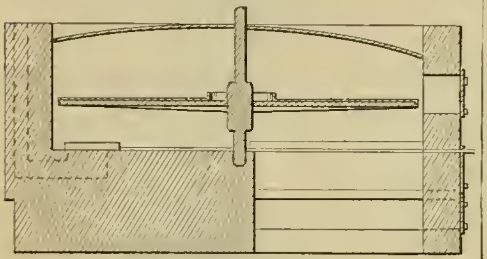
c. The *rotary hearth* is a circular floor having a cogged rim or a stem with a gear-wheel upon it.

Fig. 3445 is an illustration of the former, and Fig. 3446 of the latter. In each case, the floor for the bread is in a dome-roofed chamber, heated from the furnace beneath. The oven usually forms a part of the flue, the heated gases from the fire passing into and through the oven. The lower part of Fig. 3446 shows the duplicate arrangement of fireplace and the distribution of the heat.

3. *Metallurgic ovens.* These are of two kinds.

a. Roasting ovens, which may be properly termed *furnaces*, as in the example, where pyrites or arsenical ores are exposed to a calcining heat by which they are rendered friable, the metallic portion being oxidized and converted in a calx. See also ORE-CALCINING FURNACE; ROASTING-FURNACE.

Fig. 3447.



Metallurgic Roasting-Oven.

b. The *annealing oven*, in which iron articles are brought to a heat below fusion-point and then allowed to cool gradually, so as to decarbonize them and remove the brittleness of their ordinary "cast-iron" condition. See MALLEABLE-IRON FURNACE; ANNEALING-FURNACE, Fig. 251, p. 114. See also ANNEALING, pp. 110–114.

Other heating-chambers may be termed *ovens*; such as the *assay-furnace*, Fig. 395; the *muffle-furnace*; the *vulcanizing-furnace*, etc.

4. The *glass-annealing oven* is a chamber in which blown, pressed, or rolled glass is placed to allow it to cool slowly, in order that the particles may arrange themselves in a static condition, not liable to fracture and fly to pieces upon slight provocation. See ANNEALING, p. 110; LEER.

5. *Porcelain oven.* The firing-kiln of the porcelain manufacture. The ovens are conoidal structures of brick, 22 feet in diameter and 18 to 21 feet high, and are clustered around a brick building of similar structure, but larger, called a *hovel.*

The *ovens* are heated by fireplaces or *mouths*, about 9 in number, built around them. Flues in connection with these converge under the bottom of the oven to a central opening, drawing the flames to this point, where they enter the oven; other flues, termed *bags*, pass up the internal sides to the hight of about 4 feet, conveying the flames to the upper part. See PORCELAIN; POTTERY.

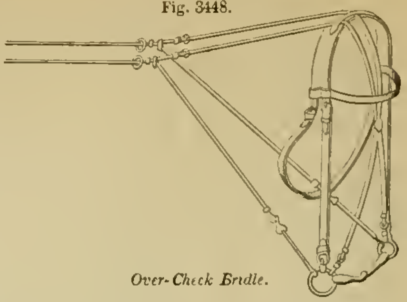
O-ver-cast′ing. 1. (*Bookbinding.*) The doubling of an edge of a single leaf or plate to be sewed in, so as to give a hold to the thread.

2. (*Sewing.*) Laying two edges of cloth together and whipping them by a thread which goes over and over. Used to prevent raveling of the edges of two fabrics sewed together.

O′ver-check. See OVER-CHECK BRIDLE.

O′ver-check Bri′dle. (*Harness.*) A driving-bridle having a rein passing over the head of the horse, so as to draw the bit upward into the angle of the horse's mouth. In the example, branch reins are attached to each end of the driving-reins, one branch answering for a gag-rein, passing over the horse's head to the ring of the snaffle-bit; the other branch connects to the same ring of the bit. The devices correspond on each side.

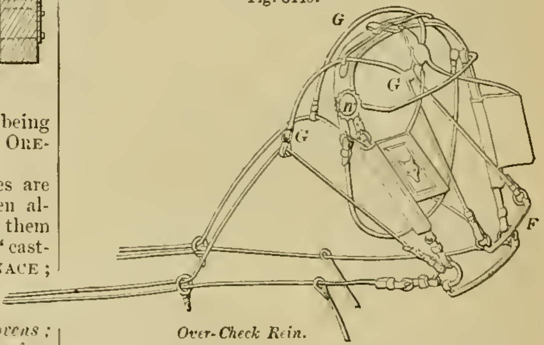
Fig. 3448.



Over-Check Bridle.

O′ver-check Rein. (*Harness.*) A rein passing over the head of the horse to the bit, so as to pull upward upon the bit when drawn upon. The example shows one which has an additional or safety rein which leads through the runners to the rings of the usual bit, and also draws upon the *over-check* rein *G*; this is connected to a separate bit *F*, which is thereby pulled upward against the palate.

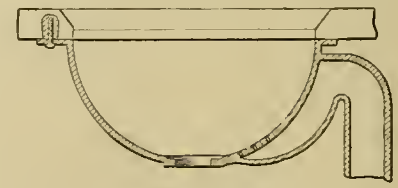
Fig. 3449.



Over-Check Rein.

O′ver-flow-ba′sin. One having a pipe to convey away excess of water and prevent it running over the brim. In the example, the overflow holes are near the bottom, but communicate with an upwardly bent pipe to allow the basin to hold water up to a given level.

Fig. 3450.

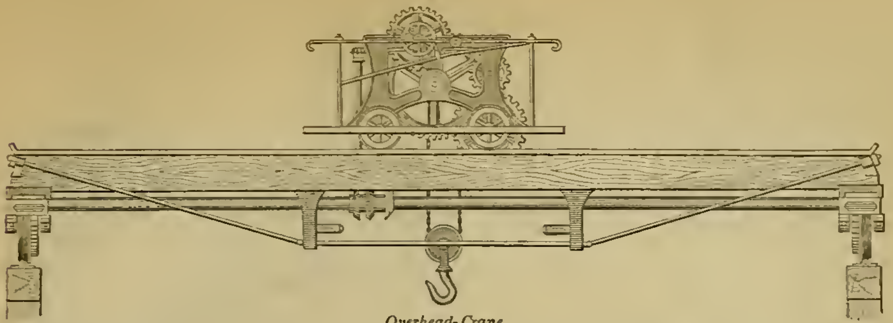


Overflow-Basin.

O-ver-haul′. (*Nautical.*) To extend the blocks of a tackle from each other and slacken the fall, that it may render through the blocks. To *fleet.*

O-ver-head′-crane. One which travels on elevated beams in a foundry, machine-shop, or on high scaffolding above a structure. The crab travels on wheels, and the object is suspended from chain-tackle beneath. See also STEAM-CRANE.

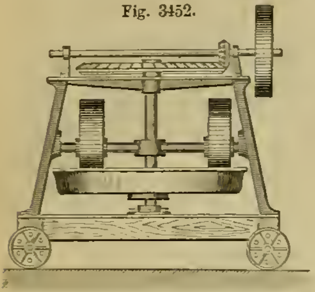
Fig. 3451.



Overhead-Crane.

O-ver-head'-gear. Driving-gear above the object driven, as in the mortar-mill, Fig. 3452, in which the bevel gearing driving the rolls of the Chilian mill are placed overhead, in contradistinction to such as receive the impulse from below, as in Figs. 146 and 147.

Fig. 3452.



Overhead Driving-Gear.

O-ver-head'-mo'-tion. (*Turning.*) A frame attached to the bench of a lathe, and rising to a hight about a foot above the head of the workman. It supports a spindle on which is a pulley driven by a band from the fly-wheel; another pulley on the same spindle carrying a band which passes down to the pulley on the spindle of the eccentric cutter. The latter spindle, to whose end the work is chucked, is stationary, while the cutter is revolved.

O-ver-head'-rein. One which passes over the horse's head, between the ears, and down the front of the face to the bit, so as to pull the latter up into the angle of the mouth, instead of pulling squarely against the jaw. See Over-check Rein.

O-ver-head' Steam-en'gine. An engine in which the cylinder is above the crank, the thrust motion being downward. Not an uncommon form with trunk and oscillating engines.

O-ver-heat'ing-pipe. (*Steam-engine.*) A pipe through which steam is caused to pass in order to be superheated.

O-ver-lap'-joint. One in which the parts lap upon each other, in contradistinction to a butting-joint, in which the edges merely are in contact. See Angle-joint, for a number of illustrations in which overlapping portions are joined by solder or by bending over upon each other.

O'ver-lay. (*Printing.*) A piece of paper pasted upon the tympan-sheet at a spot where the impression is desired to be dark and effective. This is used to bring out the darker parts of the engraving, while the lighter portions are partially relieved of pressure by *cutting out* the tympan-sheet over such places.

It is also used to obtain a proper impression of the low part of a form.

O-ver-reach'ing de-vice'. (*Menage.*) An attachment to the leg or foot of a horse to prevent the catching of the toe of the hind foot upon the heel of the fore foot in rapid traveling. See Leg and Foot Guards for Horses.

O-ver-sail'ing. (*Architecture.*) Projecting beyond the general face.

O-ver-seam'ing. (*Sewing.*) Another name for overcasting, in which the edges of two pieces of cloth are laid together and whipped over and over, to prevent raveling.

O'ver-shave. (*Coopering.*) A jointer having a concave-edged bit, on which the backs of staves are dressed.

O'ver-shoe. 1. An india-rubber shoe to protect the usual foot-covering while walking in muddy streets. A *goloshe.*

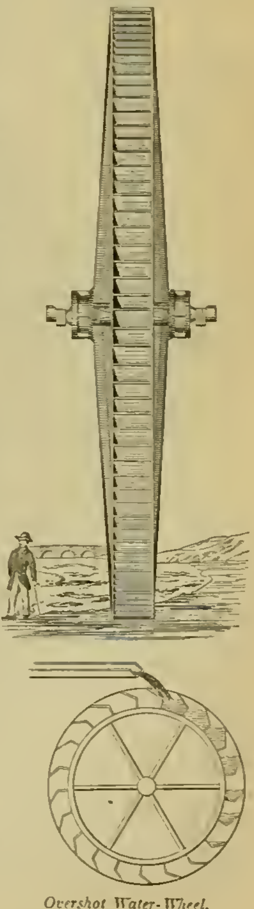
2. A shoe of buffalo hide, hair inward, used in sleighing or winter traveling.

O'ver-shot-wheel. A form of water-wheel in which the water flows upon or near the top of the wheel, as in Fig. 3453. It acts principally by gravity, though some effect is of course due to the velocity with which the water arrives. Some overshot-wheels have a circular rack or cogged rim near the periphery, so as to bring the body of water in close proximity to a pinion which communicates the motion to the machinery. In such cases, the frame of the wheel is a skeleton, comparatively light. In ordinary cases, the wheel is united by the usual arms or spokes to an axis which forms the main driving-shaft.

The upper figure shows a large wheel of the latter description.

O'vo-lo. A molding whose profile is a quarter of a circle; or, in the Grecian, a portion of a cycloid.

Fig. 3453.



Overshot Water-Wheel.

A quarter-round. See Molding.

O′vo-lo-plane. (*Joinery.*) A joiner's plane for working ovolo moldings on sash, or elsewhere. Ovolo *routers* are made like spokeshaves, to work in circular sash-frames.

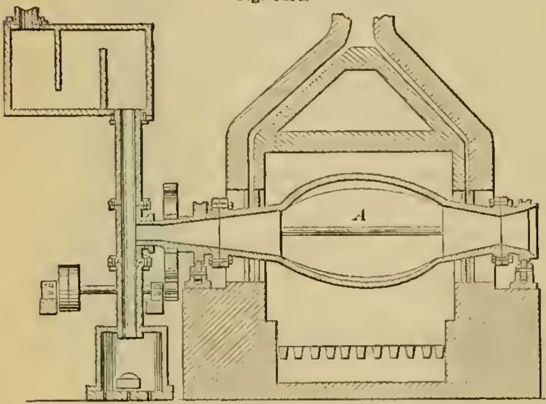
Ox-bow. (*Husbandry.*) The bent piece of wood which passes under the neck of the ox, the upper ends passing through the yoke. See Ox-yoke; Yoke.

Ox-brake. The ox-brake resembles that used for shoeing refractory horses, and consists of a stall where the neck is confined, straps to hold the animal suspended if he prove sullen and attempt to lie down, and posts and bars to which the feet are lashed for shoeing. See *a*, Fig. 3456.

Ox-eye. (*Building.*) An oval *dormer*-window.

Ox′i-diz-ing-fur′nace. (*Metallurgy.*) A furnace for treating ores or metallic substances, in which the material is exposed to an excess of air, the oxygen of which unites with the metal, forming an oxide. With ores, it may be said to be roasting with an excess of air. The term is somewhat general, and to speak of *oxidizing*-furnaces is a mode of stating chemically the action of certain furnaces under given conditions of access of air. The same furnace might be a *reducing*-furnace were the air more nearly shut off. A *reducing* flame is one which has an excess of gases, and abounding in carbon, the effect of which is to take up the oxygen from the material, *reducing* it. A neutral furnace is one in which there is enough of air admitted for perfect combustion of the fuel, and no more; the effect is therefore *nil* as regards the question of *reducing* the oxide, or *oxidizing* the metal.

Fig. 3454.



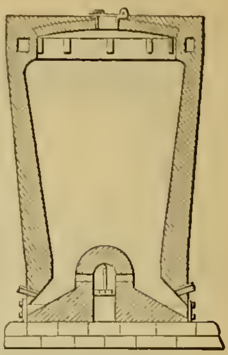
Revolving Oxidizing-Furnace.

An illustration, from among many, may be drawn from the process of *puddling* iron. The flame is first an *oxidizing* flame with an excess of air, the oxygen uniting with the carbon of the metal to convert it into relatively pure iron; a *reducing* flame is then allowed for a while, the fuel being in excess, and carbonaceous gases going over to reduce the oxide; after this air in moderate degree is admitted, the fire burning clear and consuming the fuel perfectly, as near as may be, the flame being *neutral* and merely heating the iron.

In Fig. 3454 is shown an oxidizing furnace, in which the ores are rolled over and over to expose them more fully to the action of the air. The revolving chamber has hollow trunnions open at one end to the air, and at the other communicating with the chimney. The material in chamber *A* is heated by fire in the furnace beneath, and particles carried over are caught in the upper or lower chamber, according to their relative gravity.

Fig. 3455 is a form of oxidizing and desulphurizing furnace for the treatment of auriferous pyrites and other similar ores with the gases formed by decomposing steam or superheated steam. The coal is placed in an ordinary fire-box, with grate-bars, so as to allow a good draft of air to support combustion. Steam from a boiler, which may be heated by the waste gases of the furnace, is brought into the incandescent coal in the fire-box. The resulting gases are passed into the chamber containing the ore to be treated. For the purpose of regulating the temperature of the gases in the ore-chamber, and to assist in oxidizing the metals, an additional supply of steam is passed into the ore-chamber without being passed through the fire-box.

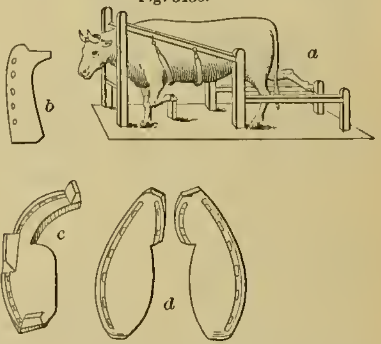
Fig. 3455.



Oxidizing and Desulphurizing Furnace.

Ox–shoe. Among the Orientals oxen to be shod are thrown, and their four feet drawn up into a bunch by cords. The animal being then helpless, the operation is completed at leisure.

Fig. 3456.



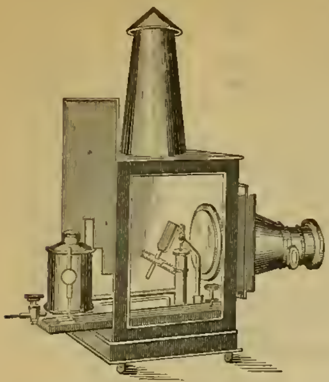
Ox-Shoes and Brake for Shoeing.

An ox-shoe consists of a flat piece of iron with five or six holes near its outer margin to receive as many flat-headed nails, whereby it is secured to the hoof. The shoe *b* represented has a projecting flap, which is bent into the cleft of the foot and flattened up against the inside of the hoof, to assist in keeping the shoe in place. This projection is not always employed. *c d* are also forms of ox-shoes.

Ox-y-cal′ci-um-light. One produced by a jet of oxygen gas forced through the flame of an alcohol lamp on to a piece of lime. This light will exhibit the usual paintings on a screen 10 or 15 feet in diameter with very brilliant effect. It is not so brilliant as the oxyhydrogen light, but it is much safer to manage. The apparatus is less bulky, troublesome, and expensive. The light is equal in brilliancy to ten argand-lamps of ordinary dimensions. See also Calcium-light; Drummond-light; Oxyhydrogen Light.

Ox-y-ge-na′tor. A contrivance for throwing a stream of oxygen into the flame of a lamp.

Fig. 3457.



Oxycalcium-Light.

Ox'y-gen-gas Ap'pa-ra'tus. Oxygen gas was first discovered by Dr. Priestly August 1, 1774. Scheele and Lavoisier appear to have made the discovery independently very shortly afterward.

Dr. Priestly first obtained the gas by heating red precipitate (red oxide of mercury, HgO) to a temperature of 752° Fah., by which the oxygen is expelled from this compound. Lavoisier verified the result by boiling mercury in a given quantity of air, thus forming red precipitate. Scheele obtained oxygen while engaged in experimenting upon some of the ores of manganese.

It may be readily obtained by heating chlorate of potash, mixed with $\frac{1}{3}$ or $\frac{1}{4}$ its weight of black oxide of manganese, in a glass vessel to a temperature of 450° or 500° Fah., and collecting over a water-bath. This process is, however, rather expensive.

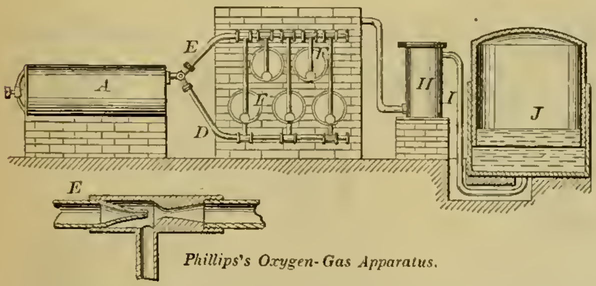
At the London Polytechnic Institute, where large quantities are used for the oxyhydrogen light, it is procured by heating black oxide of manganese (MnO_2) in wrought-iron bottles; two equivalents of the gas are liberated from each three molecules of the oxide, leaving Mn_3O_4, or red oxide of manganese.

A pipe is attached to the upper part of each bottle, through which the gas, after being purified by passing through a simple washing apparatus, is delivered into a copper gasometer. The pure oxide should yield $\frac{1}{9}$ its weight of the gas, but in practice rarely more than half that amount is obtained.

Fig. 3458 illustrates an apparatus for obtaining oxygen gas from permanganates by means of steam.

A is the boiler from which a current of steam is forced by the pipe *D* into the retorts *F*, extracting a portion of the oxygen therein contained. The steam current then passes, carrying the oxygen with it into the condenser *H*, where the steam is condensed, the oxygen being conveyed through the pipe *I* into the reservoir *J*.

Fig. 3458.

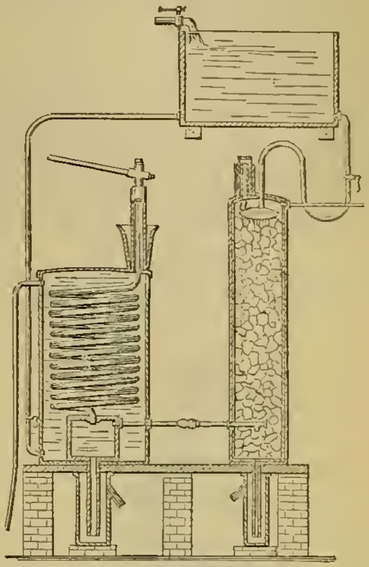


Phillips's Oxygen-Gas Apparatus.

To assist the process, a partial vacuum is formed in the retorts by a pipe *E* on the Giffard injector principle. When all the oxygen capable of being extracted is liberated, the steam is shut off and a fresh portion of air admitted through an appropriate pipe; part of its oxygen combines with the exhausted manganate, forming a permanganate which is treated as before.

Archereau's apparatus comprises a cupola of fire clay, inclosed in a leaden shell within which sulphuric acid is decomposed by exposure to an extended heating surface formed by iron bars. The mingled sulphurous-acid gas and oxygen are passed through a washer, where part of the acid is absorbed, the remainder being condensed by passing through a worm in a condenser.

Fig. 3459.



Archereau's Oxygen-Gas Apparatus.

In the process of Du Motay and Maréchal, oxygen is derived from the reactions between sulphuric acid and the oxides of various metals, which readily part with a proportion of this gas and reabsorb it from the atmosphere: the sulphurous-acid gas and oxygen liberated by this process are passed through a vessel containing oxide or carbonate of magnesia, which is converted into a sulphite; this is decomposed by heating, and the sulphurous acid which escapes is converted into sulphuric by treating with steam, air or nitrous gas, the magnesian compound being again ready for use. The patent also embraces means for procuring oxygen by heating such compounds as permanganates, chromates, and ferrates, which are reoxidated at a lower temperature.

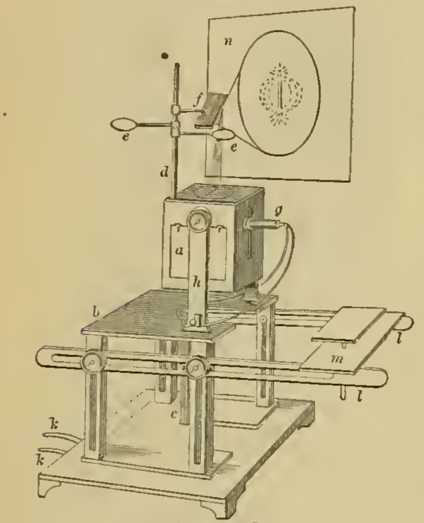
In Mallet's process, sub-chloride of copper is transformed by the air into an oxi-chloride, which parts with its oxygen when subjected to a red heat in rotating retorts lined with fire-clay. The oxi-chloride is mixed with 15 or 20 per cent of sand in the retorts. The oxygen passes through a washing-vessel to the gas-holder. Fresh oxygen is supplied to the contents of the retort by first cooling by jets of steam, and then forcing a current of air through it. For production of chlorine and oxygen at the same time, hydrochloric acid is injected in place of steam. According to the amount of acid injected oxi-chloride or pure chlorine may be evolved.

Ox-y-hy′dro-gen Blow′pipe. One used by mineralogists and chemists for reducing metallic ores in analyses. The flame is produced by the combustion of hydrogen gas in the presence of an atmosphere of oxygen, with which the combustible gas is mixed.

Ox-y-hy′dro-gen Lamp. One in which streams of oxygen and hydrogen in regulated quantities are commingled, the resulting flame being directed on a ball of quicklime and forming an extremely bright light; now used very largely by lecturers on science, to illustrate phenomena, and by exhibitors to project pictures upon a screen.

The body of the lantern *a* is swung between two uprights, to which it can be clamped firmly in any position required. The uprights are fastened in the top board of the stool *b*, which can be rotated in a horizontal plane round the upright tube *c*, to direct a beam of light in any direction. At one corner of the front plate is the bar *d*, carrying the lenses *e e* and the mirror *f*. These slide on the bar in the same manner as the rings on a retort-stand, and can be turned out of use in a moment. The jet, the lower part of which is seen at *g*, slides through a collar working in the slit at the base of the lantern. The caoutchouc tubes from the jet pass through screw pinch tabs, one of which is seen on *h*, and then they pass through the tube and underneath the base-board, as seen at *k*. The cross-pieces *l l* serve to support a table *m*, on which apparatus, such as a prism, etc., can be supported. To show magnetic curves, cohesion figures, or anything which requires to be illuminated while in a horizontal position, the lantern is clamped in an upright position, shown in the figure. The glass plate with the magnet attached is laid over the condenser, and one or both lenses, according to the size of image wished, are brought into action. The mirror is then adjusted to throw the image on a vertical screen *n*. Should it be desired to direct a beam downward, as in showing the refraction of light, the lantern is clamped with the axial line of the lenses pointing obliquely downward. The mirror is either slipped off the bar or turned out of the way, the cross-pieces and tables being removed. For exhibiting ordinary lantern-slides or photographs, a clip is attached to the front of the lantern, the instrument clamped in a horizontal position, and the slides then exhibited in the usual manner.

Fig. 3460.



Oxyhydrogen Lamp.

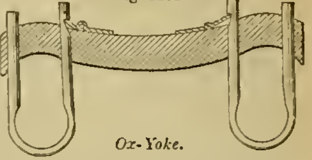
Ox-y-hy′dro-gen Light. A light of intense brilliancy produced by the combustion of lime in the flame of a combined jet of oxygen and hydrogen gases.

See CALCIUM-LIGHT; DRUMMOND-LIGHT.

Ox-y-hy′dro-gen Mi′cro-scope. A microscope in which the object is illuminated by the flame on a piece of lime or marble under the action of the compound blowpipe. The lime is placed in front of a concave mirror, and the object between this and a convex lens, by which its image, highly magnified, is thrown upon a screen so that it may be visible to any number of spectators at once.

Ox-yoke. The means whereby a steer is fastened to the tongue of the cart or wagon. It usually rests upon the neck, but the bar strapped to the forehead or poll goes by the same name. It is usually of the shape shown in Fig. 3461, and is held in place by bows.

Fig. 3461.

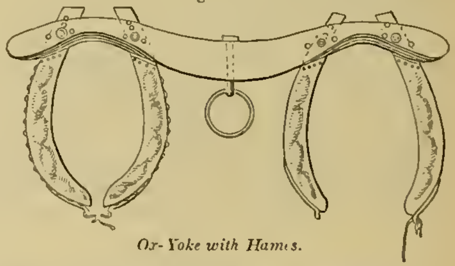


Ox-Yoke.

The bows are held in place by keys which pass through holes in the bows and rest upon the top of the yoke; or, as in the example, the hinged metallic plate engaging in a notch in the bow retains the same and obviates the use of a key.

Fig. 3462 shows a yoke with *hames* instead of bows. The hames are pivoted at their upper ends to the yoke, and fastened at the lower ends by straps. See also YOKE.

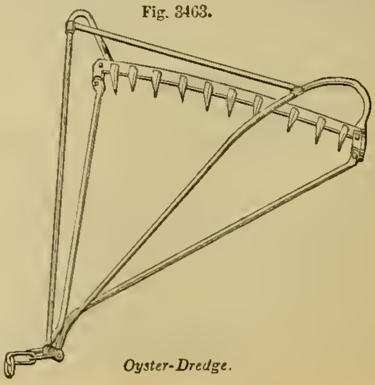
Fig. 3462



Ox-Yoke with Hames.

Oys′ter-dredge. A rake and drag-net for gathering oysters from the beds. The dredge is

Fig. 3463.



Oyster-Dredge.

thrown overboard and dragged by a sail-boat over the oyster-beds. It is then hauled up by tackle and drawn on board over a roller on the gunwale of the boat.

A stout bag is fastened to trail behind the bow of the drag and catch the oysters upturned by the rake. See also Dredge.

In olden times, the edible oyster was dived for, as the pearl-oysters now are.

> "Oysters lie at the bottom of the sea, and one cannot get at them by any other means, except by diving to the bottom." — Athenæus; Epit., B I. 22.

He also quotes Homer as saying, —

> " An active man is he, and dives with ease "
> (Iliad, XVI. 745),

in reference to a man who gathered them fast enough to keep several persons supplied.

Epicharmus, in the "Marriage of Hebe," says: —

> Bring " oysters with closed shells,
> Which are very difficult to open, but very easy to eat."

The pearl-oyster of the Indian Ocean is mentioned by Theophrastus and Athenæus, who speak of it as a precious stone resembling a large fish's eye, and that expensive necklaces are made of them for the "Persians, Medes, and all Asiatics." Theophrastus says: —

> "They are engendered in the flesh of the oyster, just as measles are in pork."

The oysters of Britain were highly esteemed by the epicures of the Roman Empire.

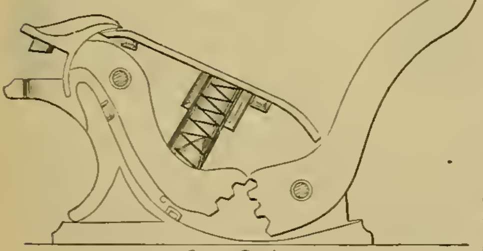
Oys'ter-knife. A strongly stocked and thick-bladed knife which is thrust between the shells of the bivalve, being a case of forcible entry. In America, the power of the mollusk is somewhat impaired by hammering upon the hinge, but in England the knife is driven between the shells without previously demoralizing the fortress.

Oys'ter-o'pen-er. An invention of Napier, England. The bivalve is laid on a stake and a notch taken out of the edge of the valves by a lever knife. It is then placed edgewise between a pair of knives, which are forced together and separate the shells.

Oys'ter-rake. One for raking up oysters from their beds. Usually dragged overboard by a sail-boat, and known as a *dredge.* See Oyster-dredge.

Oys'ter-shell Crack'er. An implement for breaking a notch in the shells of an oyster in order to facilitate entrance of the knife. The lower jaw is fixed and the upper one brought down by the lever and pivoted arm, which gear together.

Fig. 3464.

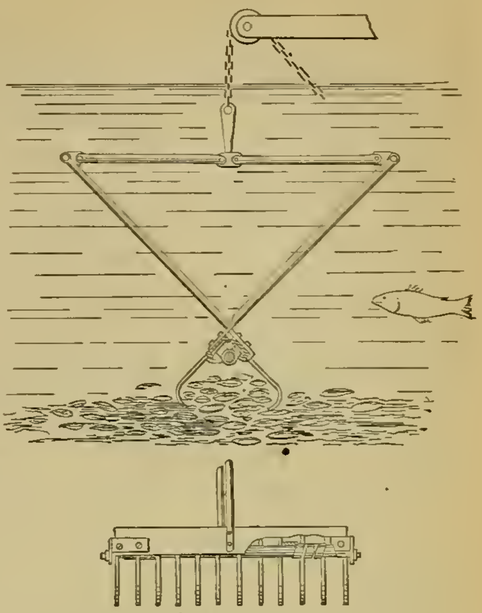


Oyster-Cracker.

Oys'ter-tongs. An instrument having two rake-shaped jaws and a pair of long handles, to grapple oysters in their beds and lift them to the surface.

On a large scale, as in Fig. 3465, the grappling-tongs are suspended over a beam rigged out from a boat, being held in extended position by a spring, and brought together by the action of raising, through means of the toggle-rods. The head is sunk by a longitudinal bar to which the jaws are hinged.

Fig. 3465.



Oyster-Tongs.

O'zone-ap'pa-ra'tus. Ozone is an allotropic condition of oxygen, also called *active oxygen.* It has the property of decomposing iodide of potassium with liberation of iodine. Its odor led to its discovery by Schönbein in 1840, though the odor which oxygen acquires by the passage of the electric spark was noticed by Van Marum more than half a century previously. Van Marum also observed its power of attacking mercury. It perhaps may be considered as an instable and extremely active condition of oxygen, having a density 1½ times greater than ordinary oxygen.

Ozone may be obtained by placing a stick of freshly scraped phosphorus in a bottle filled with air and containing sufficient water to partially submerge the phosphorus; the vessel is then closed and kept at a heat of 60° to 70° Fah. for six or eight hours. It is also produced by passing the electric spark through oxygen gas in the electrolytic decomposition of water, and by the slow combustion of ether caused by plunging a heated glass rod into a vessel containing this substance.

According to O. Loew, ozone may be obtained by passing air through the flame of a Bunsen burner.

O-zo-nom'e-ter. An instrument invented by Moffatt, for ascertaining the amount of ozone in the atmosphere.

Paper or linen, imbued with a mixture of iodide of potassium and starch, is used.

A slip of paper so prepared is placed in a current of air and protected from rain, light, and foul effluvia for a period of from six to twenty-four hours. By exposure the paper becomes brown, and when wetted acquires shades of color varying from a pinkish-white and iron-gray to a blue. The paper is compared with a prepared chromatic scale.

P.

Pac; Pack. A moccasin having a sole turned up and sewed to the upper. Though now made of leather of various kinds, the *pac*, as used by the Indians of the Six Nations, for instance, was made of hide boiled in tallow and wax; or of *tawed* hide subsequently stuffed with tallow or wax.

Pach-om′e-ter. An instrument for measuring the thickness of the glass of mirrors.

Pack. 1. (*Coopering.*) The staves and headings of a cask hooped up in a compact bundle for transportation. A *shook*.

2. A pile or bundle of sheet-iron plates, for heating or rolling simultaneously.

Pack′ag-ing-ma-chine′. A machine for bundling yarns or goods into compact shape for transportation. A *bundling-press.*

Pack-cloth. Coarse baling material: hemp, jute, etc. *Gunny-cloth.*

Pack′et. (*Nautical.*) *a.* A mail or passenger vessel plying between port and port at regular times. *b.* A vessel employed in carrying letters.

Pack′et-note. 1. A folded writing-paper, 9 × 11 inches, half the size of *packet-post*.

2. A size of note-paper.

Pack′fong. (*Alloy.*) A Chinese alloy known as white copper. Copper, 40.4; zinc, 25.4; nickel, 31.6. See Alloy.

Pack′ing. 1. A contrivance or a material to close a joint. See Piston; Piston-packing.

In the atmospheric engines of Papin, Savary, and Newcomen, the piston was packed air-tight by means of flooding its upper surface with water. Watt obtained a patent for packing pistons with lubricators instead of water, 1769.

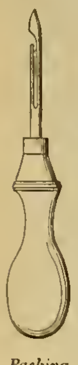
The piston-rod is also packed in its stuffing-box.

Various greasy materials with gaskets, oakum, etc., are used in joints which are screwed down; also collars of rubber, red-lead, luting. Flues and tubes are closed into the flue-sheets or tube-sheets by riveting. Tubes of condensers by thimbles, screw-joints, or preferably by Horatio Allen's collars of pine, which swell and close the joint but allow expansion and contraction.

2. (*Masonry.*) The filling in of a hollow or double wall.

3. Air-tight joints for fruit or jam can-covers are made by screwing or clamping the covers upon a gasket of rubber; or wax or resin is run into a crevice. See Fruit-jar.

Fig. 3466.



Packing-Awl.

4. Well-tubes are packed by rubber thimbles, inflatable bags filled with air or water, or with flaxseed, which swells as it absorbs water.

Pack′ing-awl. One for thrusting a twine through a packing cloth or the meshes of a hamper, in order to fasten the package by a tie.

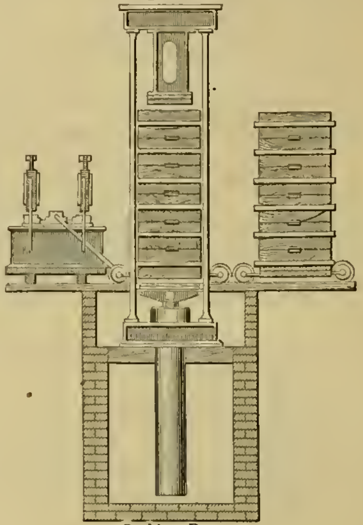
Pack′ing-bolt. (*Steam-engine.*) A bolt which secures the gland of a stuffing-box.

Pack′ing-box. 1. (*Steam-engine.*) A steam-tight composition or systems of parts around the piston-rod of an engine where it passes through the head. A *stuffing-box.*

2. A box for transportation of merchandise.

Pack′ing-press. A press for baling cotton, wool, hay, etc. The power, screw, or preferably hydraulic, is applied to the platen from beneath, and the boxes in which the substance is compressed are provided with hinges and catches so as to be readily taken apart; these are placed one above another on trucks with rollers, which are run under the press for compression, and withdrawn when the operation is finished. See Baling-press.

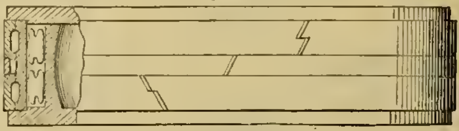
Fig. 3467.



Packing-Press.

Pack′ing-ring. (*Steam-engine.*) A ring on a piston to expand against the inside of a cylinder and prevent passage of steam. The example shows a set of three rings in which the transverse joints are kept tight by an intermediate ring with inclined edges so fitted between two packing-rings as to wedge them against the heads of the piston, and pressed outward only by the contact of the packing-rings, the latter being expanded by customary springs. See Piston; Piston-packing.

Fig. 3468.



Packing-Ring for Piston.

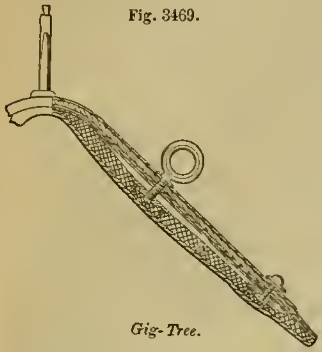
Pack′ing-stick. A *woolding* stick; one used in straining a twine around a rolled fleece of wool in tying.

Pack-sad′dle. One constructed for a pack or sumpter animal. It is provided with hooks, rings, and straps to support baggage, stores, or rations.

The pack-saddle for mountain artillery is adapted for transporting a light howitzer, with its carriage and ammunition, when the country is too rough for the passage of vehicles. For this purpose the front and rear of the saddle are made high, and in the form of arcs of a circle, and are recessed so as to readily receive the howitzer, which is lashed on the saddle, muzzle to the front. The shafts of the carriage are also lashed on the same saddle, the cross-bar resting on the cascabel of the howitzer. The carriage and wheels are carried on a similar saddle upon the back of another mule. The chests containing ammunition are carried by a third animal, one chest being suspended on each side of the saddle. See SADDLE.

Pad. 1. (*Menage.*) *a.* A cushion or stuffing, as that beneath a saddle, to keep the *tree* from galling the horse's back.

Fig. 3469.



Gig-Tree.

b. A cushion beneath a gig-tree of carriage harness, as in Fig. 3469.

c. A saddle without a tree.

d. That part of a double harness to which the girths are attached; used in place of the gig-saddle.

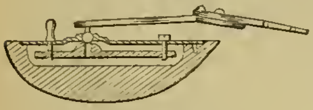
e. A cap of leather, stuffed, buckled over the knee, to keep that part from being grazed or injured by an occasional fall. See LEG AND FOOT GUARDS FOR HORSES.

2. (*Shipbuilding.*) A piece laid over a ship's beam to give the camber.

3. (*Dyeing.*) To impregnate with a mordant.

4. (*Stationery.*) A soft writing surface, as a quarter-quire of blotting-paper, for instance. A *writing-pad.*

Fig. 3470.



Hernia-Pad.

5. (*Surgical.*) *a.* The bag or knob of a truss which rests upon a hernial tumor and prevents its projection.

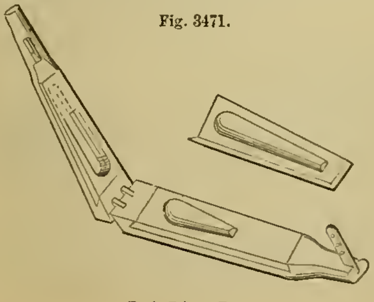
b. A bag or cushion to compress or support a part.

c. A soft wad between the splints and a fractured limb to prevent chafing.

Pad-cloth. A housing-cloth, extending over the horse's loins.

Pad-crimp Press. (*Harness.*) A press in which dampened leather is pressed into shape between protruding and hollow parts of a former. The respective portions are connected by a hinge, drawn forcibly together, pressing the piece of leather into shape, and are thus locked until the leather is dry enough to retain the shape of the mold.

Fig. 3471.



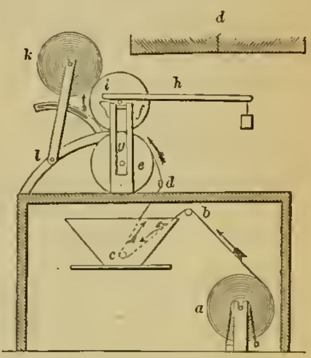
Pad-Crimp Press.

Pad′ding. 1. A method of calico-printing in which the whole surface of the cloth is imbued with a mordant, upon which different colored figures are subsequently raised, by the topical application of other mordants, joined to the action of the dye-bath. Also known as the *plaquage* style.

2. A cloth worked out of rags for stuffing collars of coats, etc.

Pad′ding-ma-chine′. (*Calico-printing.*) An apparatus for uniformly imbuing cotton cloth with a mordant in the process of dyeing. The cloth is wound upon the roller *a*, and is kept tense by a weight passing over a pulley on its axis, and by the roller *b*. It passes through the dye-trough, under the roller *c*, and is pressed against the half-round stretcher-bar *d*, the face of which has diverging grooves which stretch and smooth the cloth previous to its entry between the cylinders *c f*, which are covered with several thicknesses of cotton cloth. The journals of the roller *e* are fixed in the upright standards *g* on either side, while those of *f* admit of vertical movement so that its pressure may be varied by the adjustment of the weighted lever *h*, which is fulcrumed at *i*. The cloth passes obliquely between these cylinders, and is finally wound upon the roller *k* journaled in standards pivotally supported in the arc *l*, so as to allow for increase of size as the cloth winds upon the roller.

Fig 3472.



Padding-Machine.

Pad′dle. 1. The water-door in a lock-gate or sluice. A *clough.*

2. A float or board of a paddle-wheel.

3. A small scull for propelling a boat or canoe. A short oar, used without being shipped in a row-lock.

4. An iron bar or blade for stirring ore in a furnace.

5. A bat or pallet for working in plastic material.

6. A shovel or scoop to stir and mix materials, as sand with ashes in glass-making.

Pad′dle-box. (*Nautical.*) The upper case of a steamboat's paddle-wheel.

Pad′dle-box Boat. A boat which forms the upper section of the paddle-box, and is launched in case of emergency.

The paddle-box boat of Captain Smith of the English navy forms the top of the wheel-house in its ordinary capacity, being of a size adapted to its position and the size of the wheel. In the "Carron," 250 tons burden, it is 25 feet long, 9 feet beam, and has 4 air-tight cases, which qualify it as a life-boat. When in place, as the roof of the wheel-house, the midship thwarts are unshipped, so as not to be struck by the paddle-wheel, which revolves within six inches of her keelson.

One of the figures shows the boat in position, and the other is a transverse section of the vessel, showing the boat on one side of the vessel, turned over, suspended from the davits, and ready for lowering.

The boat lies bottom upwards on two iron davits having hinges, which enable her to be turned over and lowered down by six men in three minutes. A boat of similar capacity (capable of containing 40 to 50 men) could not be got out, if stowed in the usual position on deck, under twenty minutes, by the whole crew; and, in case of fire, probably not at all.

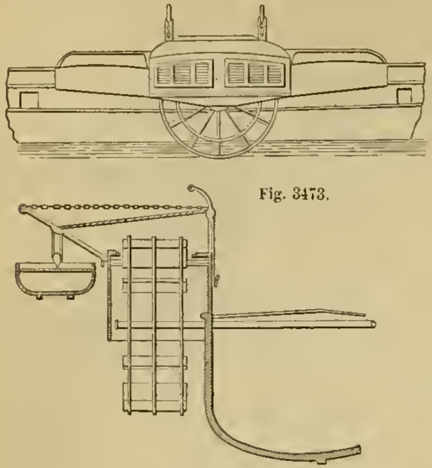


Fig. 3473.

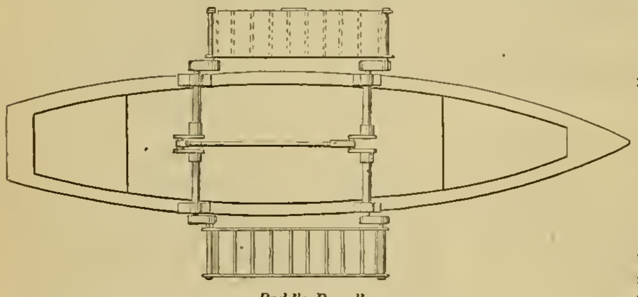
Paddle-Box Boat.

The longitudinal view shows the cabins, cook-houses, etc., before and abaft the wheel-house, similarly covered in.

Pad'dle-hole. (*Hydraulic Engineering.*) A water-channel through which the water passes from the upper pond of a canal to the lock-chamber, or from the latter to the lower pond.

Pad'dle-pro-pel'ler. A form of boat propulsion in which the vertical blades are bolted to a parallel bar and connected to cranks, by whose revolution they are alternately immersed to make the effective stroke and raised clear of the water on the return stroke.

Fig. 3474.



Paddle-Propeller.

Pad'dle-wheel. A water-wheel used in the propulsion of a vessel.

The framework of a paddle-wheel consists of *centers*, *arms*, and *rings*.

The *centers* are *disks* or *bosses*, two or three in number, keyed around the paddle-shaft and having sockets around their rims for the arms.

From each of the *centers* there radiates a set of *arms*, equal in number to the paddles. The *arms* are straight, flat iron bars, so placed as to move edgeways through the water. The outer ends of the arms are T-shaped, and to the cross-bars of each set of arms is riveted an outer *ring* of bar-iron. Inner rings, one or two in number to each set of arms, are riveted to lugs, or projections from the edges of the arms.

The proportions given by Hebert are to make the diameter of the wheel equal to four times the length of the stroke, and the depth of each paddle ⅛ of the diameter.

The first use of paddle-wheels may have been in the *velocimeters* of the ancients, in which an axis crossed the vessel, projecting over each side, and had paddle-wheels four feet in diameter, which dipped into the water and were rotated by the progress of the vessel. A tooth on the axis worked a train of gearing, so as to drop a ball at every 400th revolution of the paddle-wheel, indicating by sound and count the distance traveled.

Jonathan Hull, in his English patent of December 21, 1736, describes his boat as driven by a fire-engine, meaning a Newcomen atmospheric engine, which rotated "six fanns that turn upon an axis, ... the fanns are brought into and keep a direct motion in the water which forces forward the vessell in which the machine [steam-engine] is placed."

The paddle-wheel has been a favorite subject with inventors, the aim having been to enable it to enter the water without percussion and to leave it without raising a swell.

The greater number of these devices are for feathering the paddles, a subject which belongs to Division 2 (see below).

Some of these devices may be considered under this head, and it may be here stated that the loss of power incident to the obliquity of the blow delivered by the paddle is much exaggerated.

Galloway's patent, 1835, specifies paddles of cycloidal form, which enter the water nearly vertically and avoid concussion. They would probably lift the water when emerging worse than the common float.

Paddle-wheels may be classed under nine different heads: —

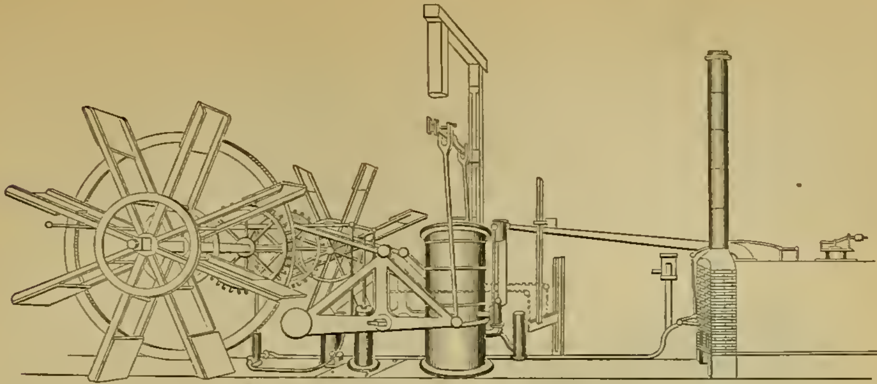
1. Floats fixed on the arms.
2. Feathering floats.
    a. Turning on horizontal axes.
    b. Turning on radial axes
3. Floats sliding radially toward and from the paddle-wheel shaft.
4. Floats attached to traversing chains.
5. Floats attached to cranks.
6. Collapsing paddles.
7. Floats in reciprocating frames.
8. Sculling paddles.
9. Cycloidal paddles.

Fig. 3475 shows the paddle-wheel used by Fulton on the "Clermont" in 1807. This was the first steamboat which can be called a practical success, she having made regular trips between New York and Albany for several years. The paddle-wheel used by Fulton is of substantially the same form as the one now in general use. See Woodcroft's "History of Steam Navigation."

Gemmel's patent, 1837, is rather a duplication than a change of construction. Two pairs of paddle-wheels are employed, the horizontal steam-cylinders having piston-rods proceeding from each end, and having cross-heads from which connecting rods reach to the paddle-wheel shafts.

2. *a.* Buchanan's parallel float-wheel. The floats are attached to horizontal shafts which have their bearings in the radial arms. On the axis of each paddle is an arm from which a rod proceeds to an eccentric on the paddle-wheel shaft. The effect is

Fig. 3475.



Machinery of Fulton's Steamboat "Clermont" (1807).

to keep the floats vertical at all points of their revolution.

In Galloway's patent of 1829 the revolution of the wheel causes an eccentric collar to rotate by the action of arms, and the radius rods cause each paddle to oscillate on its axis so as to enter and leave the water obliquely.

In Oldham's improvement in 1827, the angle of the paddles is constantly varying, being vertical only at the point of greatest submergence, and horizontal at the point of greatest elevation. The change of position is accomplished by the oscillation of the axis of the float, by means of rods, cranks, and an eccentric wheel on the paddle-shaft.

b. Dawson's feathering paddle-wheel (*A*, Fig. 3476), 1814, has floats attached to radial rods which rotate on their axes so as to enter and leave the water obliquely, but present their full surfaces squarely at the point of greatest immersion. The change is effected by affixing on the axis of each paddle two wipers which cross each other at right angles, the wipers coming in contact with inclined planes which cause the axes to oscillate to the extent of 90°.

Head's improvement, 1828, has two leaves to each float; these open so as not to oppose the action in entering and leaving the water, but during immersion form a combined broad float.

3. Leeming's sliding float (*B*), 1835. The arms are grooved and the paddle-boards slip out and in by the action of an eccentric *c* attached to the side of the vessel.

After its effective stroke each paddle is withdrawn nearly vertically.

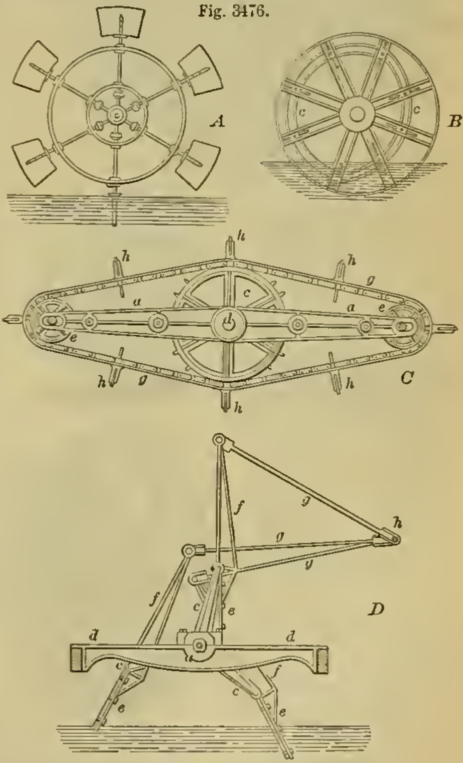
4. Floats attached to endless chains which pass over drums have been used, the intention being to give a direct impulse in the line of the vessel's motion, instead of giving the oblique blow upon the water incident to the ordinary paddle-wheel.

Spurgin's endless-chain propeller (*C*), 1837, passes over three wheels, the larger one being spiked and forming the driving-wheel, while the end wheels are drums which extend the chain and maintain its position; the middle wheel being larger, or having an axis depressed below those of the drums, so as to give a certain obliquity to the floats in entering and emerging.

a a is a cast-iron frame bolted to the side of the vessel; *c* is one of a pair of spike-wheels fixed on the engine-shaft *d*; *e e* are drums running upon the pins or studs on the ends of the frame; *g g* is an endless flat chain passing over the drums *e e*, and over and under the spike-wheel *c*. In order to keep this chain extended, the axes of the drums *e e* move in slots in the frame *a a*, and are keyed up so as to give the requisite tension to the chain. *h h* are the floats, which are carried by iron forks, which are forged in one with the middle links which support them.

5. Stevens's crank-axle paddle (*D*) (English), 1828, has three paddles attached separately to the arms of a three-throw crank, and, by means of radius and guiding-rods connected with them, the paddles are each made to describe in the water the segment of an ellipse.

Fig. 3476.



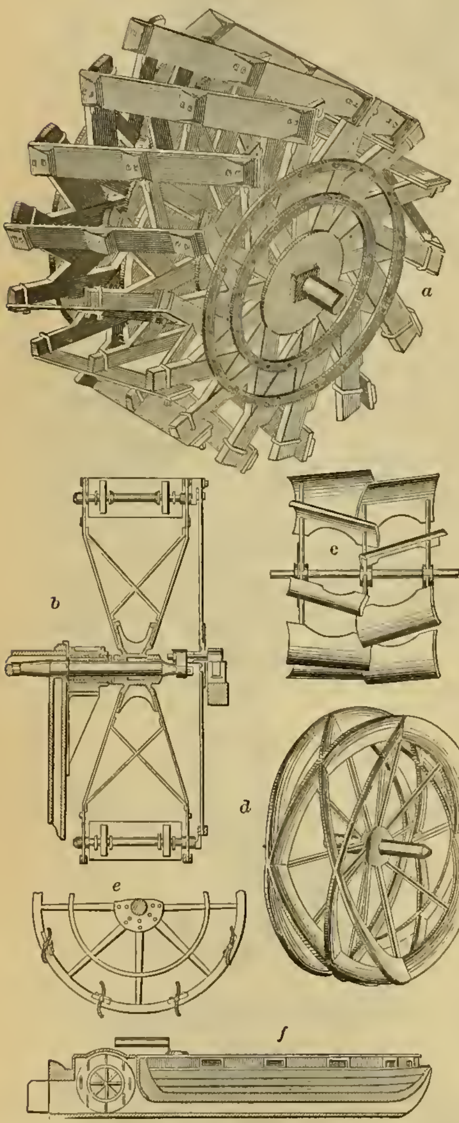
Paddle-Wheels.

a is the axis of a triple crank, the separate arms of which *e e e* move between parallel bars on the side-frame *d d* of the paddle-box *e e e* are the three paddles connected by the guide-rods *f f f* to the radius-rods *g g g*, the latter working from a fixed beam or center *h*.

6. Nairn's collapsing paddle (English patent, 1828) is allied in principle to the duck's-foot propeller. A number of levers are suspended over the sides of the vessel, extending to any suitable depth. These are made to vibrate by means of the engine, and the feet or paddles on the levers are made to collapse during the non-effective stroke, so as to offer no resistance; but when the effective stroke is made, the float expands, offers its full area to the water, and propels the vessel.

The *duck's-foot* propeller was tried by a Swiss clergyman, named Genevois, about 1737. It was of a contracting and expanding character, and was intended to resemble a duck's foot in its mode of operation. Earl Stanhope revived the idea about 1803.

Fig. 3477



Paddle-Wheels.

7. Floats in reciprocating frames. A number of vertical floats are arranged in a frame which moves in one set of horizontal guides while making its effective stroke, the paddles being submerged or nearly so. At the end of its stroke it is lifted out of the water, returned along an upper track, dropped down to its work, and then again propelled.

A number of patents have been granted for modifications of this general idea.

8. Perkins's sculling-wheel, patented in England in 1829, has paddles set obliquely on radial arms which are attached to axes sloping toward the stern, so as to make with the axis of the vessel angles of 45° and an angle of 90° with each other. On the extremities of the axis are bevel-wheels, which are both acted upon by an intermediate wheel driven by the engine.

In Fig. 3477, *a* shows a form of paddle-wheel so constructed that the blades descend obliquely into the water, so that an equal amount of blade-surface is submerged at all times and jar avoided. The position of the arms gives the blades such direction as to prevent them from lifting water.

Feathering paddles are of various forms. The object of feathering the floats is to present them to the water at right angles at all times, and to cause them to enter and leave the water edgewise.

In *b*, Fig. 3477, the floats are operated by rods from an eccentric on the crank-shaft. The crank connection between the controlling frame and guard-beam permits the bearing of the controlling frame to change its position in relation to the guard-beam whenever the latter changes its position in relation to the main wheel. In consequence of the diagonal arrangement of said connection, the controlling frame is moved to the least extent by movements of the paddle-guard in vertical and horizontal directions. The arrangement of the paddle-cranks is intended to equally divide the weight of the controlling frame between the paddle-wheel and the paddle-wheel guard.

c, same figure, gives another form of wheel constructed with the same object in view. The floats are curved as well as set diagonally to the shaft.

d is a form of oblique paddle designed to avoid jar.

e has feathering paddles automatically operated by the pressure of water against them.

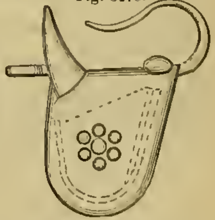
f shows the paddle within the hull, adapted to canal-boat propulsion.

The paddle-wheels of the "Great Eastern" are 56 feet diameter, 13 feet deep, 30 floats or paddles.

Pad'e-soy. (*Fabric.*) See PADUASOY.

Pad-hook. (*Saddlery.*) A hook on the back-pad to hold up the bearing-rein.

Fig. 3478.



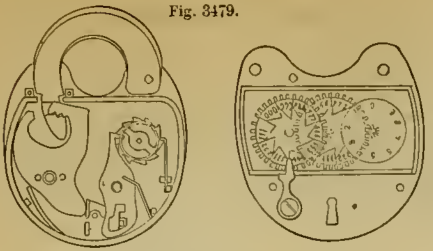
Pad-Hook.

Pad'lock. A lock with a bow to hold on to a staple. Made by Bechar at Nuremberg, A. D. 1540. Dr. Abbott's collection of Egyptian antiquities in New York contains a padlock found in a tomb at Sakkarah. They were also used by the Romans.

Fig. 3479 is an example of one in which the key, on being inserted, acts first on the tumblers, so as to free the cylinder and to allow a slide to be raised, and it then raises the slide so as to turn the cylinder. The slide-bolt is replaced in its original position by the turning back of the key after the lock has been opened.

Fig. 3480 is a combination padlock having a number of disks which must be brought into coincidence to allow the bolt to be withdrawn from the hasp. The disks are numbered on their peripheries, and

Fig. 3479.



Indicator Padlock.

perforated with central holes and radiating slots for the passage of the bolt. The bolt has an axial bar and radial arms. The arms having passed through the slots in the disks, the latter are disarranged and oppose the withdrawal of the bolt. A screw under the shackle fastens the lid, which may be opened to remove and rearrange the disks.

Fig. 3481 is a perspective view of another combination lock. In closing the hasp its shank acts against the lock-bolt and interlocks with the latter while withdrawing its dog from the gateways of the tumblers; hence, in order to lock the hasp, it is only necessary to break up the combination by turning a thumb-screw.

Fig. 3480.

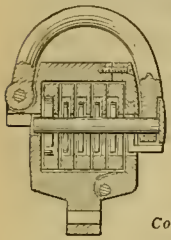
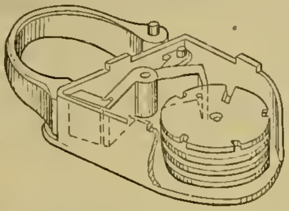


Fig. 3481.



Combination Padlocks.

Pad-plate. (*Harness.*) An iron bow, either malleable or wrought, upon which the pad is made, answering the double purpose of giving stiffness to the pad and as a means of attaching the mountings.

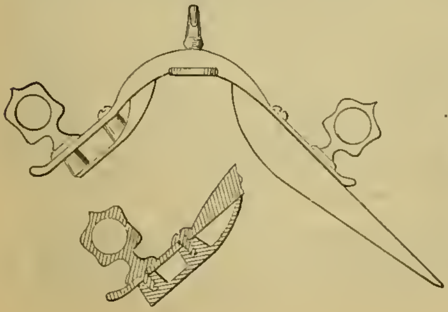
Pad-sad′dle. (*Harness.*) A saddle made of leather and padding without any *tree.*

Pad-screw. (*Harness.*) *a.* A screw-bolt having an ornamental head, used for securing the pad-sides to the pad-plate, and as an ornament.

b. A screw to hold the *tug-strap* and *gig-flat* together.

Pad-side. (*Harness.*) The strip of leather attached to the end of the pad, which furnishes a portion of the girth to hold the latter in its place.

Fig. 3482.



Pad-Tree.

Pad-top. (*Harness.*) The ornamental leather that forms the top or finish to the pad.

Pad-trace Bear′er. (*Harness.*) A strap attached to the outside of the pad-side under the end of the pad-top, and extending down outside the pad-side to permit the trace passing between it and the side; used in double harness only.

Pad-tree. (*Harness.*) A piece of wood or metal which gives shape and rigidity to the harness-pad.

Pad-u-a-soy′. (*Fabric.*) A kind of silk.

Pæ-dom′e-ter. An instrument for measuring the length of children.

Page. 1. One side of a leaf in a book.

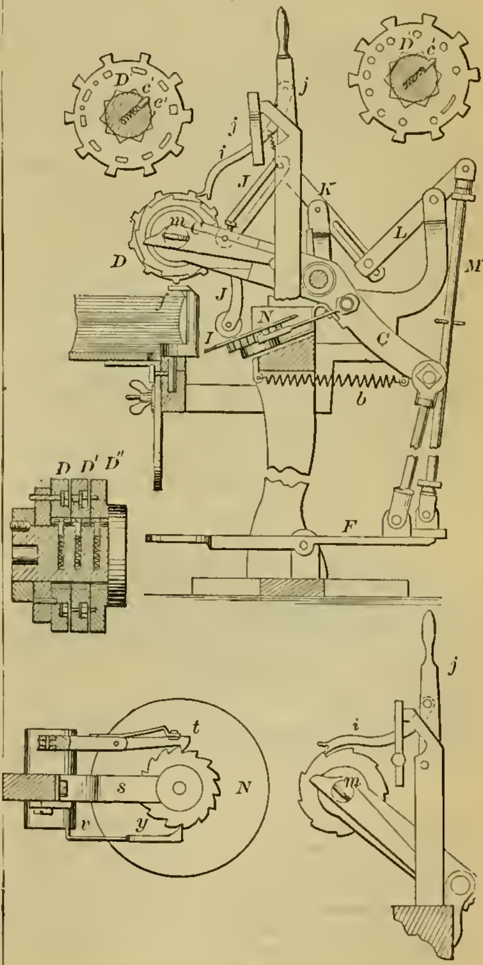
2. The track carrying the pallets, which support the newly molded bricks, and on which they are slipped to the off-bearing boy who stands at the end. See Brick.

Page-cord. (*Printing.*) Strong, smooth cord, cut in suitable lengths to tie up a page of type. It is wound three or four times about the type, and the ends tucked under, not tied.

Page-gage. (*Printing.*) A standard of length for the pages of a given piece of work, to keep them uniform.

Pag′ing-ma-chine′. (*Printing.*) A machine

Fig. 3483.



Paging-Machine.

for giving the consecutive numbers to the pages of an account or blank book. Also used, under the name of a *numbering-machine*, for giving the successive numbers to tickets, cards, checks, etc.

In one form the numbers are presented on disks which combine to form a cylinder. This is driven down upon the paper, delivering an impression. The unit-wheel is then turned a notch, which shifts the number one point, and another impression is given. The numbered disks are connected in series, as in REGISTERS, ARITHMOMETERS, GAS-METERS, etc. (which see).

Fig. 3483 shows a common form of paging-machine for printing the same number or a succession of numbers on sheets or leaves which are fed to it. The figures are on the circumference of disks *D*. These are mounted on shaft *m* in such a manner that they revolve independently of it. The disks are held above the paper *f* by the force of a coiled spring *b* at the other end of pivoted arm *C*. Pressure of the foot upon the treadle end of lever *F* brings down the face of the type on the sheet, and at the same time throws back the inking-roller *I* upon the ink-distributing disk *N*. When the pressure upon the treadle ceases, the type-disks rise, and the inking-roller passes across their lower face by the action of toggle levers *J K*, *L M*. The figure on the units disk is at the same time shifted by the pawl *i*, operated by lever *j*, acting on the ratchet-wheel, or this part may be thrown out of gear and the same number retained. Each revolution of the units disk moves forward the tens disk one figure, and so on.

The ink distribution is effected by the revolution of disk *N* through the mechanism *s t v y*, shown in one of the detached figures.

Disks *D D′ D″* may be shifted to the extent of two figures when it is desired to have a series of alternate figures, as in paging the right or left hand pages of a book.

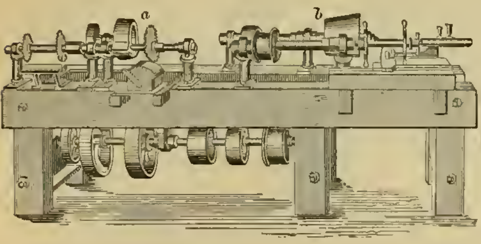
The disks are held in their places by a catch working in notches *c′*. An extra notch *e′* is provided, not in line with any figure of the disk, by which means the latter may be held to such a position that none of its type will print.

By the use of a machine of this class, an expert can number the pages in a book as rapidly as the leaves can be turned. The mechanical adjustment of the figures insures extreme accuracy in numbering a series of papers.

Pail-lasse′. An under-bed of straw. The form and purpose being retained, other materials have been substituted, as moss, finely shredded wood, called *excelsior*, corn-husks, sponge, hair. A *mattress*.

Pail-lathe. One in which buckets are turned on the outer and inner sides and the ends trued, dressed, and the croze made. The lathe shown in Fig. 3484 has two portions, *a* and *b*. The staves for a pail being assembled and held by a truss-hoop, the pail is placed on the chuck *a*, while the outside is turned off smooth and one end dressed, the hoop being shifted once so as to reach the whole surface. The pail thus dressed on the outside and one end is then stuck into the hollow chuck *b*, which holds it while the inside is turned smooth and the other end shaped and dressed. Operating on each end of head *a* are circular saws, whose distance apart is equal to the hight of the pail, and these act simultaneously, to saw off the ends.

Fig. 3484.



Fay's Pail-Lathe.

Pail-ma-chine′. A bucket-making machine. See PAIL-LATHE.

Pail-nail. A kind of nail used in making some kinds of buckets.

Paint. 1. A pigment, white or colored.

The colors used by painters are principally derived from the mineral kingdom, though animal and vegetable substances are to some extent employed. The following tabular statement indicates the composition of those most generally used.

	Name.	Composition or Derivation.
WHITE.	White lead	Carbonate of lead.
	Zinc white	Oxide of zinc.
	Spanish white	Purified carbonate of lime.
	Sulphate of baryta	
YELLOW.	Yellow ochre	An earth composed of silica and alumina, colored by oxide of iron.
	Naples yellow	Antimoniate of lead.
	Chrome yellow	An impure chromate of lead.
	Gamboge	A gum principally derived from Siam.
BLUE.	Ultramarine	From *lapis lazuli;* also prepared artificially.
	Cobalt blue	Phosphate of alumina and oxide of cobalt mixed with arsenite of cobalt.
	Smalt-Saxon blue	Double silicate of cobalt and potassa, mixed with earthy and metallic oxides.
	Antwerp blue	Prussian blue with various proportions of alumina and carbonates of magnesia and zinc.
	Prussian blue Berlin blue	Ferro-cyanide of iron.
	Indigo	From plants of the genera *indigofera*, *isatis*, and *nerium*, principally the former.
BLACK.	Lampblack	Carbon from the soot of burning rosin or other vegetable or animal matters.
	Ivory black	Calcined wine lees.
RED.	Red ochre	From calcination of yellow ochre.
	Red lead or minium	A mixture of protoxide and binoxide of lead.
	Madder	From the madder plant, *rubia tinctoria*.
	Cochineal	The dried bodies of the cochineal insect.
	Vermilion	Cinnabar, a sulphide of mercury, natural or prepared.
GREEN.	Chrome green	Sesquioxide of chromium.
	Schweinfurt green	Acetate and arsenite of copper.
	Scheele's green	Arsenite of copper.
	Verdigris	Acetate of copper.
BROWN.	Terra di Sienna	A natural earth found in the vicinity of Sienna, Italy; when burned it forms a red.
	Umber	An earth from that part of Italy anciently forming the Roman province of Umbria.
	Bistre	Soot of wood, preferably beech.

Numerous other colors are used by artists for producing different shades, and a large list might be made of those employed in dyeing and paper-staining, each having its peculiar fitness for special purposes. Among these, the various shades of violet, blue, green, red, etc., derived from aniline, a product of petroleum, have of late years assumed great importance. See ANILINE-COLORS; DYEING; WATER-COLORS.

2. (*Rubber-manufacture.*) Stuff mixed with caoutchouc in the process of manufacture, and intended to harden it. Sulphate of zinc, whiting, plaster-of-paris, lampblack, pitch, and other materials are used.

Paint-brush. Paint-brushes are generally made of hogs' bristles, but for artistic purposes the hair of other animals, as the fitch, badger, sable, and camel, is employed. Paint-brushes are commonly either round or elliptical in cross-section; the latter are usually made of the best bristles, and are termed varnish-brushes.

In one method of attachment the handle is round, and its enlarged base has a prong on each side between which the thick ends of the bristles are inserted, and afterward secured by a wrapping of twine which is coated with glue mixed with red-lead.

Another way is to insert the tapering handle, around which the bristles have been previously fastened by wrapping, into a metallic cap; the handle is then driven home, so as to firmly hold the bristles between it and the cap.

Smaller brushes of this kind are known as sash-tools, fitches, lettering-brushes, etc., according to size, shape, or material. Graining-brushes, called blenders, are made of camel's hair, and are flat in shape.

James Watt recommended rats' whiskers as the best material.

Various other modes of securing the bristles have been tried.

In Fig. 3485, the metallic top has upper and under sockets, in the former of which the handle is inserted. The latter contains the bristles, which are held in place by a wedge *D* drawn upward by a screw, which also serves to secure the handle.

Fig. 3485.

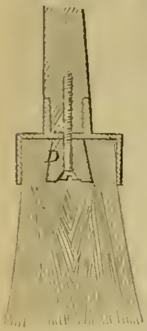
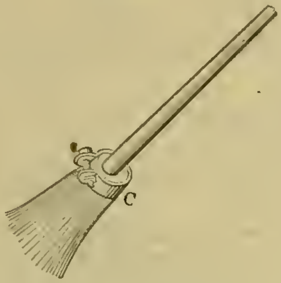


Fig. 3486.

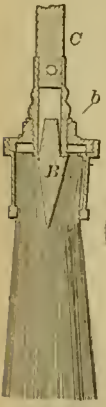


Paint-Brushes.

In Fig. 3486 the bristles are secured between the butt of the handle and an open ring *C*, the ends of which are drawn together by a screw passing through two lugs.

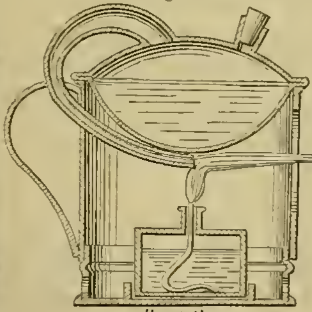
In Fig. 3487, the end of handle *C* is provided with a screw-thread, and is made hollow to receive the shouldered wedge *B*; the bristles being inserted in the tubular top *b*, the wedge is forced in between them by screwing the handle *C* into place, causing them to be firmly retained between the wedge and the outer tube.

Fig. 3487



Paint-Brush.

Fig. 3488.

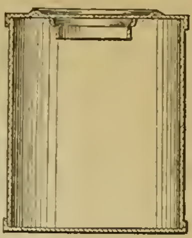


Paint-Burner.

Paint-burn'er. A blowpipe and lamp by which a flame is directed upon paint, to burn it off and prepare the surface for a new coat. In the example, the alcohol furnishing the vapor for the blowpipe is contained in the retort above the lamp.

Paint-can. A can specially constructed for holding paint. For convenience, paint is usually sold in cans of given capacity, and ingenuity is exercised in devising means for cheaply and securely closing, enabling them to be readily opened and conveniently used as paint-pots. Fig. 3489 has a removable cap.

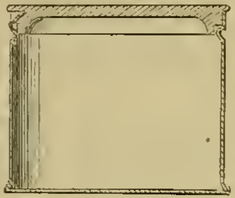
Fig. 3489.



Paint-Can.

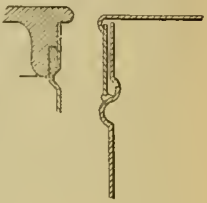
Fig. 3490 has an inwardly projecting bead to hold the gasket on which the cover rests. The cover has notches into which the rim of the metallic can is pressed to fasten the cover.

Fig 3490.



Paint-Can.

Fig. 3491.

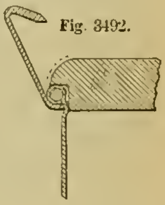


Can-Lid.

In Fig. 3491, the can has protruding and intruding circumferential beads. The rim of the cover fits down over the latter and forms an air-tight closure; being cut around at that level, it subsequently forms a lid.

In Fig. 3492, the hooks are soldered to the upper part of the can and turned over, so as to penetrate and hold the wooden cover.

Fig. 3492.



Lid-Fastening.

Paint'er. (*Nautical.*) *a.* The bow rope which fastens a boat to a wharf or alongside a ship.

b. A rope by which the shank of an anchor is secured to the gunwale. It is made partly of chain. A *shank-painter.*

Paint'ing. (*Fine Arts.*) The art of covering surfaces with pigments for decoration and protection; also the representation of objects in their natural colors by similar means.

In house-painting, the pigment most extensively used is white-lead. This is white, but it may be tinged with other ingredients to form grays, blues, and yellows of various shades, as well as many other colors. Zinc-white is also largely used, but does not possess the "body" of white-lead, requiring more to cover a given surface. Ochres and other earthy minerals are employed for forming different tints, of yellow, brown, and dull red. Other oxides and salts of lead, mercury, chromium, iron, and copper, form reds, greens, blues, and yellows. The impalpable powders derived from the smoke of some vegetable and animal products constitute different grades of blacks. See PAINT.

Any intermediate tints may be produced by the judicious intermingling of these principal colors. These are mixed with linseed-oil, either raw or boiled, to which, for most purposes, a greater or less proportion of spirits of turpentine is added. Rapid drying is insured by the addition of a small proportion of litharge, sugar of lead, or Japan varnish, according to material or color.

Painting as a fine art probably originated at even an earlier period than its employment for preservative purposes, having been derived from the practice, almost coëval with the introduction of man on the earth, of sketching the outlines of animals and other objects on hard substances; outline drawings of the extinct elephant and rhinoceros having been found engraven on bone in caverns, the condition and contents of which indicate that in some parts of Europe they were contemporaneous with man at a period prior to the glacial era. From outline to monochromatic painting was but a step; shading, to produce the appearance of relief in rounded and projecting parts, and the employment of differently colored substances to imitate their natural hues, gradually followed.

The ancient Egyptians appear to have never advanced beyond the last step, shading having been unknown until introduced by the Greeks, whose esthetic minds improved and beautified every art which they borrowed from others. Such of their works as remain do not enable us to judge how far their knowledge of perspective had advanced, but it does not seem to have been reduced to an exact and systematic science among them.

The enamel, encaustic, and fresco work of the ancients has come down to us in profusion. Their paintings on paper, canvas, leather, and wood have mostly perished. The even climate of Egypt and the seclusion of the tombs excavated in the rock by its ancient inhabitants have, however, preserved many specimens of their painting on wood and fabric in the mummy cases and wrappings.

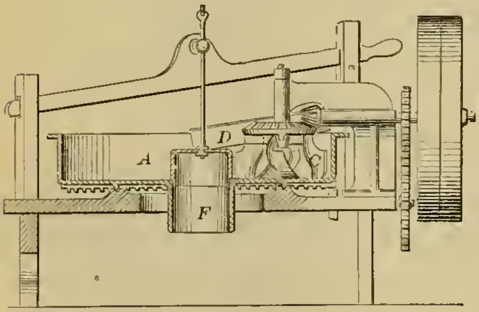
The bricks of Mesopotamia and the pottery of Etruria are also very ancient and interesting, the latter especially exhibiting a refined taste.

The modes in which colors may be applied to produce various effects, and possess more or less endurance, are described under DESTEMPER, ENCAUSTIC, ENAMEL, GLASS, OIL, SIZE, WATER-COLORS. See list under FINE ARTS.

Paint-mill. A machine for grinding pigments.

In Fig. 3493, a circular pan *A* containing the paint is rotated by appropriate mechanism, while stirring and scraping feet are caused to revolve therein by means of bevel-gearing. The discharge is effected by a curved scraper *C*, which brings the mass to a central opening *F*, provided with a tubular cover or valve *D*.

Fig. 3493.

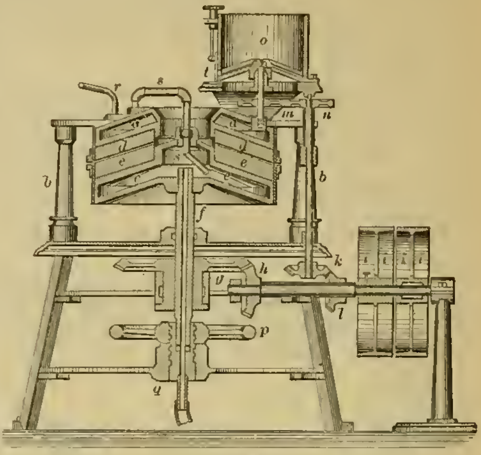


Paint Mill.

In Masury's paint-mill the upper millstone bed *a a* is supported on pillars *b b* bolted to a cast-iron table; both the upper and lower beds *a a c c* are hollow and receive thin annular disks of stone *d d e e*; the lower is supported on a hollow shaft *f* rotated by the bevel-gears *g h*, driven by the pulleys *i*, which also, through the medium of bevel-gears *k l* and spur-wheels *m n*, turn an arm in the mixer *o*.

The lower stone is raised into contact with the upper one by turning the wheel *p*, which raises the screw-step *q* of the hollow shaft *f*, which slides through the bevel-wheel *g*. The stones are cooled by water admitted through the pipe *r* to the open space *a a*, whence it passes through the pipes *s s* to the open space *c c* in the lower bed, and is discharged through the tubular shaft *f*. The material to be ground is placed in the mixer *o* and gradually fed into the mill through a small opening *t* provided with a gate for regulating its flow; the lower stone is brought into the required proximity with the other in the way above described, and a continuous flow of water allowed to circulate through the hollow spaces within the beds; by this means the particles of paint may be ground to an extreme degree of fineness without material evolution of heat. Mills constructed on this principle may also be used for grinding other substances.

Fig. 3494.



Paint-Mill.

Pair-horse Har'ness. The general name given to double harness in England.

Paix'han Gun. A large chambered shell-gun, so called from Colonel Paixhan of the French army, who introduced it in 1822.

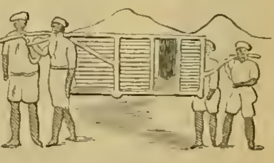
Guns of this kind of the caliber of 8 and 10 inches, known as sea-coast howitzers, formerly constituted a part of the armament of coast fortifications in the United States. These differed from the *columbiad*, invented by Colonel Bomford, United States army, about 1812, in being lighter in proportion to their caliber and in having no elevating rack on the cascabel, and have been superseded by ordnance of more modern forms. See CANNON.

Pa'la. (*Nautical.*) The blade of an oar. The *wash*.

Pal'ace-car. (*Railway Engineering.*) A car fitted with first-class accommodation, sofas and chairs, instead of the ordinary seats. The car is usually fitted for conversion into berths or couches for night traveling. See SLEEPING-CAR.

Pal'an-quin'. A carriage borne by men who relieve each other at intervals. It is an ordinary mode of conveyance in India and China.

Fig. 3495.



Palanquin.

Pal'ate, Ar'ti-fi'cial. A plate applied in cases of cleft palate, to improve articulation. It consists of an aluminium, gold, silver, or rubber plate, accurately fitted, to close up the opening in the roof of the mouth.

Pale. 1. A kind of fencing consisting of vertical slats supported by posts and rails, or posts and wires. *Paling.*

2. (*Shipbuilding.*) One of the interior shores for steadying the timbers of a ship while building.

Pal′ette. 1. (*Painting.*) A thin oval plate of porcelain or other material, having a hole near one edge through which the thumb may be inserted, used by painters in oil for rubbing-up or holding colors.

2. (*Metal-working.*) The breastplate against which the person leans to furnish a pressure for the hand-drill. Sometimes called a *conscience.*

3. (*Surgical.*) *a.* A light wooden spatula used for percussion, to excite the tone of the skin and tissues.

b. A splint to hold a burnt hand in shape and prevent deformation by the cicatrices.

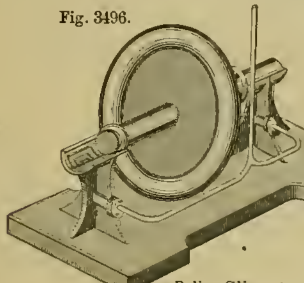
c. An instrument composed of two perforated plates to catch and withdraw the stylet in operations for *fistula lachrymalis.*

Pal′ette-knife. A flat, thin, flexible knife with a rounded end, used by painters to mix colors on a palette, or on the grinding slab. A *spatula.*

Pal′ier-glis′sant. A "slippery support" for a shaft or axle, a film of water being introduced beneath it by pressure. It is described for vertical and for horizontal shafts in Bramah's planing-machine, English patent, 1802. The inventor makes it adjustable by pumping in water *ad lib.* See Hydraulic Pivot ; Water-bearing.

In Girard's palier-glissant the water, under a considerable head of pressure, is introduced beneath the journal, lifting it slightly from its bearings ; after two or three oscillations the journal assumes its proper bearing on the box, the water flowing between them in a continuous and almost infinitesimally thin sheet. The comparative friction of this and a bearing lubricated by oil may be tested by imparting rotation to two wheels journaled, one in each way, by hand, when that provided with the palier-glissant will be found to maintain its rotation much longer than the other ; if, however, the supply of water be cut off, the wheel immediately stops.

Fig. 3496.



Palier-Glissant.

Pal′imp-sest. A piece of parchment whose original writing has been removed in order to fit it for a subsequent record. Many old documents were thus obliterated, and the writing is restored by an infusion of gall, dilute hydrochloric acid, oil, etc., a certain trace of the materials of ink remaining in the substance of the parchment which acts upon the substance applied.

Pal-i-sade′. (*Fortification.*) A row of stakes set firmly in the ground and presenting a sharp point to an advancing party. The stakes are placed vertically at the foot of the slope of the counterscarp, or presented at an angle at the foot of a parapet, or on the banquette of the covered way.

Pal-i′ta. A light shovel. A trowel.

Pal-la′di-um. Equivalent, 53.3 ; symbol, *Pd.*; specific gravity, 11.8 ; difficult to fuse. Discovered by Dr. Wollaston in 1803.

It is a white, malleable, ductile, hard metal ; fusible with the oxyhydrogen blowpipe.

The alloy of palladium and silver is eminently suitable for the graduated circles of mathematical instruments.

Palladium was used in constructing the balances for the United States Mint, and has been used for the medals of some learned societies.

Palladium alloyed with silver and copper makes an elastic, non-tarnishing blade capable of high polish.

Pal-la′di-um-iz′ing. A process for protecting iron by means of a thin coating of palladium, in lieu of zinc, as in the so-called "galvanizing" process.

The articles to be protected are first cleansed, as in zincking, by means of the double salts of zinc and ammonia, or of manganese and ammonia, and then thinly coated with palladium, applied in a state of amalgamation with mercury.

Pal′lam-poor′. A style of East Indian cotton chintz, printed in large-sized pieces and used for counterpanes. The printing is in the *resist* style, a substance being painted on the cloth having the power of *resisting* access of the dye to the fabric. With the *pallampoor* cloth this was softened wax laid on with a hair-pencil. We have no means of ascertaining how long this style of the art has been practiced, but it seems to be as old as Pliny. Madras has long been famous for this manufacture. One piece 5½ yards long by 2½ broad (French yards) is mentioned by Ure : "said to be the labour of Hindoo princesses, which it must have taken a lifetime to execute."

Pal′let 1. (*Machinery.*) A click or pawl to which a reciprocating motion is imparted, and by which an intermittent rotary motion is communicated to a wheel, as in many feed motions ; or by which the rotary motion of a wheel is made intermittent.

2. (*Horology.*) In an escapement, a lip or leaf connected with the pendulum, or upon the arbor of the balance-wheel, as the case may be, and acting consecutively upon the teeth of a wheel which is driven by the main-spring or weight, and is known as the *scape*-wheel.

3. One of the series of disks or pistons in the chain-pump or chapelet.

4. A bed ; a mattress ; a palliasse.

5. (*Painting.*) An oval board or piece of ivory to hold paint. A *palette.*

6. (*Nautical.*) A ballast-locker in the hold of a small vessel.

7. (*Clay.*) *a.* A board on which a newly molded brick is carried away to the *hack.*

b. A potter's wheel.

c. A paddle used in beating and shaping plastic material in forming crucibles, etc.; or in taking up mortar for use.

8. (*Bookbinding.*) *a.* A tool for gilding the back over the bands.

b. The instrument with which gilders take up gold-leaf from the pillow.

Pal′let-mold′ing. (*Brick-making.*) As distinguished from *slop*-molding. The bricks are turned out of the mold on to a piece of board of somewhat larger area, called a *pallet,* and on this they are removed to the drying-ground. In pallet-molding the molds are usually sanded ; in slop-molding they are wetted.

Pal-li-asse′. (Fr. *Paillasse.*) An under bed of straw. A straw mattress.

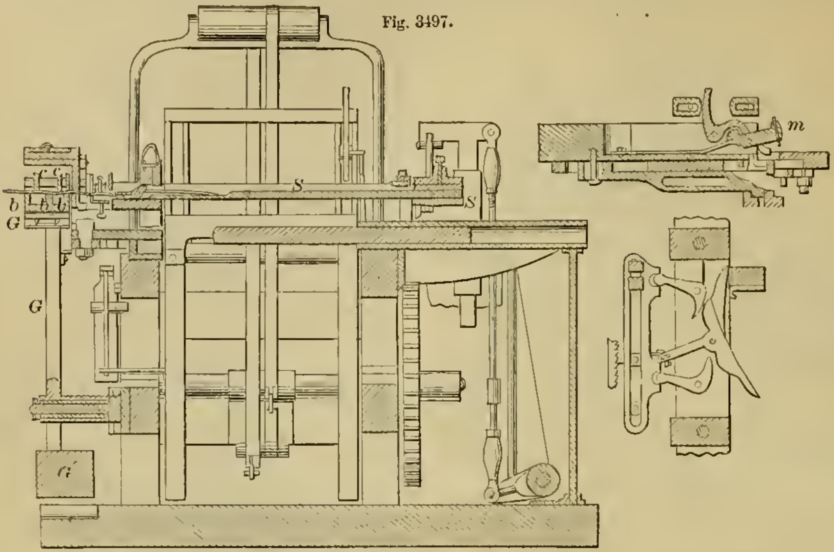
Palm. 1. (*Nautical.*) *a.* The sailmaker's substitute for a thimble. It goes over the hand, and has a fitted shield by which the needle is pushed through the canvas.

b. The flat face of an anchor-fluke which forms the holding surface. See ANCHOR.

2. The breadth of the hand, four inches.

Palm-leaf Loom. Strips of palm-leaf of proper width and length for the weft of the desired fabric are placed side by side between fingers *b c* at the top of a vibrating holder *G* at the side of the loom-frame. The ends of the strips next the selvedge are cut off evenly by a knife, and a weight *G′* at the bottom of the holder keeps the holder pressed in one direction with sufficient force to keep the edge of the strip to be selected against a gage about in line with the selector. A feeding-arm *m* catches the end of one strip at a time and presents it to the selector *S*, which has at one end a pair of pinchers, and the selector draws the strip between the warps. The weaving mechanism is as usual.

Fig. 3497.



Palm-Leaf Loom.

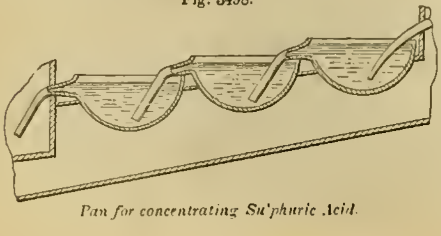
Palm-tree. (*Pyrotechnics.*) A device consisting of a series of green fires on a frame representing the body and head of a palm-tree. It was first designed by the Roman pyrotechnist Ruggieri: the composition is crystallized verdigris, 4; sulphate of copper, 2; sal-ammoniac, 1: ground with alcohol and used to saturate cotton rovings, which are festooned about the frame, and fired before the spirits have evaporated.

Pam′phlet. (*Printing.*) A work consisting of more than one sheet and not over five. It has a paper cover, if any.

Pan. A vessel for boiling or evaporating. Originally an open metallic vessel in which sirups or solutions are boiled for the purpose of concentration or crystallization, as a *sugar-pan*, *salt-pan*, etc. See EVAPORATING-PAN.

The purpose being maintained, closed vessels for the same purpose are also called *pans*. See VACUUM-PAN.

Fig. 3498.



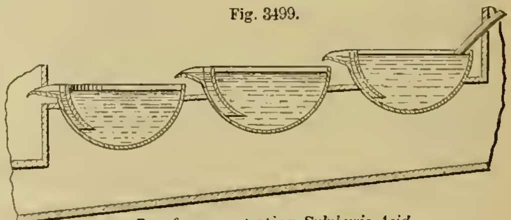
Pan for concentrating Sulphuric Acid.

The shape being preserved, open vessels in which the contents are not heated are called *pans*, as an *amalgamating-pan* (see AMALGAMATOR), *prospecting-pan* (see GOLD-MINING).

1. Overflow furnace-pans are used in concentrating sulphuric acid. In Fig. 3498, the upper pans discharge by pipes near the bottom of the next pan in the series. The effect is to move the whole contents of the pan below.

In Fig. 3499, each pan overflows into the one next below, and by means of the partial partition and spout the liquid is taken from the bottom of the pan, where it is in the most concentrated condition.

Fig. 3499.



Pan for concentrating Sulphuric Acid.

2. (*Soap-making.*) Soap-pans are made with a wooden frame and an iron bottom; called, respectively, the *curb* and the *pan*.

The same device is used for the preliminary heating and partial condensation of the sugar-water or maple sap, as it is variously called in different sections of the United States.

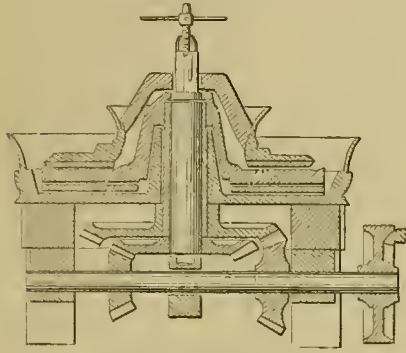
3. (*Tin-plate Making.*) A cold pot with a grating at the bottom in which tinned iron-plate is put on edge to drain and cool. It is the fourth in the series of iron pots and pans used in the manufacture

of tin-plate. *Tin-pot, wash-pot, grease-pot, pan, list-pot.* See TIN-PLATE.

4. (*Metallurgy.*) A name applied to that description of amalgamator consisting of an open metallic vessel in which the comminuted ore and quicksilver are ground together by rotating mullers. There are many varieties, which are described under the *Pan Process.* See AMALGAMATOR.

In the example, the pan has a central conical hub, through which a hollow shaft passes. On the lower part of a spindle which passes through a hollow shaft is keyed a bevel-wheel, and on the lower part of the said shaft is also keyed a similar bevel-wheel, and into these wheels beveled pinions gear, by means of which the mullers are rotated in opposite directions. On the upper part of the hollow shaft a square is formed, which is above the conical hub, and on this square is fitted the square portion of a conical hub, which extends down over the hub and is connected with the muller, which is provided on its under face with shoes. A sleeve provided with a slot is fitted over the upper end of the spindle, and a pin passes through said slot and spindle. This pin and openings cause the spindle to rotate the sleeve, while the openings allow the said sleeve to be adjusted by means of a screw.

Fig. 3500.



Amalgamating-Pans.

5. The powder cavity of the old flint-lock fire-arm.

6. (*Carpentry.*) The socket or sole for a hinge.

Pan-a-ma′ Hat. A leaf hat made in Ecuador and New Grenada of the undeveloped leaf of the "bombonáje" (*carludovica palmata*), which is a screw pine rather than a palm. The trunk of this plant is only a yard in hight, but the leaf-stalks are two yards in length. The bark of these leaf-stalks is woven into baskets, and the expanded leaves are used for thatching. It is the leaf before it has opened that is prepared for the manufacture of hats. It then consists of a bundle of plaits about two feet long and one inch in diameter. The green outside of this "cogollo" or bunch is stripped off; and then, by an instrument called a "picadera," resembling a pair of compasses with legs set half an inch or less apart, according to the fineness of the straw required, the leaflets are made into strips of uniform size with parallel sides. The cogollo is then boiled to toughen the fiber, and hung up in the sun to dry and whiten, when the leaflets run up into cordlike strands, which are then ready for use. The longest straw which can be procured from the bombonáje is twenty-seven and a half inches. It takes sixteen cogollos for an ordinary hat and twenty-four for the finest; and a single hat is plaited in from four days to as many months, according to texture. — PROFESSOR ORTON of Vassar.

Pan′cake. (*Leather.*) A factitious leather made of scraps agglutinated by cement or glue, and pressed into a flat cake for insoles, etc.

Pan-de′an Pipes. The emblems of Pan, the rural divinity of the Greeks, were a shepherd's crook and a pipe of seven reeds. The reeds are bound together in a parallel series, the mouths on a level and the lengths so proportioned as to give the notes of the gamut.

The instrument yet survives in England as an accessory to the exercises of Punch, playing the air to a base-drum accompaniment. See SYRINX.

Fig. 3501.

Pandean Pipes.

A porcelain representation of the Pandean pipes was found by Dr. Abbott at Sakkarah.

Pan-dore′. (*Music.*) A rebec. A kind of lute. See *Pandura,* Plate LI., Bonanni's "Istromenti Armonici," Roma, 1776.

Pane. 1. A compartment or square.

a. A sheet or light of window-glass occupying one opening in a sash. In the *apodyterium* of a Pompeian bath was a pane of cast glass 2 feet 8 inches by 3 feet 8 inches. In the *tepidarium* was another window with four panes.

b. One square of the pattern in a plaid or checker-work fabric.

c. One of the sides of a roof, tower, spire, etc.

2. *a.* A flat dressed side of a stone.

b. One of the parallelopipeds of buhr-stone which are confined by hoops and form a millstone.

3. (*Joinery.*) One of the divisions of a work which has sunken portions surrounded by framing. A PANEL (which see).

4. (*Machinery.*) The divisions or sides of a nut or bolt-head; as, a *six-paned* nut, *i. e.* a hexagonal nut. *Panel* is an allied word.

The pointed or edged end of a hammer-head. Properly PEEN (which see).

5. (*Hydraulic Engineering.*) One of the divisions of a plat between a feeder and an outlet drain.

6. (*Diamond-cutting.*) One of the sides of the *table* or upper surface of a *brilliant-cut* diamond. The table has eight panes. See BRILLIANT.

Pan′ei-con′o-graph. See PANICOGRAPH.

Pan′el. 1. The sunken portion of a *door,* wainscoting, head-board of a bedstead, etc. Its edges are mortised into the surrounding frame, whose uprights, in a door, are termed *stiles,* and horizontal pieces, *rails.* Middle vertical pieces between double panels are *munions.*

Carriage panels are, in the United States, usually of poplar strengthened by strong canvas fastened thereto by glue.

2. A compartment in a sunken ceiling, soffit, bay, or wainscot.

3. A face of a hewn stone.

4. (*Painting.*) A thin board on which a painting is made.

5. A square. See PANE.

6. (*Bookbinding.*) *a.* A depressed part of the sides within a relatively elevated bordering portion.

b. A space on the back between bands.

7. (*Mining.*) *a.* A heap of dressed ore ready for sale.

b. A system of coal-mining in which the projected *winning* is divided into large square allotments divided by massive walls of coal, instead of placing the whole working in one undivided arrangement. The *pillars* are left very large, the *rooms* small; the *pillars* are worked out, props being substituted; these are knocked out and the *goaf* filled up by the caving down of the ceiling.

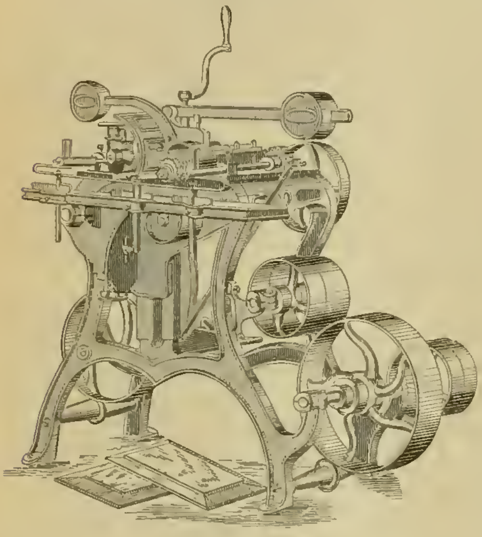
8. A pad or packing beneath a saddle to protect

the horse's back from contact with the tree. It is usually made of basil stuffed with wool, doe-hair, or horse-hair, lined or quilted with woolen serge, or at times, for hot climates, with holland, and for race-saddles with silk or other soft material. The principal difficulty with panels is to keep them of their original softness.

Pan'el-plane. (*Wood-working.*) A long stocked plane having a handle or *toat*. The stock is somewhat deeper than that of the jack-plane.

Pan'el-rais'er. (*Wood-working.*) One employed to rabbet away the angle and a part of the surface of a board, in order to give it a sunken margin, leaving a *raised panel*. The cutters have such a contour as to give the required molding to the edge of the raised portion. The example is known as a *double-head panel-raiser*, working upon two edges of the board at once, at a gaged distance apart. A couple of the worked panels are shown on the floor below the machine.

Fig. 3502.



Fay's Panel-Raiser.

Pan'el-saw. A hand-saw for paneling. It has six teeth to the inch.

Pan-ic'o-graph. A mode of obtaining printing-plates direct from a subject or transfer by applying it to the face of a plate of zinc, and building up a printing surface in relief corresponding to the design transferred. The processes are: —

1. Place on the polished plate the design in transfer ink; dust rosin on the ink, which gives it hardness and substance; then eat in the uncovered surface.

2. Coat the zinc with a non-conducting surface; draw or write the design with a conducting ink; throw down copper on the lines in the electroplating bath; remove the non-conducting coat and eat down the zinc surface by making the plate the positive electrode of the battery.

3. Coat the plate with whiting and etch with a point; cover with varnish, which will adhere to the uncovered metal; wash off the whiting and bite in the parts of the plate not covered by the varnish.

Panne. (*Fabric.*) Worsted plush of French manufacture.

Pan'nier. 1. (*Hydraulic Engineering.*) A basket or gabion of wicker-work containing gravel or earth, and used in forming a basis for earthy material in the construction of dikes or banks to exclude water or to resist its eroding action upon its natural banks.

2. Baskets — usually in pairs — slung over the back of an animal of burden to carry a load. The ancient Egyptian paintings show asses with panniers full of children.

Pan-nus-co'ri-um. A kind of leather cloth used for making boot uppers.

Pan-o-ra'ma. A painting of a complete scene, such as that of London as viewed from a central point, by Barker, from the summit of St. Paul's, or made continuous upon an unrolling canvas, as if the spectator were passing the particular spots consecutively.

In a *diorama* the scenes are isolated and viewed through a large opening, the surrounding proscenium affording a frame for the picture or succession of pictures. This mode of pictorial representation was invented by Daguerre and Bouton. It has great facilities for scenic and illuminative accessories, by opaque and transparent painting, screens, shutters, reflectors, etc.

A *cyclorama*, as its name indicates, is, or should be, a circular view.

The invention of the panorama is due to Barker, a portrait-painter of Edinburgh, who obtained a patent for his invention in 1787. His panorama of Edinburgh was painted in 1789. In 1792 he exhibited his panorama of London. Fulton introduced the art into France, 1799. In 1821, during the absence for repairs of the cross of St. Paul's, Barker erected an observatory at that giddy hight, and during the summer completed his sketches on 280 sheets of drawing-paper, covering 1,680 square feet. The painting made from his drawing adorned the interior of the dome of the Athenæum, Regent's Park, London.

The panorama of the Mississippi was made in 1840 by the skill and patience of the painter Banvard, who floated down the river and took the sketches of prominent points and expressive features of the river-banks. It gave rise to a host of similar productions: oceans and river routes, pilgrims' progresses, paradises lost, funerals of Napoleon, moral, immoral, and temperance serials, trades, arts, politics, overland routes to India, emigration to Australia and New Zealand, and, to cap the climax, a cyclorama of the great Lisbon earthquake, which happened about one hundred years previously.

Pan-o-ram'ic Cam'e-ra. (*Photography.*) One in which pictures may be taken on one flat plate, including an angle of 90°, more or less, as required, without introducing defects due to oblique pencils of light. Invented by Sutton. The lens-tube is turned about its axis and directed in succession to the different portions of the field, the dark slide moves with it and presents the proper portion of the sensitized plate opposite to the lens.

Pan'o-type. (*Photography.*) A name given to collodion pictures.

Pan'ste-re-o-ra'ma. A model of a town or country in wood, papier-maché, cork, etc., in which the objects are shown in the proportional relief.

Pan-tel'e-graph. An instrument invented by the Abbé Casseli, for transmitting autographic messages and portraits.

The essential features of the invention are a line connecting a pair of pendulums which have isochronous vibrations. The pendulum at one end of the line carries an iron point over the portrait or message executed or written in insulating ink on a metallic paper, and the other pendulum at the other end of the line carries an iron pencil over a paper prepared with a solution of the yellow cyanide of potassium.

The electric circuit is completed where the stylus at the transmitting end crosses the insulating ink, and at a corresponding place on the paper at the delivery end a blue mark is made by the other stylus on the prepared paper. See AUTOGRAPHIC TELEGRAPH.

Bonelli's telegraph is of somewhat similar character. See Deschanel's "Natural Philosophy," Part III. pp. 730–733.

Pan'tile. A tile curved to an ogee shape, so that the prominent edge of one is covered by the dependent edge of the next. The usual size is $14\frac{1}{2} \times 10$ inches, and they are laid with a 10-inch gage. 170 tiles cover 1 square, i. e. $10 \times 10 = 100$ square feet.

Fig. 3503

Pantile.

Pan'to-chro-nom'e-ter. An instrument which is a combination of the compass, sun-dial, and universal sun-dial.

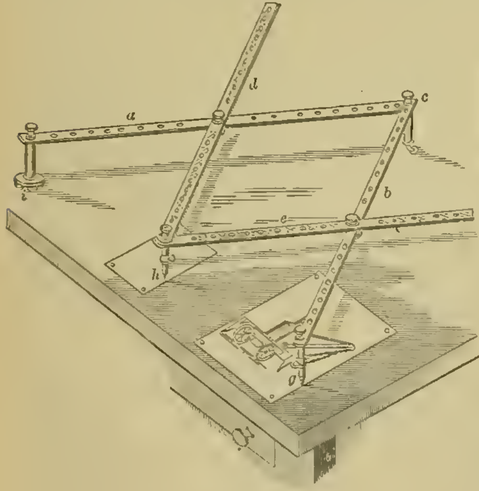
A sun-dial is attached to a magnetic needle, suspended in the usual way, in such a manner as to allow for the variation. The divisions of the hours and their fractions are carried on to an additional exterior circle, correspondingly divided ; and to a fixed circle around the dial, on which are inscribed the names of a number of places. By this arrangement the gnomon gives the time at the place of observation and also for any other place inscribed upon it.

Pan'to-graph. An instrument for copying drawings. Its invention is ascribed to Christopher Scheiner, a Jesuit, 1603. It has since undergone various modifications and improvements.

A device of this kind is alluded to by Pepys.

"This evening Mr. Spong [the inventor] came and first told me of the instrument called a *parallelogram* [pantograph], which I must have one of, showing me his practice thereon, by a map of England." — PEPYS'S *Diary*, October 27, 1668.

Fig. 3504.



Pantograph.

The pantograph consists of four metallic rules, two of which *a b* are jointed at *c*, and the other two *d e* are jointed over *h* ; each rule is perforated with a series of holes, and the two *d e* are provided with thumb-screws by which they may be connected to *a b*, at either of the holes of the series. *g* is a tracer ; *h*, a pencil or pricker ; and *i* a screw or point which is forced into the drawing board or table to hold the instrument in position.

For use, the rules *d e* are secured to the others by inserting the thumb-screws through the holes marked with the numbers ; as, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, etc., corresponding with the scale to which the drawing is to be reduced or enlarged ; the point *i* is fixed in a convenient position, and the tracer *g* passed over the outlines of the original ; this causes the point *h* to move in a direction parallel to that of the tracer, the extent of its motion being governed by the adjustment above described ; and if a pencil-point be employed it describes a figure similar to the original but differing from it in size. In right-line drawings it is more usual to employ a plain needle-point, pricking a sufficient number of points into the paper to serve as a guide to the draftsman, who afterward connects them by lines. The instrument shown in Fig. 3504 is the one used in the reduction of drawings for the illustrations in this work.

The pantograph is used in transferring patterns to copper cylinders for calico-printing. The system was patented by Rigby in England in 1854, and improved in 1857, so that by employing a number of tracers all the similar figures in a pattern may be produced at once.

In this process the pattern to be copied is first drawn on paper which is placed in a camera which throws an enlarged image on a sheet of paper ; this is traced on the paper, which is then transferred to a zinc plate, in which the figures are cut with a graver. The plate is then laid on the curved bed of the pantograph machine, on which a varnished roller is mounted ; a number of diamond-points corresponding to that of the lateral repetitions in the pattern are brought in contact therewith, and the tracer is successively passed over each part of the enlarged pattern on the zinc plate, causing the diamond-points to describe a series of figures, reduced to the size of the original drawing on the varnished copper cylinder, which are afterward etched in with acid.

The *micropantograph*, for copying on a very minute scale, may be described as a system of connected pantographic levers, the last of which carries a piece of glass on which the original is reduced in a proportion determined by the relation between the lengths of the longer and shorter arms of the series.

The glass rests and moves upon a diamond-point while the point remains stationary. The diamond may be raised or lowered by appropriate mechanism, to regulate the width and depth of the cut or entirely remove it from the glass.

With an instrument of this kind the Lord's Prayer has been written within the space of $\frac{1}{356000}$ of a square inch. In the same ratio the whole of the Old and New Testament would be contained within $\frac{1}{27}$ of a square inch. See MICROPANTOGRAPH.

Pan-tom'e-ter. An instrument for measuring angles for the determination of elevations, distances, etc.

Pa'per. A material made in thin sheets from a pulp of ground rags or other fiber, and used for writing or printing upon or for wrapping. The name is derived from *papyrus*, an Egyptian reed whose stalk furnished for so many centuries the principal material for writing upon and for wrapping, to the nations bordering upon the Mediterranean. In his day, Pliny remarked : —

> "All the usages of civilized life depend in a remarkable degree upon the employment of paper. At all events, the remembrance of past events."

This observation, undoubtedly true 1,800 years ago, is much more remarkably so now ; indeed, in considering that paper as we now understand it was entirely unknown to Europe in the time of Pliny, the expression of the great dependence upon what seems to us so fragile and inefficient a substitute for real paper appears strange.

The Greek name *papuros*, mentioned by Theophrastus, a contemporary of Aristotle and Alexander, was probably the Egyptian name of the reed with a Greek termination. It was also called *biblos* by Homer and Herodotus, whence our term *bible*. The term *volumen*, a scroll, indicates the early form of a book of bark, papyrus, skin, or parchment, as the term *liber* (Latin, a book, or the inner bark of a tree) does the use of the bark itself. Hence also our words *library*, *librarian*, etc.

Pliny indorses the statement of Varro that the discovery of the use of the papyrus was an incident in the victorious expedition of Alexander of Macedon; this was not correct, but no doubt the expedition contributed to introduce the papyrus to the nations of the West. Egyptian tombs show that it was used many ages before the time of Alexander, and, indeed, long prior to any authentic historical accounts of Greece; its existence being proven nearly as far back as the stone records of Egypt extend, or nearly to the time of Menes himself (2400 B. C.).

It seems to have been early known to the Hebrews. Isaiah refers to the papyrus plant when he says, —

> "The paper reeds by the brooks, and everything sown by the brooks, shall wither, be driven away, and be no more."

This prediction of the prophet has been long since fulfilled, and the plant is now comparatively rare.

An ancient Egyptian papyrus on the preparation of medicines, which was found at Thebes by Dr. Ebers, has lately been placed in the Leipsic Library. It is in a good state of preservation, and consists of one hundred and ten columns; written on the back is a double calendar in eight columns. Each column is eight inches wide, and contains twenty-two lines. The writing is from right to left; it is all in black ink, except the beginnings of chapters, which are in red ink. The characters are distinct, bold, and tasteful, and their form appears to fix the seventeenth century B. C. as the date of the manuscript; the fact that in the calendar the name of King Ra-ser-ka (Amenophis I.) is mentioned, proves that the papyrus is not posterior to the first half of that century.

The work itself dates from a period more remote than its transcription on papyrus. It is known that the most ancient Egyptian writings were works about medicine. Manetho tells us that the Egyptians honored one of their first kings as a physician. This assertion is confirmed, not only by the fragment of papyrus of Brugsh and Chabas, preserved in the Berlin Museum, but also by the present document.

The first chapter of the papyrus treats of the original production of the book, which came from the Temple of On (Heliopolis). Then follow the remedies employed for the cure of various diseases, together with extensive details as to diseases of the eye, remedies against the falling off of the hair, for sores, fevers, the itch, etc. The chapter devoted to the mistress of the house is succeeded by one about the house itself, which insists on the importance of cleanliness, and tells how to banish insects, to exclude them from houses, to prevent serpents from coming out of their holes, to avoid the stings of gnats and the bites of fleas, and to disinfect clothing and dwellings. Then there is a treatise on the relations between soul and body, with secret methods of studying the heart and its movement.

The gossiping and agreeable Pliny gives a detailed account of the preparation of paper from the Nile reed. This indefatigable man is principally known to us by one only of his voluminous writings, his treatise on "Natural History." This, however, treats on a great multitude of subjects, including agriculture and the arts and sciences, and affords a very interesting record of the state of practical knowledge at that time. He was suffocated by the mephitic vapors at the eruption of Vesuvius, A. D. 79, which he had imprudently approached too nearly, for the purpose of scientific investigation.

It may be remarked, that this eruption of Vesuvius, described with so much animation by Pliny the Younger, did not utterly destroy the cities of Herculaneum and Pompeii, as is popularly supposed. We find them emerging from their ruins in the reign of the Emperor Titus, in the fifth year of whose reign they suffered so much. They yet subsisted in the reign of Hadrian, under the Antonines, and are mentioned as inhabited cities in the chart of Peutinger, which is of the date of Constantine. The eruption of A. D 471 was probably the most frightful on record; and if we may believe Marcellinus, the ashes of the volcano were vomited over a great portion of Europe, reaching to Constantinople, where a festival was instituted in commemoration of the strange phenomenon. After this, we hear no more of the cities, but the portion of the inhabitants who escaped built or occupied suburbs at Nola in Campania and at Naples. In the latter city, the *Regio Herculanensium*, or *Quarter of the Herculaneans*, an inscription marked on several lapidary monuments, indicates the part devoted to the population driven from the doomed city.

From Pliny we learn that the papyrus plant grew in the marshes of Egypt or in the sluggish waters of the river Nile in pools which did not exceed 3½ feet in depth, forming a gracefully tapering stalk, triangular in cross-section and not over 16 feet (10 cubits) in hight.

The paper made from papyrus was of nine different qualities, varying in size, color, and texture. It was made "by splitting the successive folds of the stalk with a needle into very thin leaves, due care being taken that they should be as broad as possible. That of the first quality is taken from the center of the plant, and so on in regular succession, according to the order of division."

Each quality was known by a different name, as "Augusta," "Liviana," "Hieratica," etc., the latter from the fact that it was reserved for religious books. The "tamotic" and "emporatica" were sold by weight, and used by dealers for wrapping, while the bark was used for making cordage.

All these various kinds were made upon a table moistened with Nile water; a liquid which, when in a muddy state, was supposed to have some of the properties of glue. There is little doubt, however, that this adhesive property was inherent in the plant itself, and in some instances we know that paste was employed. The table being first inclined, the flakes of papyrus were laid upon it lengthwise to such length as the papyrus would admit of, the jagged edges being cut off at either end; after which a cross-layer was placed over it. When this was done, the leaves were pressed close together and then dried in the sun, after which they were united to one another, the best sheets being always taken first, and the inferior added afterward. There were never more than twenty of these sheets to a roll. The width varied according to quality from thirteen to six fingers' breadth.

In making, the leaves were beaten and thinned out with a mallet, and the leaves united by paste. Roughness was subsequently smoothed down with a burnishing tooth or shell, which polished the surface. We may remark that modern microscopical investigation has demonstrated the fact that three instead of two layers of the liber were usually if not universally employed.

As a material for writing upon, the Mexicans used cotton cloth or skins nicely prepared, or a composition of silk and gum, but principally a fabric prepared from the aloe, *Agave americana*, called by the natives *maguey*, which grows freely over the table-land of Mexico. The paper somewhat resembles the Egyptian *papyrus*, and is polished to resemble parchment. It took color and ink excellently, and many specimens remain. It was sometimes rolled up in scrolls; at other times was made up in packs of leaves, with a tablet of wood for the outsides. The leaves were separate.

A species of incombustible paper was made from asbestus in the time of Pliny.

To give an idea of the bulky nature of papyrus manuscripts it may be mentioned that Ovid's Metamorphoses occupied fifteen rolls.

The abundance of papyrus in Egypt, the chief source of its production, the magnificence of the kings of that country, and the concourse of learned men who resorted thither, caused it to become the seat of those immense libraries which we read of as having perished in the flames during the siege of Alexandria by Julius Cæsar, B. C. 47, under Theodosius about A. D. 388, and finally under Omar the Saracen about A. D. 639. During this interval, however, the Alexandrian library had been increased by the addition of that of Eumenes, king of Pergamos, which had been presented by Marc Antony to Cleopatra. The volumes composing this latter were written largely on parchment, and, according to the old story, this material was invented or discovered by Eumenes, about 200 B. C., in consequence of a prohibition laid on the exportation of papyrus from Egypt, due to the fact that one of the Ptolemies wished to have no rivals in the matter of libraries, and proposed by this means to prevent Eumenes from proceeding with his proposed collection. The latter, however, it appears, was not to be thus deterred from his favorite project, and contrived a method of preparing skins of animals which fully answered his intended purpose.

As skins for records had been known for so many ages, among the Hebrews for instance, we may fairly presume that the invention of Eumenes merely related to a peculiar mode of dressing. It may be conjectured, perhaps, that previous to the time of this king writing upon skins had been done with paint, and not with ink. Paint consists of a pigment ground in oil, and ink is a dye dissolved in water. The former does not flow freely, and cannot well be used with a pen, but requires an implement of the brush kind for its proper application. Neither, however, can well be applied to skins which still retain a large portion of their fatty matters; an ink can hardly be used at all for forming legible characters on skins in this condition, though a paint, to a certain extent, may.

Parchment, in addition to having been selected and reduced to a regular thickness, has been specially treated with detergents, and a proper surface raised by pumice-stone, so that it is adapted to receive and retain ink. Papyrus being the ordinary material for writing, and being eminently calculated to receive the aqueous colored solution called ink, it was the object of Eumenes to render the skins of animals suitable for the reception of such a fluid, and avoid the necessity of going back to the use of paints. The name of Crates of Mallos is honorably associated with that of Eumenes in the enterprise, if not the invention.

All public documents under Charlemagne were written on parchment except by the Popes, who used papyrus till the twelfth century. Papyrus continued to be used for epistolary correspondence till the introduction of paper by the Saracens.

The bull of Pope Agapetus, dated 951, was written on papyrus, and perished in the burning by the French communists of the library of the Louvre, May 24 – 25, 1871.

Many ages must have passed in Egypt before the ingenious mode of obtaining paper from papyrus was devised. At this distant period we may assume that Pliny's remarks were true of the Nile land, as in that writer's own age they were true of Asia and parts of Europe.

"At first men wrote upon leaves and afterward upon the bark or rind of trees." Reference has already been made to the terms *volumen* and *liber*, and the origin of another set of words is no less apparent. The modern word *page* is from the Latin word *paginæ*, flat leaves; and the word *leaves* is also applied, being the translated form of *paginæ*, as *page* is the derived word. *Folio* is also from *folium* (Latin), a leaf, indicating the material so commonly used. Writing on palm-leaves was practiced among all peoples where that tree flourished; the Singhalese and other East-Indian nations retain it to the present day. Oblong pieces of the green leaf are trimmed uniformly, so as to be strung together to form a book, — a shaky and insecure binding, but one quite common in museums. The writing is scratched through the external cellular matter of the leaf, which shrinks away from the incision, into which a black pigment is sometimes rubbed.

Many other materials have been used by savage and semi-civilized nations for records more or less enduring. Under the article PEN may be found some references to pictured and inscribed rocks, to writings on tablets, skins, stones, slabs of clay, bones, shells, linen, metallic plates, and ivory. See PEN.

Close at home we have an excellent substitute in an emergency, birch-bark, used by the northern tribes of Indians. In Polynesia and Oceanica, as well as in China and Japan, the *Morus papyrifera*, or paper-mulberry, yields an inner bark which is of great value. In Java and Sumatra it is the ordinary material for writing upon. Its use as a garment is perhaps most extensive among the Feejees.

Among these ingenious cannibals the *tappa* cloth, as it is termed, is made by removing the bark from the tree in strips six feet long and three inches wide. These are soaked and then beaten on a table with flat grooved mallets, until the strip is extended into a sheet as wide as it is long. This is then flattened with a smooth mallet, and pieces may be united by beating their edges together.

In the due course of the ages, papyrus and parchment having rendered an elastic pen (*calamus*, a reed) and a fluid ink the most convenient materials for writing, we find they long maintained an almost uninterrupted sway, the variations being in the use of waxed tablets, leaden plates, and waxed linen, as explained under PEN.

The great change occurred when *true paper* was made of *rags or other vegetable fiber, reduced to a pulp, gathered into a sheet, felted in setting, and dried.*

Human invention had, in this case, been anticipated by the wasp, which insect may be considered as a professional paper-maker, devoting a large portion of her time and energies to the production of this fabric, of which she builds her nest. For this purpose she seeks dry wood,—fence-rails and weather-beaten boards are a favorite source of supply, — which she saws or rasps by mastication, mixes with a natural size exuded for the purpose, works into a paste, and spreads into sheets in a manner truly marvelous. Any one who has pelted hornets' nests with stones from a safe distance, or given them a passing blow with a stick as they hang from a limb in the orchard, will be led to admire the strength which a pulp of chewed wood and albumen may be capable of exhibiting.

The structure is generally a prolonged irregular spheroid, wonderfully light, and is bound by repeated layers and bands of paper to the bough from which it is suspended. The material resists rain, partly from the shape, the roof being rounded; partly from the fact that the successive layers overlap, or, in other words, that the dome is *shingled;* and partly, we presume, from its being rendered semi-waterproof by the size in its composition.

The mode of procedure is interesting. Having finished the ceiling, the hornet begins to build the first terrace of her city. The females and neuters do most of the work among all insects of this class. The charges and distractions of maternity are, however, in most cases removed from the workers whose gender is suppressed, though the mother hornet, unlike the queen bee, is eminently industrious. To resume: the upper terrace of cells in the interior of the structure is of a general circular shape, and is suspended from the ceiling of the dome by a stalk and stays of the same material which composes the body of the nest. The cells in the terrace are hexagonal in form, and have their mouths downward. These are not appropriated to honey, as the insects do not lay up provisions, but they are devoted to the rearing of the young. A set of cells being completed and eggs laid therein, the work is intermitted, and the mother's time devoted to supplying food for the grubs, which soon require her care. When, in a few weeks, they are able to go abroad themselves, they help extend the quarters, and a new terrace is constructed, supported by stems from that above. The community of paper-makers may amount to 30,000 in a single season, according to Reaumur.

The Chinese, at the time of Kung-fu-tze (about 600 B. C.), wrote with a style upon the liber of trees, as their records state. Paper was used, perhaps invented, in that country in the reign of Wan-te, 179 –

156 B. C. That made previous to the Christian era is supposed to have been of silk. Engrossing on cloth and silken stuffs had been practiced for many centuries previously. The Chinese silk paper is stated by Martini to have been invented in China about 120 B. C., and to have found its way into Persia and Arabia about A. D. 620.

The bark-paper of China is made in the following manner: The small branches of a species of tree resembling the mulberry (*Broussonesia*) are boiled in lye to loosen the bark; this is then macerated in water for several days, the outer part scraped off, and the inner part boiled and agitated in lye until it separates into fibers. It is then washed in a pan or sieve and worked by the hands into a pulp, which is afterward spread on a table and beaten fine with a mallet. The pulp is next placed in a tub containing an infusion of rice and a root called *oreni*, and thoroughly stirred to mix the materials. The sheets are formed by dipping a mold, made of strips of bulrushes confined in a frame, into the vat containing the pulp, and are, after molding, laid one on another with strips of reed between. A board and weights are laid on the pile to express the water, and they are then separated and dried in the sun. This paper is so delicate as to bear writing on one side only. When it is desired to write on two sides a couple of sheets are pasted together back to back.

The Chinese paper of bamboo fiber is likewise very ancient, and is made by pulping and gathering the pulp in films.

The Chinese *rice-paper*, so called, is prepared from the inner portion of the stems of a hardy leguminous plant that grows plentifully about the lakes near Calcutta and also in the island of Formosa, whence the Chinese import it in large quantities. The stems of the plant being cut into the proper lengths for the sheets, the pith is cut spirally into a thin slice, then flattened, pressed, and dried. It thus resembles very closely the papyrus in the mode of manufacture.

It is said that in Japan, previous to the year A. D. 280, silken stuff, with a facing of linen, was used for writing upon. Subsequently paper was imported from the Corea, and about 610 A. D. the *Broussonesia papyrifera* (paper mulberry) was introduced, from which the greater part of the paper now used in that country is made.

This is manufactured by boiling the stalks of the plant, causing the bark to separate. The outer portion of this is converted into paper of an inferior quality, while the inner skin is treated by farther boiling, washed, and pounded by beating with clubs on a wooden table. The pulp thus formed is made into balls, from which portions are broken off as required and mixed with a paste made from the root of the *troro*, a sort of shrub. The mixture, thoroughly incorporated and of proper consistency, is poured into a mold consisting of an inner and outer frame, the former having a false bottom. The sheet thus formed is turned out of the mold and dried on boards. The whole process and its manipulations bear a striking analogy to those employed in making hand-laid paper in the European way, as will be subsequently described. The process differs in some respects from the Chinese plan described above.

The conquests of the Saracens cut off the supply of papyrus to Europe, and that energetic people made amends by introducing true paper.

They are supposed, by their conquests in Bucharia about the year 704, to have acquired the art of making cotton paper, and substituted it for the silk of the far East and the papyrus of the South. In the eighth century the Saracens conquered Spain, and through that peninsula the art of making paper reached the rest of Europe. In the same century, the art is said to have been introduced into Constantinople from the East. Paper was made by the Saracens in Spain from flax, and afterward from cotton. Some time previous to this, however, a cotton paper, made in Damascus and designated as *Charta damascena*, had been known in Europe.

An Arabian author of the thirteenth century states that cotton paper was invented at Mecca by one Joseph Amru, about the year of the Hegira 88, that is, A. D. 706. Another Arabian authority states that a paper manufactory was found at Samarcand, in Bucharia, when the Arabs conquered that country in the year of the Hegira 85.

The oldest manuscript written on cotton paper in England is in the Bodleian collection of the British Museum, and bears date 1049. The most ancient manuscript on the same material in the Library of Paris is dated 1050. In 1085 A. D., the Christian successors of the Spanish Saracens made paper of rags instead of raw cotton, which is recognized by its yellowness and brittleness. A very early specimen of *linen* paper is found in a manuscript bearing the date of 1100 A. D.; though some twelve years afterward we find Roger, king of Sicily, granting a charter to some paper-makers who were then established on that island. The paper made by them was, however, probably of cotton, which was then extensively grown in Sicily.

In 1151, we learn from an Arabian author that paper of a superior quality was manufactured at Xativa, in Spain, the Christian Spaniards having improved upon the processes of the Moors, from whom they learned the art, by stamping the raw material, raw cotton and rags, by the aid of a water-mill.

In 1170, Eustathius, the commentator on Homer, remarks that papyrus had fallen into disuse.

In 1178, we find several specimens of flax paper in Spain, and in the University of Riteln in Germany a document is preserved, signed by Adolphus, Count of Schaumberg, made from linen rags. A letter from Joinville to Louis X. of France, dated 1315, and written on paper made from rags, is yet extant. After this period the notices of paper and of paper-making become frequent.

Linen paper is found in documents of 1241 (edict of Emperor Fred. II.) and 1300. The Arabian physician Abdollatiph, who visited Egypt in 1200, says that the mummy-cloths (*linen*) were habitually used to make wrapping-paper for the shop-keepers. The linen paper of the thirteenth century had the water-lines and water-mark. One specimen had a tower.

The earliest manuscript on linen paper known to be English bears date fourteenth year of Edward III., 1320. The first water-mark, a ram's head, is found in a book of accounts belonging to an official of Bordeaux, which was then subject to England, dated 1330. It has been claimed that linen paper was made in England as early as 1330, though it is supposed that no linen paper was made in Italy previous to 1367.

In 1390, Ulman Strother established a paper-mill at Nuremberg in Bavaria, operated by two rollers, which set in motion eighteen stampers. This indicates the process of pulping the fiber by beating, which continued in use for nearly four centuries. This was the first paper-mill known to have been established in Germany, and is said to have been the first in Europe for manufacturing paper from linen rags.

In 1498, an entry appears among the privy expenses of Henry VII. for "a reward given to the paper-mill," 16*s.* 8*d.* This is probably the paper-mill mentioned by Wynkin de Worde, the father of English typography. It was located at Hartford, and the water-mark he employed was a star within a double circle. The jug or pot was a favorite water-mark about the middle of the fifteenth century, preceding the fool's cap, which has given its name to the largest size of writing-paper now in common use. About 1540, it appears that Henry VIII. of England, to show his animosity to the Pope, with whom he had then quarreled, used for his private correspondence a paper of which the water-mark was a hog with a miter.

The barbarous law of England imposing a duty on paper appears to have had a precedent in France under Charles IX., the author of the St. Bartholomew massacre, who, in 1565, levied an impost on that article, which was soon abolished at the instigation of the University of Paris.

It appears that wall-paper, as a substitute for tapestry or hangings, began to come into vogue about the year 1640.

It does not appear that the paper manufacture flourished in England until after the revolution of 1688, as we find that in 1663 England imported from Holland alone paper to the amount of £100,000.

This hardly preceded the establishment of paper manufactories in America, as we find that William Rittinghüysen, anglicized Rittenhouse, — a name afterward memorable in the history of American science, — a native of Holland, in conjunction with old William Bradford, one of the earliest of American printers, who will be doubtless remembered by those who have read Franklin's Autobiography, established a paper-mill at Roxborough, near Philadelphia, on a stream still called Paper-mill Run, a tributary of the Wissahickon. The raw material for its supply was derived from linen rags, the produce of the old clothes of the vicinity, and native rags long continued to be the chief source from which American paper was derived. In 1710 another paper-mill — the second in America — was erected at Crefeld, now forming part of Germantown, by William De Wees, a connection of the Rittenhouse family. In 1724, William Bradford endeavored to induce the New York legislative council to grant him a monopoly for the exclusive manufacture of paper for fifteen years, but was unsuccessful.

Reaumur in 1719 suggested, from the examination of wasps' nests, that a paper might be manufactured from wood, but we do not find this idea farther acted upon until a later period, when inventors seem to have exhausted their ingenuity, regardless of expense, in the selection of materials from which paper might be manufactured.

Paper, in fact, cannot, as a general thing, be economically made from fibrous material which has not already previously been manufactured. That is to say, so long as the prices of vegetable fibrous substances, as cotton, flax, etc., remain the same, it will be much more economical to use them for the purpose of reducing into pulp for paper-making after they have already undergone the process of manufacture into clothing, than to take them in their raw state, when they may still be subservient to the economic physical wants of man.

Since Reaumur first suggested wood as a substance from which paper could be made, the articles proposed for that purpose have been almost innumerable; in fact, anything having a fibrous texture *may* be used, and the question resolves itself into one of economy. See PULP-BOILER.

Koops in 1800 published a work on paper, which was printed on paper made of straw, with an appendix on paper made of wood. A second edition was published in 1801, upon paper re-made from old printed and written paper. In 1835, Piette published a work on the subject of "Paper from Straw," etc., giving 160 specimens.

In 1765, Schaeffer, of Ratisbon, printed a book on sixty varieties of paper made from as many different materials; a copy is now in the Smithsonian Institute Library.

In 1786, the Marquis de Vilette published in London a small book, printed on paper made from marsh mallow; at the end are leaves of paper manufactured at Bruges from twenty different plants, such as nettles, hops, reeds, etc.

The following is a list of materials (numbering in all 402) from which paper has been made or proposed to be made, with references to the authorities from which the information has been derived.

PAPER-MAKING MATERIALS.

The following materials, among others, have been used or suggested for paper-making. The authorities are cited as follows: —

a refers to English patents.
b refers to Examiner's Digest, Patent Office.
c refers to Munsell on Paper-making.
d refers to Schaeffer on Paper.
e refers to "Central Blatt," "Papierfabrikation," Dresden.
f refers to "Journal des Fabricants de Papier," Paris.
g refers to "Die Fabrication des Papieres," Piette, Cöln.

Abelmoschus esculentus, *e*, xiv. 17.
Abutilon avicennæ, *b*.
Acacia, *a*; *f*, xii. 97, xiv. 354, xvi. 117.
Agave, *a*; *d*.
Alfa fiber, *c*.
Alga marina, *b*.
Algæ (fresh-water), *b*.
Aloe fiber, *d*.
Aloes, *a*; *d*: *e*, i. 107, iii. 520, vi 210, x 119, xiii. 117, 126, xiv 17, xvii. 111; *g*, ii. 114; *f*, xiv 354.
Alsimastrum, *a*.
Althea, *e*, xiii. 117.
Ammonum, *a*.
Anacharsis, *a*.
Ananas (see PINEAPPLE).
Animal excrement, *a*.
Animal substances, *c*.
Anonaceæ, *a*.
Apociueæ, *a*.
Aporentype, *c*.
Arrocbe, *c*.
Artemisia bark, *d*.
Artemisia wood, *d*.
Artichoke, *a*.
Artiplex, *d*.
Artocarpeæ, *a*.
Arundinaria macrosperma, *b*; *c*.
Asbestus, *a*; *b*; *d*; *g*, ii. 149; *f*, viii. 296. See also page 167, supra.
Asclepiadiæ, *a*.
Asclepias, *d*; *f*, xi. 29.
Asparagus, *a*.
Aspen, *c*; *d*; *e*, vii. 81, xvi. 184.
Asphodel, *a*.
Bagasse, *a*.
Bagging, *c*.
Bamboo, *a*; *b*; *e*, xiv. 17, xvi. 71; *f*, xv. 187.
Banana, *a*; *e*, i. 107, iii. 520, vi. 210, xvii. 171.
Bark of wood (various), *e*, v. 557; *g*, 31. 32, 33.
Barks of resinous woods, *b*.
Barley straw, *c*.
Basswood, *c*.
Bean leaves, *d*.
Bean vines, *a*; *e*, xiii. 117.
Beans, *b*.
Beechwood, *d*.
Beet, *a*; *e*, iii 519, ix. 181, 186.
Beet and mangold-wurzel root, *b*.
Begonaceæ, *a*.
Berries, *a*.
Birch, *a*; *e*, xiii. 184, xviii. 9.
Blackberries, *a*.
Blue cabbage stalks, *d*.
Blue grass, *c*.
Boehmeria, *a*; *e*, xiii. 126.
Bombax, *a*.
Bracken, *c*.
Bran, *a*; *c*.
Brazil wood, *d*.
Brazilian grass, *c*.
Brewery refuse, *a*.
Bromeliaceæ, *a*; *e*, v. 142, vi. 210, xvii. 171.
Broom, *a*; *e*, v. 94, vi. 210, xiii. 117, xv. 113.
Broom corn, *b*.
Broom, swamp, *b*.
Broussonesia, *a*; *e*, vi. 234, xvii 171.
Bryona, *a*.
Buckwheat, *a*.
Bulrushes, *a*.
Burdock, *a*; *d*.
Cabbage, *b*
Cabbage stumps, *c*.
Cactus, *a*.
Canes, *a*; *b*.
Cardanus metans, *c*.
Cat-tail down and leaves, *d*.
Cecrops draceua, *a*.
Cedar wood, *b*.
Cenodruli, *a*.
Chaff, *f*, iii. 137, 148, 164, 184, iv. 3, 21, 33, 51, 66, 82, 164, v. 28, 117, 132, 189, 204, 221, vi. 87, 106, ix. 67, xii. 121.
China grass (*Rhea*), *e*, v. 142, vi. 222, xiii. 126, xvii. 171, xix 134; *f*, x. 359, xiv. 354, xvi 117.
Cissus family, *a*.
Clematis bark, *d*.
Clematis wood, *d*.
Clematite, *c*.
Clover, *a*.
Coir, *e*, xiii. 126, xiv. 17.
Coltsfoot, *c*.
Compositeæ, *a*.
Conferva, *c*; *d*.
Coniferæ leaves, *a*.
Convolvulaceæ, *a*.
Coral moss, *d*.
Cordage, *a*.
Cork, *a*; *e*, xvii. 54.
Corn cobs, *b*; *c*.
Corn husks, *a*; *d*.
Corn leaves, *c*.
Corn stalks, *b*; *c*.
Coton du peuplier, *c*.
Cotton, *a*.
Cotton plant, *b*.
Cotton seed, *b*.
Cotton stalks, *b*.
Couchgrass, *a*.
Cruciferæ, *a*.
Cryptogams, *a*.
Cucumbers, *a*.
Cucurbitaceæ, *a*.
Cupheæ, *a*.
Cyprian asbestus, *d*.
Daphne, *e*, iv. 673, vi 210, 247, xiv. 17, xvii. 171, xviii. 5.
Decayed wood, *c*.
Diss, *g*, ii. 115.
Dog's grass, *a*.
Dunbee (*Sesbanea aculeata*, *e*, xiii. 126.
Dury, *e*, i. 248.
Dust, *a*.
Dwarf palm, *c*; *e*, xi. 210, xvii. 171.
Dyewoods (spent), *a*.
Earth moss, *d*.
Ejoo, *e*, xiv. 17; *f*, xii. 19, 146.
Elder, *a*.
Elm, *c*.
Ericaceæ rushes, *a*.
Erigerone, *c*.

Erytoxylon guttaferæ, *a*.
Esparte, *c*.
Espartero, *c*.
Esparto grass, *b*; *c*; *e*, xiv. 19, xv. 69, 108, 121, 138; *f*, vi. 132, 150, 166, 186, vii. 5, 21, xiv. 178, 295; *g*, ii. 24, 116, xvi. 187.
Euphorbiaceæ, *a*.
Excrement of herb-eating animals, *a*; *b*; *f*, iii. 59, viii. 54.
Fenequen (Sisul hemp, Sosquil), *e*, vi. 247, xvii. 171.
Feros, *a*; *f*, iii. 100, xiii. 117; *g*, ii. 80, 81, 84.
Fibrilia, *e*, xiii. 117.
Fir, *c*.
Flags, *a*
Flax, *a*; *e*, vi. 236, xiii. 117, xiv. 17; *f*, xiv. 354, xvi. 17, 119.
Flax, New Zealand. xiii. 126, xvi. 17, 282, xvii. 171.
Flax, hemp, etc., *b*.
Floss silk, *c*.
Fourdrini, *a*.
Frog spittle, *c*.
Furze, *a*.
Galeg officinalis, *b*.
Galega orientalis, *b*.
Galingale, *a*.
Genista, *a*; *d*.
Genista after extracting dye, *d*.
Geld (*Marsdenia tenacissima*), *e*, xiii. 126.
Gnaphalium, *c*.
Gramina, *a*.
Gramineæ, *a*.
Grape-vine, inner and outer bark, *d*.
Grape-vines, *c*, xiii. 117.
Grasses, *a*; *e*, xiii. 117; *f*, vii. 117
Grass, Spanish, *b*.
Grass, Tule, *b*.
Gutta-percha, *a*.
Gunny, *e*, xvii. 4.
Gun cotton, *f*, iv. 90.
Hair, *a*.
Hay, *a*; *g*, ii. 4.
Heather, *a*; *e*, xiii. 117.
Hemp, *a*; *d*; *e*, vi. 222, xiii. 119, xvii 171; *f*, xiv. 354, xvi. 17, 119.
Hemp, flax, etc., *b*.
Hemp, jute, dressed, *b*.
Hibiscus esculentus, *b*; *c*; *e*, vi. 249, 283, viii. 126, xiv. 19, xvii. 171.
Hides, *c*.
Hollyhock, *c*.
Hop bark, *d*.
Hop vines, *a*; *d*; *e*, vii. 77, xiii. 117, xvii. 171.
Hornet's nest, *c*.
Horse-chestnut leaves, *d*.
Horse-dung, *a*.
Horse-radish, *a*.
Immortelle (cudweed, *Gnaphalium*), *e*, vi. 248.
Indian-corn husks, *d*.
Iris, *a*.
Ivory shavings, *b*; *c*.
Indigo, *e*. xiii 117.
Jucca (*Yucca*), *e*, xiii. 126.
Juncaceæ, *a*.
Juniper, *a*.
Jute, *a*; *e*, vi. 234, xiv. 17, xvii. 171; *f*, xiv. 17, 354; *g*, ii. 129.
Kaolin, *f*, i. 4, 12, v. 14, 84, 190, vi. 21, ix. 54.
Libitaæ, *a*.
Lace from aloe fiber, *d*
Leather, *b*; *e*, ii. 302; *f*, i. 133, 136.
Leather cuttings, *a*
Leaves, *c*; *e*, vi 319; *f*, i. 165; *g*, ii. 64.
Leaves of trees, *b*.
Leaves of trees, withered, *c*.
Lecistera formosa, *a*.
Leguminous plants, *a*.
Lentils, *e*, v. 160.
Liliaceæ, *a*.
Lily of the valley, *c*.
Lily of the valley leaves, *d*.
Lily root, *a*.
Lime, *c*.
Linden, *c*; *e*, xviii 9.
Linden leaves, *d*.
Linen, *a*.
Liquorice wood, *c*.
Liquorice root, *e*, ix. 173.
Long moss, *e*, vi 249.
Lucerne, *a*; *f*, xi. 361, 430.
Lucipodium equisetum, *a*.
Lychnophora, *a*
Madder, *a*.
Maize, *a*; *e*, ix. 184, x. 358, xi. 10, xiii. 117, xiv. 33, xv. 31, 49, xvii. 171.
Maize husks, *b*.
Mallow, *d*; *e*, xiii. 117.
Malpighiaceæ, *a*.
Malva, *a*.
Malvaceæ, *a*.
Mandioca, *a*.
Mangel-wurzel, *a*.
Manila, *a*; *b*.
Manispernum, *a*.
Manure, *c*.
Maple, *a*.
Marzi, *a*.
Masse-d'eau, *c*.
Medichey, *a*.
Melastomaceæ, *a*.
Mineral fiber, *b*.
Moorva, *e*, xiii. 126.
Morus bark, *a*.
Mosses, *a*; *d*; *e*, xvii. 171.
Mothwort, *c*.
Mudar (*Calotropis gigantea*), *e*, xiii. 126, xviii. 5.
Mulberry, *a*; *e*, vi. 234, xiii. 117; *f*, xii 97, 167.
Mulberry inner bark, *d*.
Mulberry-trees, *b*; *f*, viii. 262.
Mulberry wood, *d*.
Mummy cloth, *c*.
Musaceæ, *a*; *e*, vi. 247, xiii. 126, xvii 171.
Muscovy mats, *c*.
Mustard, *a*.
Mya grass, *a*.
Myrtaceæ, *a*.
Nettle bark, *d*.
Nettle wood, *d*.
Nettles, *a*; *e*, vi. 210, 234, xiii. 117; *g*, ii. 21.
Oak, *c*.
Oakum, *c*.
Okra (*Hibiscus esculentus*), *b*.
Orache, *d*.
Osier, *a*.
Onocarpus, batava, *e*, xiv. 17.
Palm, dwarf, *c*.
Palm leaves, *a*.
Palm, palmetto, etc., *b*; *e*, xiii 117, xiv. 17; *f*, xiv. 296; *g*, ii. 113
Palmetto and chamœrops (palmetto cabbage), *b*.
Palygaleæ, *a*.
Pampas grass, *a*.
Panax, *a*.
Pandanus, *a*.
Pappus, *c*.
Papyrus, *a*; *f*. xv. 162.
Pasteboard scraps, *c*.
Peas, *b*.
Pea stalks, *a*; *e*, xiii 117.
Peat, *a*; *b*; *d*
Pederia fœtida, *e*, xiii. 126.
Phormium, *a*.
Phorminum terrax, *a*
Pine cones, *d*, *e*, xiv. 7, xvii 171.
Pine shavings, *c*.
Pine-tree, inner bark of, *b*.
Pineapple leaves, *a*; *e*, xiii. 117, 126.
Pisang, *e*, xvii. 171; *g*, ii. 125.
Pita, *e*, v. 142, vi 210, xiv. 17, xvii. 171.
Plane-tree (buttonwood), *e*, vi. 247
Plantain, *c*; *e*, vi. 210, 222, viii. 142, xvii 171.
Plantain cocoa, *a*.
Plantain-tree (*Musa sapientum* and *paradisiaca*), *b*.
Pollen of plants, *c*.
Poplar, *a*; *e*, xviii. 9.
Poplar down, *d*.
Poppy, *g*, ii. 36.
Potatoes, *d*, ix. 126, 173, 182, xiii. 117.
Potato skins, *b*; *d*.
Potato-vines, *b*.
Pourretia plantanifolia, *b*.
Printed waste, *c*.
Pteris (brake), *e*, ii. 52, 68, 84, 115, iii. 6, 54.
Pulps, *a*.
Pulungor, *e*, xiii. 126.
Rags, *a*.
Ramie, *e*, viii., vi. 210.
Raspberry, *a*.
Reed, *d*.
Reeds, *a*.
Rhamneæ, *a*.
Rhubarb, *a*.
Rice plant (*Oryza*), *b*
Rice, stalks of the wild, *b*.
Rice straw, *a*.
Ricinus, *a*.
Roots, *a*.
Roots of grasses, *f*, i. 182, ii. 5, 19, 33.
Rope, *a*.
Rosaceæ, *a*.
Rose mallow (*Hibiscus*), *a*.
Rubiaceæ, *a*
Rue, *c*, xiii 117
Rushes, *a*; *e*, xiii. 117, xiv. 17, xvii. 171; *f*, xv. 289.
Rutaceæ, *a*.
Rye grass, *a*.
Sacks, old, *c*.
Sago, *b*.
Satin, *c*.
Sawdust, *a*; *b*; *d*.
Scotch ferns, *c*.
Sea mallow, *a*.
Sea grass, *e*, vi. 210, xvii. 171.
Sea weed, *a*; *b*.
Secrate, *a*.
Sedge (anticle), *b*; *e*, vi 210.
Seed down of thistles, *d*.
Seratula ervansis, *c*.
Shavings, *d*.
Shavings, wood, *b*.
Shingles, old, *d*.
Sida, *a*; *e*, xiii 126.
Silk, *a*; *g*, ii. 135
Silk plant (*Asclepias*), *d*.
Skins, pieces of, *b*.
Solaneæ, *a*.
Solonaceæ, *a*.
Sorghum, *a*; *b*; *f*, xi. 436.
Sparganium family, *a*
Spartium (Spanish broom), *a*; *e*, iii 594, x 199, xvii. 171.
Spartina juncea, *b*
Spartina cynosuroides (cord grass), *b*.
Spindle-tree, *c*.
Spruce fire-wood, *d*
Sterculia urens, *e*, xvi. 17.
Stinging nettle, *d*.
Stipa tenacissima, *a*.
Stone, *c*.
Stramonium or stinkweed, *b*.
Straw, *a*; *b*; *e*, xiii. 117; *f*, xi. 6, 20, 45, 325, 411, xii 19, 43, xiii. 341, 364, xv. 1, 187; *e*, iii 449, 519, 557, 593, v 13, 63, 109, 126, vi 211, 319, ix 184, x 93, 202, xi. 38, xvi. 13, 127, xvii. 38, xx. 1; *f*, v 51, 144, xv. 152.
Straw, barley, *d*.
Straw paper. Books printed on Koops's "Historical Account," 1800.
Stypa spartum, *a*.
Sugar-cane, *a*; *e*, xiii. 117; *g*, ii. 113.
Sultana bark, *c*.
Sunflower, *a*; *e*, xvi. 13
Sunn, *e*, xiii. 126.
Sweet broom, *e*, xiii. 117.
Tan, *e*.
Tan bark, etc., *b*; *e*, iii 519, vi. 124, 287. x. 252; *g*, ii. 89.
Tan (spent), *a*.
Tarred rope, *f*. x. 6, xi. 292.
Terebinthenaceæ, *a*.
Thistle down, *d*.
Thistle stalks, *d*.
Thistles, *a*; *e*, xiii. 117; *f*, ii. 123; *g*, ii. 24.
Tillandsia, *a*.
Tobacco, *a*; *e*, xi. 126.
Tow, *c*; *d*; *e*, iii. 519, vii. 121, x. 17, 119. 353.
Tracena endivisa, *b*.
Tree moss, *d*.
Traphis, *e*, xviii 4.
Tulip leaves, *d*.
Turf, *a*; *d*; *e*, iv. 671, vi. 210, 219, xi 147, xxii. 171; *g*, ii. 150.
Turnips, *a*
Twitch grass, *a*.
Typha, *d*; *e*, xvii 170.
Typha lutefolia, *b*.
Ulmus, *a*.
Ulva marina, *c*.
Urticeæ, *a*; *e*, xiii. 126, xiv. 17.
Usnea, *d*.
Vareck, *e*, xvii. 171; *f*, xi. 427.
Vellozieæ, *a*.
Vines, grape, *d*.
Vines, hop, *d*.
Walnut leaves, *d*.
Wasps' nests, *d*.
Water broom, *c*.
Water lilies, *a*.
Water moss, *d*.
Water plants, *a*; *e*, iii 519.
Water weeds, *a*.
Wayfaring tree, *c*.
Weeds, *b*.
Wheat straw, *b*.
Whin, *a*
Whitewood, *c*.
Willow, *a*; *e*, xiii 117, xviii 9.
Willow, inner bark, *d*; *e*, v. 557; *g*, 31, 32, 33.
Willow twigs, *c*.
Willow wood, *d*.
Wood, etc., *a*; *b*; *e*, iii. 463, 519. v. 94, vi. 211, vii, viii. 241, 375, ix. 183, x. 148, xi. 78, 81, 161, 177; Supplement, 16; *f*, vi. 129, 197, vii 23, 129, 135, 137, ix. 241, xiii. 184, xiv. 65, 273, xv. 150, xvi 120; *g*, ii. 36.
Woolen, *a*; *g*, ii 134.
Woolen grass (*Typha*), *d*.
Wrack grass, *a*.
Yellow wood after extracting dye, *d*.
Yucca filamentosa, Yucca angustifolia, Agr. Dep't Museum, 1868, *e*, xiii. 126.
Zopissa, *e*, xvi 7, 68.

In the modern process of paper-making, the rags, linen or cotton as the case may be, are sorted by hand into various qualities, proper for different kinds of paper, the best and finest of course being selected for the stock from which the better qualities of writing-paper are to be made.

The sorting is done by women and children, who work at tables covered with wire-net. Each table has a stationary knife at its edge, against which the rags are drawn so as to divide them into shreds, the dust and dirt falling through the meshes into a receptacle below. The sorted rags are next washed with hot water and alkali, usually in a circular pan similar to the *bucking keir* employed in bleaching, and are afterward reduced to pulp by the rag-engine. It was formerly customary to allow them to ferment or rot by steeping them for several weeks in vats; but this practice, occasioning great loss and sometimes injuring the rags by discoloration, has caused the process to be superseded by the treatment of boiling in alkaline lye, by which a large saving is effected. The fermentation, however, materially assists in the process of disintegration, rendering the pulping comparatively easy. Pulping was formerly effected by beating in mortars of hard wood having an iron bottom provided with teeth, the pestles or hammers being grooved so as to cut the rags to pieces. The hammers were either so arranged as to rise and fall perpendicularly, like the stamps of an ore-crusher, or else were so disposed as to operate in the manner of a trip-hammer. The mortars were finally superseded by the rag-engine, which was invented in Holland about the middle of the seventeenth century, and which still maintains its place in the manufacture. Of these two are employed, sometimes arranged one above the other so that the stuff when partially pulped in the upper one may be let down into the lower. The two are alike in general construction, consisting of an oblong trough with semicircular ends. They are made of wood lined with lead, or may be entirely formed of cast-iron. The trough is divided by a longitudinal partition, on one side of which is journaled a revolving cylinder provided with teeth. This cylinder is capable of being raised or lowered, and works against a block fixed in the lower part of the trough, which is also provided with cutters corresponding to those of the cylinder.

The first or upper machine is termed the *washer*, as into it the rags, after being boiled in lye, as previously described, are introduced. A current of water is allowed to flow through the trough, and the roller, in its elevated position, is set in motion, which thoroughly washes and cleanses the rags. The roller is then lowered in its bearings and the speed of rotation increased, causing a constant current circularly around the trough, carrying the pulp between the roller and the block until it is reduced to what is technically known as *half-stuff*, which is then transferred to the second engine, known as the *beater*. During this part of the process the bleaching material is added. The beater or pulping-engine is precisely similar to the washer, but its roller and block are provided with a larger number of cutters, and it is driven at a higher speed. Size, and smalt for imparting a blue color to the paper, were formerly added at this stage of the process, but the latter practice has now fallen into disuse. It is a pity that the same cannot be said with regard to barytes and other substances employed to impart whiteness and factitious weight to the paper, so as to make a very inferior article appear good to the unpracticed eye.

The pulp in its finished condition is called *whole stuff*, and is run into a reservoir, whence it is taken out as wanted to supply the vats.

Formerly, all paper was made by hand, and it is believed that a better article can be produced in this way than machine made. However this may be, machine-made paper has carried the day, and is now, perhaps, the only kind made in this country, though in England and the Continent of Europe *hand-laid* writing-paper is still manufactured.

The process is as follows: The pulp, after having been sufficiently comminuted in the beater, is transferred to the vat whence it is to be molded into sheets of paper. The *mold* is a shallow rectangular frame, having a top composed of close parallel longitudinal wires, which are crossed at more distant intervals by transverse wires of larger size. The marks of these wires are very evident in examining old specimens of paper. The water-mark is also inwoven into the mold, so as to leave its impress in the pulp in a way which cannot afterwards be eradicated. To the mold is applied an open rectangular frame, called the *deckle*, the interior dimensions of which exactly correspond with those of the intended sheet of paper. It is held closely against the mold by the hands, and the two together are dipped into the vat containing the pulp and withdrawn horizontally, leaving a layer of pulp on the mold, to which a horizontal vibration is given while the water is draining off, in order to insure a uniform distribution of the pulp and consequent uniformity in the thickness of the paper. When sufficiently drained, the deckle is removed from the mold, and the sheet of paper, now partially solidified, is transferred to a sheet of felt and covered with another sheet of the same material, on which another sheet of felt is laid, and so on alternately until a pile, usually of six quires, has accumulated, when the whole is transferred to a press, in which they are kept until an equal amount has again accumulated, when the first are removed, the alternating sheets of felt withdrawn, and the paper itself without the intermediate felts is again subjected to pressure. It is then hung up to dry on racks overhead, two or three sheets deep, sized by dipping in a solution made from the clippings of leather and parchment, again dried and pressed, examined and sorted. The blueing previously referred to constituted a part of the sizing process. Smalt was formerly employed for this purpose, but was finally, to a great extent, superseded by ultramarine, which latter, however, had the disagreeable result of allowing the gelatine size to decompose, thus imparting a most offensive smell to the paper, as may be well recollected by those of our readers who may have been brought in contact with the blue writing-papers at one time so much in vogue.

In 1798, Robert announced that he had discovered a means of making by machinery paper of large size, even 12 feet wide and 50 feet long; and in the succeeding year the invention was carried into practical effect at the paper-mill of François Didot, at Essone, France, in whose employment Robert was at the time. The invention was patented in this year. In 1800, a reward of 8,000 francs was granted by the French government to Robert, and permission was granted him to carry his working model to England, where, in fact, the invention was first brought into practical working form.

Gamble, in 1801, obtained a patent for a machine similar to that of Robert, but the credit of introducing the machine into England is due to the Fourdriniers and Donkin, the former of whom furnished the capital and the latter the skill. Donkin completed his first machine, acting on the ideas of Robert, in 1803; and in the succeeding year, Henry and Sealy Fourdrinier purchased the patents of Didot and Gamble. These gentlemen may be considered as the great introducers of machine-made paper, and, like many other projectors, were rewarded by impoverishment.

The Fourdrinier machine (1) receives the pulp on an endless web of wire-cloth, which passes over rollers. The Dickenson machine (2) employs a perforated cylinder, which serves as a substitute for this endless web. See Plate XXXVII., PAPER-MAKING MACHINE, where several kinds of paper and cardboard machines are represented.

Two hundred and ninety-nine Fourdrinier machines were running in the United States in 1872.

In 1809, Mr. Dickenson, an English paper-maker, invented the cylinder machine, in which a polished hollow brass cylinder, perforated with holes and covered with wire-cloth, is substituted for the endless wire-web of the Fourdrinier machine. In this the air is exhausted through the trunnions or axis of the machine. (See Plate XXXVII.) In the year 1872, 689 cylinder machines were running in the United States.

The patents on the subject of paper-making are very numerous. Donkin, however, who devoted so much time and talent to the matter, undoubtedly is entitled to the first rank after Robert, who suggested the idea of making paper in a continuous web.

One great difficulty to be obviated was the wetness of the sheet of pulp, which, of course, impaired its tenacity, rendering the manipulations exceedingly difficult. This was, in a large degree, removed by the invention of the *dandy* by Wilkes, patented in England in 1830. This is a hollow perforated roller, corresponding to the *doffer* of a carding-machine, over which the paper is caused to pass and is pressed under another roller. The dandy may be so constructed as to exhaust the air from beneath the paper by forming it of an inner and exterior casing of sheet-metal, but in practice this has not been found necessary.

The introduction of threads, net, or other woven material into the paper is described in Dickenson's English patent, 1809.

In the machine-made papers the trouble of assorting, trimming, and hanging up to dry is entirely avoided, a perfectly uniform thickness is attained, the time required to produce a sheet from the pulp is reduced from weeks to minutes, and sheets of indefinite length may be produced; for example, a sheet was made at Colinton, England, in 1839, on the Fourdrinier machine, over a mile long, 50 inches wide, and weighing 533 pounds. This length might perhaps be extended indefinitely.

Dickenson, who has been already mentioned as the inventor of the cylinder paper-machine, invented a paper composed of two webs of different texture, which were united while in a pliant condition, so as to render them inseparable; the web constituting the face was made of finer material than that intended for the back. This paper was particularly designed for copperplate printing. To prevent counterfeiting special papers have been devised, such as that used by the Bank of England and by the United States Treasury Department. In these cases the difficulty of manufacturing a similar article is relied on to prevent fraud; complicated and expensive machinery, not within the reach of ordinary counterfeiters, being required. The paper on which United States currency is printed contains silk fiber mixed with the pulp, producing a peculiar appearance, which is readily recognized, and which would be difficult, if not impossible, to imitate without the aid of the peculiar machinery by which the paper is produced.

A paper has also been made with a knitted fabric inclosed, which leaves an unerasable mark on the back of the fabric, and prevents all erasures and alterations of writing on its surface.

Analine (*an*, priv., without *line*, i. e. flax) is a name applied to paper destitute of flax, and must not be confounded with *aniline*.

Sponge paper is made by adding finely divided sponge to ordinary paper pulp. The paper absorbs moisture readily and retains it for a long time. It has been used to advantage for dressing wounds, and is capable of several important technical applications.

Incombustible paper and cloth were made of asbestus in the time of Pliny. The pulp is prepared in the usual manner from a pulp consisting of vegetable fiber, asbestus, alum, and borax, in about the following proportions: Vegetable fiber, one part; asbestus, two parts; borax, one tenth part; and alum, two tenths of a part. The vegetable fibers are minutely divided, and treated in the manner usual in the production of ordinary paper; the asbestus is also divided as much as possible, and the two are then intimately mixed with the alum and borax in a sufficient quantity of water to make a pulp of the requisite consistency, which is then made into paper by any of the well-known processes.

The fire-proof ink for writing or printing on incombustible paper is made according to the following recipe: Graphite, finely ground, 22 drams; copal or other resinous gum, 12 grains; sulphate of iron, 2 drams; tincture of nutgalls, 2 drams; and sulphate of indigo, 8 drams. These substances are thoroughly mixed and boiled in water, and the ink thus obtained is said to be both fire-proof and insoluble in water. When any other color but black is desired, the graphite is replaced by an earthy mineral pigment of the desired color. Paper is rendered transparent by a varnish composed of Canada balsam dissolved in turpentine.

Carbolic-acid paper is now much used for packing fresh meats for the purpose of preserving them against spoiling. The paper is prepared by melting five parts of stearine at a gentle heat, and then stirring in thoroughly two parts of carbolic acid, after which five parts of melted paraffine are added. The whole is to be well stirred together till it cools, after which it is melted and applied with a brush to the paper, in quires, in the same way as in preparing the waxed paper so much used in Europe for wrapping various articles.

SIZES OF PAPERS.

	Sheet.	Folio.	4to.	8vo.	16mo.	32mo.
	Printing Papers.					
	Inches	Inches.	Inches	Inches.	Inches.	Inches.
Demy . .	22½×17½	17½×11¼	11¼× 8¾	8¾× 5½	5½× 4¾	4¾×2¾
Medium .	24 ×19	19 ×12	12 × 9½	9½× 6	6 × 4¾	4¾×3
Royal . .	25 ×20	20 ×12½	12½×10	10 × 6¼	6¼× 5	5 ×3⅛
Super-royal .	27½×20½	20½×13¾	13¾×10¼	10¼× 6¾	6¾× 5⅛	5⅛×3⅜
Imperial . .	30 ×22	22 ×15	15 ×11	11 × 7½	7½× 5½	5½×3¾
Double foolscap	27 ×17	17 ×13½	13½× 8½	8½× 6¾	6¾× 4¼	4¼×3⅜
Double crown .	30 ×20	20 ×15	15 ×10	10 × 7½	7½× 5	5 ×3¾
Double post .	32 ×20	20 ×16	16 ×10	10 × 8	8 × 5	5 ×4
	Drawing Papers.					
Emperor . .	72 ×48	48 ×36	36 ×24	24 ×18	18 ×12	12 ×9
Antiquarian .	53 ×31	31 ×26½	26½×15½	15½×13¼	13¼× 7¾	7¾×6½
Double elephant	40 ×26¾	26¾×20	20 ×13¼	13¼×10	10 × 6½	6½×5
Atlas . .	36 ×26	26 ×18	18 ×13	13 × 9	9 × 6½	6½×4½
Columbia .	34½×23½	23½×17¼	17¼×11¾	11¾× 8½	8½× 5¾	5¾×4¼
Imperial . .	30 ×22	22 ×15	15 ×11	11 × 7½	7½× 5½	5½×3¾
Elephant .	28 ×23	23 ×14	14 ×11½	11½× 7	7 × 5¾	5¾×3½
	Writing Papers.					
Super-royal	27 ×19	19 ×13½	13½×9½	9½×6¾	6¾×4¾	
Royal . .	24 ×19	19 ×12	12 ×9½	9½×6	6×4¾	
Medium . .	22 ×17½	17½×11	11 ×8¾	8¾×5½	5½×4⅜	
Demy . .	20 ×15½	15½×10	10 ×7¾	7¾×5	5×3¾	
Large post .	20¾×16½	16½×10¼	10¼×8¼	8¼×5⅛	5⅛×4⅛	
Small post .	19 ×15¼	15¼× 9½	9½×7½	7½×4¾	4¾×3¾	
Foolscap . .	17 ×13½	13½× 8½	8½×6¾	6¾×4¼	4¼×3⅜	

Copperplate papers are made the same size as drawing-papers down to *medium*. Below this they are cut by the printer. The paper is more absorbent than *drawing*-paper.

This absorbent paper is without size, and is known as *soft plate*.

When engravings are to be colored, they are printed on sized drawing-paper, which is known as *hard plate* when used in this connection.

See under the following heads: —

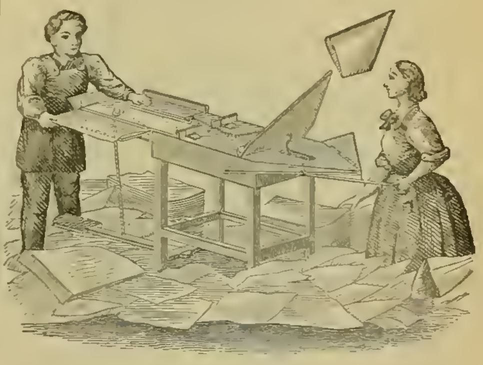
Addressing-machine.
Antiquarian paper.
Ass.
Atlas-paper.
Autographic paper.
Bark-paper.
Bath note-paper.
Beating-engine.
Bill-holder.
Billet-note.
Binder's board.
Blotter.
Blotting-paper.
Board.
Bond-paper.
Bristol board.
Bronzing.
Brown paper.
Calendering-paper.
Cap-paper.
Card-board.
Card-cutting machine.
Carton.
Carton-pierre.
Cartridge-paper.
Case-paper.
Cloth-paper.
Columbier.
Copy-paper.
Copying-paper.
Cosaques.
Cotton-paper.
Cross-rule paper.
Crown-paper.
Curtain-paper.
Cylinder-engine.
Dandy.
Dekle.
Demy.
Devil.
Diluting roller.
Doctor.
Double-cap.
Double-elephant.
Double-imperial.
Double-medium.
Double-royal.
Double super-royal.
Drawing-paper.
Drum-paper.
Drying-paper.
Dry-press.
Duster.
Elephant.
Embossed paper.
Embossing-machine.
Enameled board.
Enamel-paper.
Engine-sized.
Envelope.
Envelope-dryer.
Envelope-machine.
Exchange-cap.
Fanning-out.
Filer.
Filtering-paper.
Finisher.
Flat cap.
Flock.
Folding-machine.
Foolscap.
Forming-cylinder.
Fourdrinier-machine.
Glazed board.
Glazing-machine.
Half-stuff machine.
Hog.
Hot-press.
Imperial.
India-paper.
Inkstand.
Ivory-paper.
Knotter.
Label.
Lace.
Laid-paper.
Letter-clip.
Letter-file.
Letter-paper.
Letter-stamping machine.
Lifter.
Linen-paper.
Lithographic paper.
Littress.
Mailing-machine.
Manilla-paper.
Map and chart holder.
Marble-paper.
Medium.
Metallic paper.
Mill-board.
Music-paper.
Nepaul-paper.
Newspaper clamp.
Newspaper-folder.
Oiled paper.
Paper-bag machine.
Paper-boat.
Paper-box machine.
Paper-clip.
Paper-cloth.
Paper-collar.
Paper-coloring.
Paper-cutting machine.
Paper-enameling machine.
Paper floor-cloth.
Paper-folding machine.
Paper-gage.
Paper-hanging.
Paper hot-pressing.
Paper-knife.
Paper-making machine.
Paper-mold.
Paper-muslin.
Paper-punch.
Paper-polishing machine.
Paper-size.
Paper-splitting.
Paper-stock bleacher.
Paper-stock washer.
Paper-tube machine.
Paper-twine.
Papier-maché.
Parchment-paper.
Pasteboard.
Pasteboard-cutter.
Peel.
Perforating-machine.
Porcelain-paper.
Portfolio.
Post.
Potcher engine.
Pottery-tissue.
Pott.
Pounce paper.
Printing-paper.
Profile-paper.
Protective paper.
Pulp
Pulp-boiler.
Pulp-dresser.
Pulping-machine.
Pulp. Making articles from
Pulp-mill
Pulp-washer.
Quire.
Rag-dusting machine.
Rag-engine.
Razor-paper.
Ream.
Register.
Rice-paper.
Roll-blotter.
Roofing-paper.
Rotary cutter.
Royal.
Ruling-machine.
Safety-paper.
Sheathing-paper.
Stamp-attacher.
Straw-board.
Straw-boiler.
Straw-paper.
Stuff-chest.
Stuff-engine.
Stuff-shovel.
Super-royal.
Tar-board.
Test-paper.
Tinted paper.
Tip-paper.
Tissue-paper.
Tobacco-paper.
Token.
Toned paper.
Touch-paper.
Tracing-paper.
Transfer-paper.
Tribble-paper.
Vegetable-parchment.
Velvet-paper.
Wall-paper.
Wall-paper cutter.
Washer.
Water-mark.
Water-proofing paper.
Wet-press.
Wood-paper.
Wove-paper.
Wrapping-paper.
Writing-case.
Writing-paper.

Pa'per-bag Ma-chine'. A machine, usually automatic, operating upon paper from the roll or upon blanks previously cut, to fold and paste it into bag shape.

The kinds are various, and the prominent ones will be cited in order of date. The principal and most successful ones take the paper from the roll, either of a width for forming a bag, or else cut into strips which are simultaneously acted upon by separate sets of devices. The strip, assuming there to be but one, is bent over into tubular shape, cut off into lengths, the shape at the point of severance being such as to leave a flap to paste over, and thus close the bottom; or a piece is cut off the flat strip and portions of it are folded over the remainder and flaps pasted for closing the side and bottom; or a piece is folded into a conical form with pasted flap. Other minor variations might be cited. Much of the ingenuity has been expended in cutting the paper to make no waste; also in forms for so folding the portions at the bottom as to make what is called a satchel-bottom, where the parts are folded upon each other, making several thicknesses at the part most exposed to wear and tear.

Fig. 3505 is a hand-machine, having two ends at which square and conical bags are made respectively. In such case, a piece of paper of the required size and shape is laid upon the table and held by a hinged piece which corresponds to the inner size and form of the bag; this former, holding down the sheet, side flaps are folded over, carrying with them portions of the paper which lap upon each other a sufficient width for a pasting surface. One machine is shown operated by a hand-lever, the other by a treadle. The farther one, for square bags, has a bottom flap for the bottom piece, which folds over upon and is pasted to the side pieces.

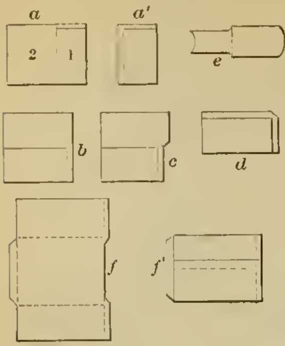
Fig. 3505.



Paper-Bag Machine.

Wolle, October 26, 1852, and May 29, 1855, was perhaps the first to make bags by automatic machinery. The bag made is shown at *a a'*, Fig. 3506. *a* is the blank with a notch; the portion 1 is folded over the part 2, and then appears as represented at *a'*. The folding over of the top and bottom flaps fin-

Fig. 3506.



Blanks for Paper Bags.

ishes the operation. The paper is fed from a roll, the web is cut into oblong sections, notched, folded by a blade which drives the bottom edge between rollers, from whence the folded blank passes to the gummers and flap-folders.

b c d shows a bag in successive stages as made in Wolle's machine of July 6, 1858. The piece is not removed to form the notch, but is folded in to make double the bottom of the bag.

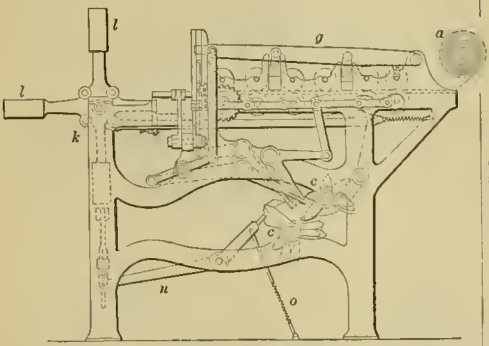
The Rice machine, April 28, 1857, was the first to bend a continuous web of paper over into a tubular shape and cut it off obliquely, so that an angular piece is left to be bent over and form the flap of the bag-bottom.

e represents a blank cut from a continuous web in a Goodale machine, May 29, 1855. The narrower portion is folded on to the wider, and the side flaps pasted and turned down. The bag has a projecting lip, due to the curved line of severance.

f f' shows Goodale's paper bag, July 12, 1859. This cuts from the web without waste, and the bottom has two flaps, strengthening it at that point. See also his patent, Aug. 23, 1859.

Koch's paper-bag machine, March 13, 1855, is adapted for making bags or boxes, the paper from a continuous web *a* being drawn between successive sets of rollers, etc., which are caused to turn intermittingly in one direction by means of cams on a shaft operating jointed levers and connecting rods. As the paper moves onward it is cut to the proper form and size by a cutter or cutters vertically reciprocated by the lever *g*, which, together with a corresponding lever on the other side, derives its motion through an intermediate series of levers from cams on the shafts *c c*. The lever *g* also operates the paster.

Fig. 3507.



Koch's Paper-Bag Machine.

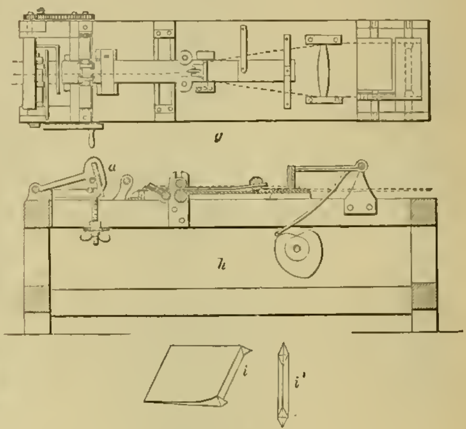
After being pasted the blank is carried forward by the two succeeding pairs of rollers and received upon a slide which forms one side of a hollow mold within which the bag is formed; at the same time the shaft *k* is rotated one quarter around, so that one of the formers *l* is in proper position to permit slides corresponding to the three other sides and the bottom of the bag to be successively brought up against it: this is effected by cams on the shafts *c c*, which operate compound levers connected with the slides and having toes against which the cams strike during the rotation of the shaft.

The forward movement of each slide turns in its side of the paper upon the former *l* and joins the pasted edges. The bottom is also similarly turned in and united to the sides. Farther rotation of the shafts *c c* causes the withdrawal of the slides and imparts a movement to the *former*, on which is the completed bag. This is withdrawn from the *former* by a pair of nippers or pinchers, which are caused to rise at the proper moment and seize the bag, by the bent lever *n* actuated by a spring *o*. The nippers is withdrawn, taking with it the bag, by a semicircular cam on the shaft *c*, its jaws being opened and closed at the right time by projections on the standards between which it works

Pettee's machine, May 29, 1860. The roll of paper is fed beneath an elevated roller, and, passing over and partially around a drum, passes beneath the folder, which consists of two longitudinal strips with an opening between them, through which one edge of the paper projects, enabling paste to be applied by means of a horizontally revolving paste-wheel. Passing onward, it is seized by two clamps, drawn over a slide, and the two sides united so as to form a tube. As it is released by these clamps, it is seized by a second pair, which pass over the first, drawing it forward by a hand-over-hand movement, and passing it between the two blades of a stationary clamp, which holds it while it is severed by a reciprocating knife. It is then subjected to the action of a wedge-shaped trough containing paste. The lower edge of this trough has a longitudinal slit, the width of which may be adjusted so as to deposit the proper quantity of paste on the bottom of the cut-off bag. At the moment of depositing the paste the edge of the trough forces this part between two rollers, which bend over the edge of the bottom and complete the bag. The various motions requisite to the operation of the machine are derived from a driving-shaft, having belt and pulley connection with the motor.

g, Fig. 3508, represents the Armstrong machine, October 2, 1860. The bag is made from a continuous web, bent by a spindle-shaped roller and by side guides into a tube, the lapping edge pasted, the tube flattened, and then a bag cut off. The sides of the bag are held apart at different parts of the length of the tube, so that a single stroke makes an oblique cut across the tube of paper. The projecting serrated flap is pasted and folded over upon the body of the bag

Fig. 3508.



Paper-Bag Machines.

Greenough's machine, February 3, 1863, works from a continuous web, making square-bottomed, box-shaped bags, portions being removed from each side of the strip to make the requisite indentations and flaps.

Pettee, May 5, 1863, bends a continuous web of paper into a trough shape, by a pair of rollers adjustable in relative distance according to size of bag Then the edges are bent over by another roller to form a tube, the edges gummed, a portion cut off obliquely to make a bottom flap.

Taggart, August 15, 1865, has a table with a slit which holds the flatly folded bag, exposing that portion above the table which is to be folded satchelwise.

h is the Goodale machine. September 12, 1865. The continuous web is cut by the descending knife *a*, giving the edge of the blank a wavy shape The sides are then folded over by side flaps, the folded portions lapping over each other the width of the pasted surface. The bottom flap is turned over and pasted on to the sides

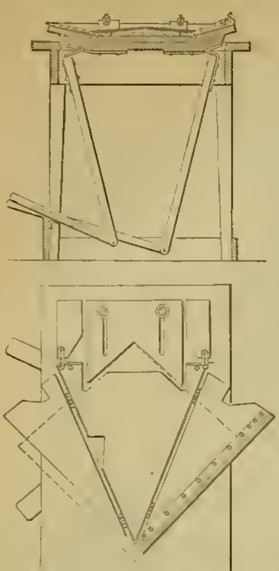
i i' are two views of the Hollingsworth bag, January 24, 1865, which is made upon a vertical former with dilatable sides.

Jaeger's machine, May 7, 1857, is shown in Fig. 3509. It is somewhat similar to the one shown at Fig. 3508. It takes a square blank and folds over two angular flaps, making a conical bag.

Mallary's machine, July 28, 1868, like the Goodale machine just cited, has side and end flaps which fold those portions over the former. As the continuous sheet of paper is fed to the machine, the several devices perform their respective functions of delivering the paper to a knife, which cuts off a piece of suitable length for a bag, drawing such piece into the folders which produce the side laps, pressing the end lap against the pasting-roller, and at the same time turning it upward over the edge of the folding-blade, and then moving the bag forward between pressure-rollers, which join the pasted edges of the laps to the bag.

In his patent of November 3, 1868, one edge of the sheet is

Fig. 3509.



Jaeger's Paper-Bag Machines.

pasted by means of a roller as it passes into the machine; then one of its sides is folded over a former, and over it is folded the pasted side. The bag so far formed is drawn off by rollers, by which it is passed into an inclosure made with a bottom of a series of rollers, which carry it forward. One roller applies paste across the bag near the bottom, while another forms a fold for the bottom lap. It then passes out between another pair of rollers, which dress the bottom fold of the bag into place.

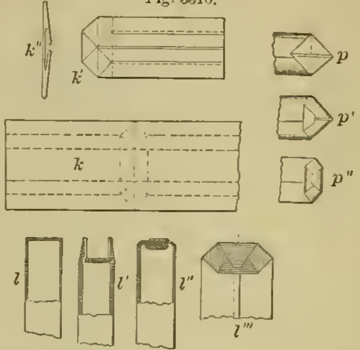
In Amazeen's machine, November 17, 1868, the paper, in passing into the machine from a mounted roll, has paste applied to its margin at one side, and is fed forward to toothed knives, which cut off a piece large enough to form a bag. The pasted and detached piece is then made to pass on beneath a plate or former, around which it is deflected into tubular form by bent guide-plates. The paper, being delivered from this forming device, has its pasted side pressed down upon the adjoining edge. One side of the paper tube is now longer than the other (a result due to the shape of the knives), and the mechanism, which finally comes into play, applies paste to the projecting end, folds it over to finish the bag, and discharges the latter from the machine.

Lockwood's machine, March 9, 1869. The web of paper is drawn over rollers *a d*, paste being applied to one edge by a roller in the trough *f*. It is partially formed in a tubular shape by the pivoted ball *g*, which prepares it for the action of the former *h*, by which, and the side clamps *i i*, the two edges are thrown over toward each other, but are prevented from touching by a finger until arriving at or near the guides and press-rollers which unite the two edges.

The tube is passed onward by a roll and endless band, which hold it firmly while being severed between the stationary serrated knife and a movable knife below it. The endless belt *n* conveys the bag into a position to be acted on by a knife, which is brought alternately into contact with a roller revolving in a paste-trough and with the end of the bag, which it pastes and creases preparatory to being seized by the rollers which, by pressing the turned-over portion and the body of the bag, form the bottom and complete the operation.

M. E. Knight's machine, July 11, 1871, manufactures flat or satchel-bottomed bags from a continuous tube of paper fed from a roll over a former, and cut, folded, and pasted. The peculiar feature is a device to hold back a point or portion of one edge of the paper tube, while the blade or tucking-knife makes the first fold. The successive conditions of the fold are shown at *p p' p''*, Fig. 3510.

Fig. 3510.

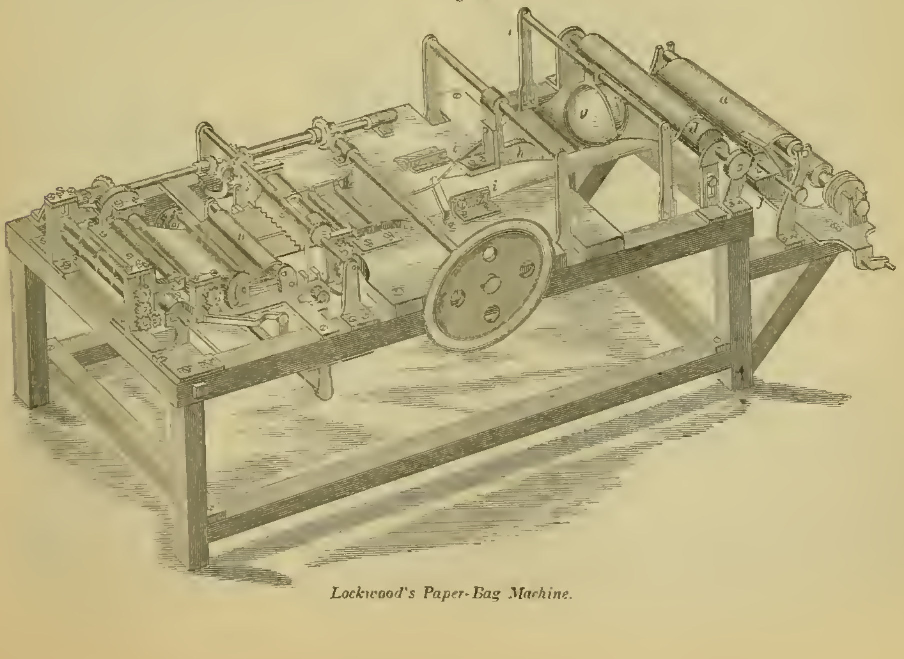


Forming a Strip into a Flat Tube.

In Arkell's machine, December 26, 1871, square-bottomed bags are made from a roll of paper, which is passed over a former, and its edges pasted together so as to be delivered in the form of a tube, which is cut into lengths, one end of which is cut, folded, and creased to facilitate the operation of forming the bottom. The partially formed sack is carried automatically through the machine on a carrier, which moves continuously in one direction, and on which it is subjected successively to the mechanism for applying the paste and finishing the bag bottom. Fig. 3510 shows the successive shapes assumed by the paper in forming a strip into a flat tube.

The Benner bag, January 9, 1872, is shown at *k k' k''*. A strip double the length of the bag to be formed is folded at mid-length. By the action of long formers, having at their sides hinged blades, the edges of the blank are folded, reverse folded,

Fig. 3511.



Lockwood's Paper-Bag Machine.

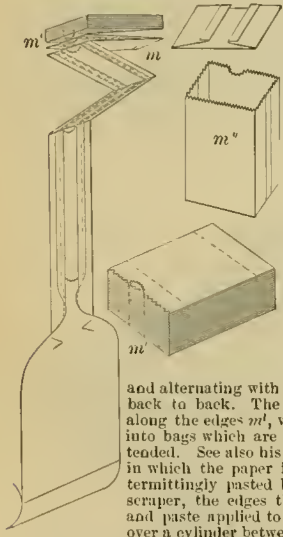
and lapped to form a tube which, when distended, is rectangular in section. See also Guild's patent, January 23, 1872

Bibby and Baron's English machine, October 1, 1872, for making square-bottomed bags, takes the paper tube from a roll, cuts, pastes, folds, presses, prints, and delivers the completed bag.

Annan's machine, November 12, 1872. A strip of paper, one edge pasted, is fed over curved guides (carrying diagonal spreading-rolls) attached to pivoted lever-arms, and its sides turned inward and lapped by twisted guides. This tube is pressed and fed forward by rolls (between which it is cut) upon a folding-table, where its lower ply is held down and the freshly pasted seam protected by an exhaust through orifices in the bed, and the forward end of the upper ply blown up by a blast through a pipe. Three rollers, journaled in cross-heads which reciprocate in radial slots of the revolving frame, successively carry the upper ply back on the tube to form the first diamond-end fold, the tube having been clamped by fingers at the angle thus formed; then deposit two lines of paste over the laps clamped by double fingers at the points where they are next to be folded, and after a folding-plate has folded over the last flap then lap the last fold on the opposite end of the bottom, the finished bag being fed out by rolls or belts.

In Hotchkiss's machine, January 28, 1873, the bag shown at $l\ l'\ l''\ l'''$ is made. The paper is fed by rolls from under the delivery-table over the recess of the folding-table, where it is held on one side by a spring and on the other by a gravitating bar, when a bag-length is cut by the shears. A right angular bar, rocked in and out of a vat, applies paste to one edge and part of the rear end. The rectangular former, descending, carries the blank into the forming-box, causing its sides to stand vertically, that which is dragged from under the bar being longest to form the overlap or seam. The folding-plate moves forward to lay one lap, followed by the opposite combined plate and roller, which lays the other flap and completes a square tube. These folding devices are so connected by levers, that one shall move in advance of the other, and the last folder plays under the pasting-table. The side-end folders are reciprocated successively to lay the side folds of the bag end, the pasted one first, over which partially completed end a paste-roll, vibrated out of a paste-vat, lays a line of paste on the inside surfaces of the top and bottom end-folds, the latter being protected by a supporting lip. The side-folders retreating, the upper end-folder descends and lays its fold, and, retreating, is followed by the lower end-folder, which completes the bottom. The *former* now rises, and, as a new feed is accomplished, its interior piston ejects the bag from the former on to a table, from which it is fed by an apron against the upper of a pair of rolls, where a vibrating bar breaks down its upper edge and forces the lower corner of the bottom into the bite of said rolls, which press and deliver it flat.

Fig. 3512.



Crowell Bag.

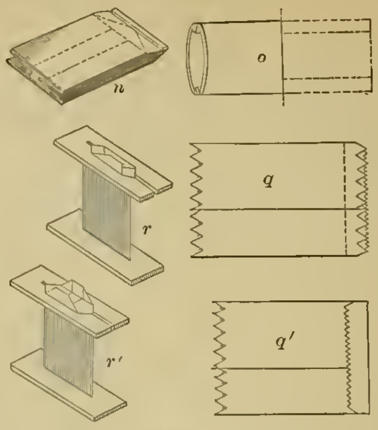
Fig. 3512 shows the Crowell bag, April 8, 1873, in which the edges of a strip of paper are folded in and then a portion lapped outwardly, the face of the latter being pasted. By doubling the strip thus prepared inward and outward, zigzag fashion, as at m, the parts become united together in pairs, faces fastening paste to paste, and alternating with unpasted portions lying back to back. The bolt thus made is cut along the edges m', which separates the pile into bags which are like m'' when fully distended. See also his patent, October 14, 1873, in which the paper is cut longitudinally, intermittingly pasted by the paste-wheels and scraper, the edges then being folded under and paste applied to them. Thence it passes over a cylinder between it and a second cylinder, when the bottom is folded, the bag-length cut off, and the edges pressed together. Then the bag passes over the printing-roll to the table, where it is automatically removed and counted.

n represents the Parker bag, January 6, 1874, which is formed by folding inwardly the opposite edges of two strips of paper, uniting the folded edges, and folding and pasting one end of the united strips.

Crowell's paper-bag, January 13, 1874. o has a bottom made by a central transverse fold of the paper, and has its sides closed by edge-folds which, at each side of the paper, are cemented together and to one of the adjacent sides of the bag.

$q\ q'$ illustrate Murphy's mode of making the division of the paper tube so that when the side portions, which are deeply serrated, are folded over upon the mid portion, both will be exposed to the pasting-brush, as shown at q, and may be securely fastened down to the side of the bag over which the bottom flap is folded.

Fig. 3513.



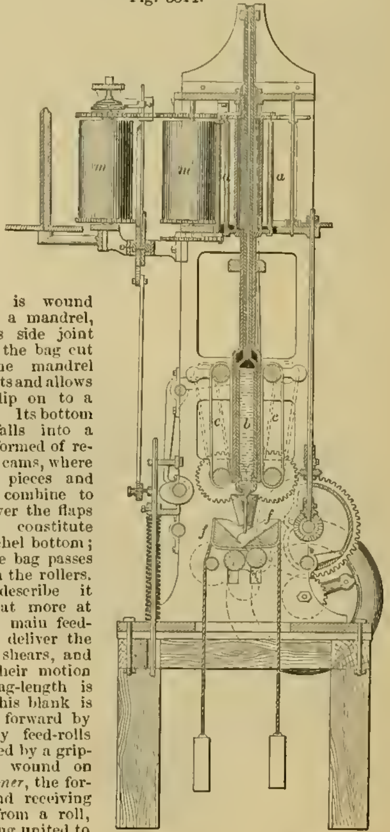
Paper Bags.

$r\ r^1$ illustrate the mode of making the Taggart bag, the blank being slipped into a slit plate, and then the portion projecting above the plate being folded down, first the ends and then the sides.

Biedinger's, March 10, 1874, is an upright machine in which the web of paper is fed upon its edge between a pair of vertical rollers, is wound around a mandrel, and, its side joint pasted, the bag cut off, the mandrel contracts and allows it to slip on to a former. Its bottom then falls into a cradle formed of revolving cams, where folding pieces and fingers combine to bend over the flaps which constitute the satchel bottom; and the bag passes between the rollers.

To describe it somewhat more at length: main feed-rolls m deliver the web to shears, and cease their motion as a bag-length is cut. This blank is carried forward by auxiliary feed-rolls m', seized by a gripper, and wound on the *former*, the forward end receiving paste from a roll, and being united to the rear end by

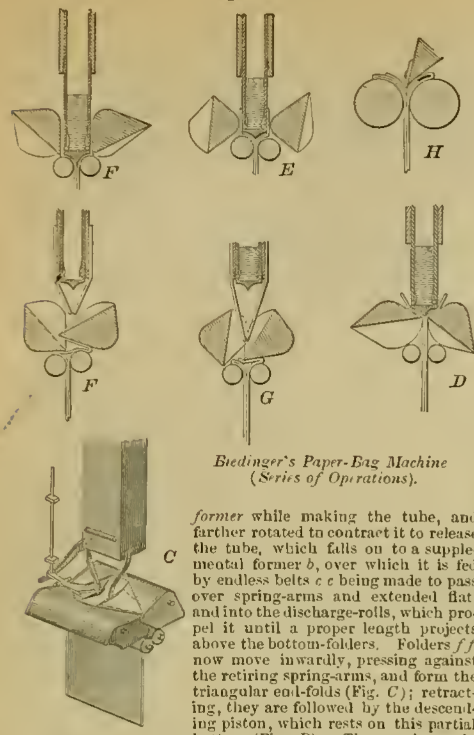
Fig. 3514.



Biedinger's Paper-Bag Machine.

pressure against the delivery-roll. The *former* consists of a set of rolls *a a* on eccentric shafts, partially rotated, to expand the *former* while making the tube, and farther rotated to contract it to release the tube, which falls on to a supplemental former *b*, over which it is fed by endless belts *c c* being made to pass over spring-arms and extended flat, and into the discharge-rolls, which propel it until a proper length projects above the bottom-folders. Folders *f f* now move inwardly, pressing against the retiring spring-arms, and form the triangular end-folds (Fig. *C*); retracting, they are followed by the descending piston, which rests on this partial bottom (Fig. *D*). The continuously revolving folders crease the sides against the angles of the piston, press a line of paste thereon, carry the piston and bag downward together until the central rib of the piston enters and spreads the bag-bottom in the bite of the discharge-rolls (Fig. *E*), where, the piston rising, the folders lay the side-laps successively (Figs. *F*, *G*), one folder (Fig. *H*) carrying a knife, folding the bottom centrally and into the rollers which discharge it pressed flat for packing.

Fig. 3515.



Biedinger's Paper-Bag Machine (Series of Operations).

Paper-Bag Machines patented in the United States.

No.	Name.	Date.
9,355	F. Wolle	Oct. 26, 1852.
12,511	Louis Koch	March 13, 1855.
12,786	Smith and Petteo	May 1, 1855.
12,945	E W. Goodale	May 29, 1855
12,982	F. Wolle	May 29, 1855.
13,647	E. W. Goodale	Oct. 9, 1855.
17,184	B. F. Rice	April 28, 1857.
19,506	Jacob Keller	March 2, 1858.
20,838	Francis Wolle	July 6, 1858.
21,657	Henry R. David	Oct. 5, 1858.
22,199	S. E. Pettee	Nov. 30, 1858.
24,734	William Goodale	July 12, 1859.
25,191	William Goodale	Aug. 23, 1859
27,959	Louis D. Barrand	April 24, 1860.
28,188	G. F. Lufberry	May 8, 1860.
28,537	S. E Pettee	May 29, 1860
30,191	H. G. Armstrong	Oct. 2, 1860.
32,777	John Miller, Jr.	July 9, 1861.
37,573	J. J. Greenough	Feb. 3, 1863
37,726	C. H. Morgan	Feb. 17, 1863.
38,253	Joseph Wells	April 21, 1863.
38,452	S. E. Pettee	May 5, 1863.
40,001	Joseph Wells	Sept. 15, 1863.
42,313	Joseph Wells	April 12, 1864
43,773	J. M. Hurd	April 12, 1864.
45,999	E. A. Hollingsworth	Jan. 24, 1865.
49,454	B B. Taggart	Aug. 15, 1865.
49,735	B. F Ellis	Sept. 5, 1865.
49,951	E W. Goodale	Sept. 12, 1865.
62,342	Kirk and Howlett	Feb. 26, 1867.
64,537	G. L. Jaeger	May 7, 1867.
70,601	E B Olmsted	Nov. 5, 1867.
74,190	James Arkell	Feb. 11, 1868.
80,298	George H. Mallary	July 28, 1868.
83,648	George H. Mallary	Nov. 3, 1868.
84,076	C. Amazeen	Nov. 17, 1868.
87,608	Joseph Wells	March 9, 1869.
87,689	H. C. Lockwood	March 9, 1869.
90,624	C. F. Annan	June 1, 1869.
94 511	J. P. Pultz	Sept. 7, 1869.
101,299	C. J. Moffatt	March 29, 1870.
104,169	H. Law	June 14, 1870.
105,099	Lorton and Davison	July 5, 1870.
110,536	C. F. Annan	Dec. 27, 1870.
111,802	C. F. Annan	Feb. 14, 1871.
111,803	C. F. Annan	Feb. 14, 1871.
112,005	P. E. Armstrong	Feb. 21, 1871.
114,743	A. Adams	May 16, 1871.
116,842	M. E. Knight	July 11, 1871.
118 327	James Arkell	Aug. 22, 1871.
119,307	J. M., J. P., and S. H. Bryant	Sept. 26, 1871.
119,915	B. S. Binney	Oct. 17, 1871.
122,099	James Arkell	Dec. 26, 1871.
122,510	L. D. Benner	Jan. 9, 1872.
123,013	George Guild	Jan. 23, 1872.
123,812	L. C. Crowell	Feb. 20, 1872.
131,841	Bibby and Baron	Oct. 1, 1872.
132,312	H. B. Morris	Oct. 15, 1872.
132,890	C. F. Annan	Nov. 12, 1872.
133,395	J. Arkell	Nov. 26, 1872.
134,035	B. Cole	Dec. 17, 1872.
134,580	C. F. Annan	Jan. 7, 1873.
135,145	M. Murphy	Jan. 21, 1873.
135,275	T. Hotchkiss	Jan. 28, 1873.
138,844	L. D. Benner	May 13, 1873.
139,104	H. G. Armstrong	May 20, 1873.
140,342	N. Biedinger	July 1, 1873.
141,862	G. Dunham	Aug. 19, 1873.
143,358	W. Liddell	Sept. 30, 1873.
143,674	L. C. Crowell	Oct. 14, 1873.
143,925	J. S. Ostranger	Oct. 21, 1873.
145,125	J. P. Raymond	Dec. 2, 1873.
146,372	W. Webster	Jan. 13, 1874.
146,773	R. W. Murphy	Jan. 27, 1874
146,774	M. Murphy	Jan. 27, 1874.
147,998	C. B. Stilwell	Feb 24, 1874.
148,280	C. G. Biedinger	March 10, 1874.
151,258	W. F. West	May 26, 1874.
151,862	G. Dunham	June 9, 1874.

Pa'per Boat. Paper boats or "shells" have of late years largely supplanted those of wood for racing and sporting purposes. These are made by applying sheets of manilla paper, or paper prepared from pure unbleached linen stock, to the exterior of a model or former corresponding to the interior lines of the shell. The sheets are fully equal in length to the model; and if manilla be employed, the first sheet is damped, applied smoothly to the surface of the model, and secured by tacking to strips on its upper face; it is then coated with an adhesive varnish, another sheet is applied over the first, and so on successively until the required thickness is attained.

When linen paper is used, but a single thickness of $\frac{1}{20}$ to $\frac{3}{8}$ of an inch is employed. The model with its envelope is then removed to a drying-room and exposed to a heat of 150° Fah., which obliterates all wrinkles in the paper and hardens it; it is next covered with boiled linseed-oil and turpentine, and afterward with shellac varnish; the framing is then inserted, and the decking and metal work put in place. Such boats may be made about one third lighter than wooden boats of the same dimensions, are impervious to water, and the skin is not liable to spring. See Boat; Canoe.

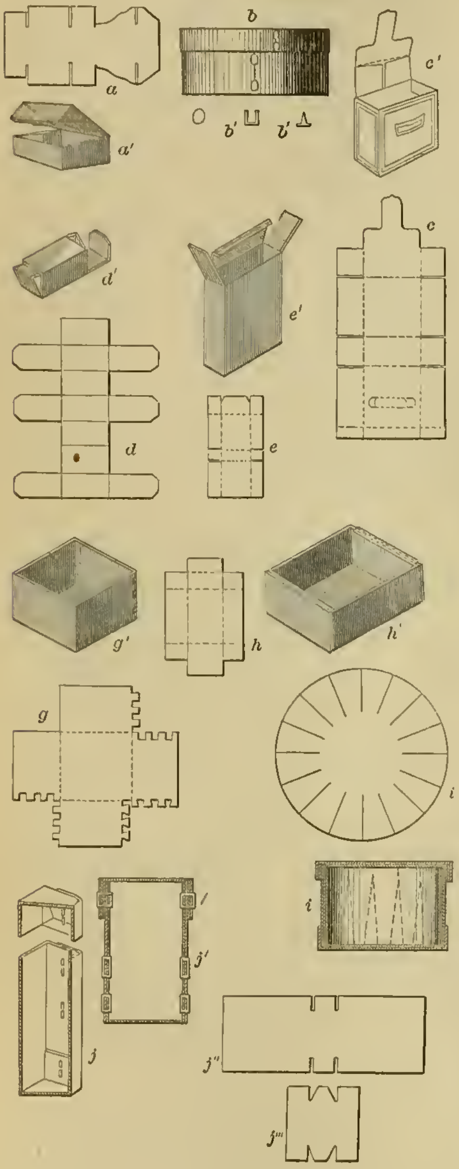
Pa'per Box. Paper boxes are made in several ways.

1. *Pill-boxes.* Paper from a coil is wrapped around a former, making a cylinder of a thickness depending upon that of the paper and the number of plies. The inside surface of the paper is coated with paste, and thus the joint is made. Such boxes are completed by pushing a disk of paper into the cylinder. The lid is but a shallow box, a trifle larger. Such boxes are also made by coiling a wide sheet of paper on a mandrel in the manner described, and then cutting it into lengths as desired. Lids are made in the same way. Colored boxes are made by an outer ply

of colored paper. Such boxes are also made by machinery. (See Fig. 3516.) In one mode of covering, the strip which is to cover the cylindrical portion has gored margins, which lap over upon the bottom of the box or the top of the lid, as the case may be, and match together.

2. Boxes are made from a roll of paper, which is bent over into shape, cut off, the bottom folded in against a former, the contacting portions being pasted *in transitu*.

Fig. 3516.



Paper Boxes.

3. Boxes of paper or pasteboard cut from the roll, shaped, and secured by rivets or staples.

4. Boxes made from blanks of the required size and shape, the machine taking them from the pile, shaping and fastening the parts together. See PAPER-BOX MACHINE.

a a' are, respectively, a blank and a box made therefrom, the scale of the latter being enlarged somewhat. With the exception of two slight gores on the edges of the lid-flap, no portion is wasted. Some portions of the box are double and others treble. Parts secured by paste or rivets.

b b' b' show a round box and the metallic fastenings which hold the lapped portions.

c c' are the plan of the pattern and the folded box with a tuck and keeper. *d d'* illustrate another mode of shaping and folding. *e e'* still another, with a lapping lid. *g g'*, a paper box with dovetailing angles. *h h'*, the plan of a blank and the box made from a similar larger blank.

i, a box made from a circular blank, cut on the principle of *i'*, but of larger size.

j j' j'' j''', Heyl's box, whose overlapping pasteboard flaps are secured by rivets.

Seamless paper boxes, lamp-shades, hats, and other hollow articles of paper are made upon formers which are dipped into the pulp; the latter collects on the reticulated surface by means of a partial exhaustion of the air from the interior of the former, the air being withdrawn through an elastic pipe communicating with a bellows or cylinder.

The water being drawn through the perforations, a film of pulp adheres to the surface of the *former*, which is then raised from the vat, and, the coating of paper-pulp being removed and dried, forms a seamless article which requires no farther manipulation for most ordinary purposes, but for ornamental uses may be covered wholly or in part with a second coating of colored pulp, and embossed or otherwise ornamented by stamps, swaging, or perforation. See PAPER-MOLDING.

Pa'per-box Ma-chine'. A machine for making boxes from the roll or from blanks of paper.

Hatfield's machine, March 8, 1870, is designed for attaching the bottoms to cylindrical paper-box bodies previously formed by another machine. The shaft *a* is hollow, and through it works a spindle, operated by means of a hand-lever *c*, and carrying a fixed bead or disk.

On the end of the shaft *a* is an expanding head *d*, formed in segments, which are pushed radially outward by links operated by a lever and arm.

f is a tube containing the bottoms of the boxes; these are pressed by the follower *g*, kept in contact therewith by a cord and weight *h*; *i* is a plunger cut-off by which the bottoms are pushed down one by one into contact with the follower *k*. This is advanced by a lever *l* operated by the hand-lever *c* through the medium of the rod *m*; *o* is a treadle connected by cranked arms and rods to the rock-shaft *p* of the lever *l*, and to the arm of a lever having a divided head in which a roller is journaled.

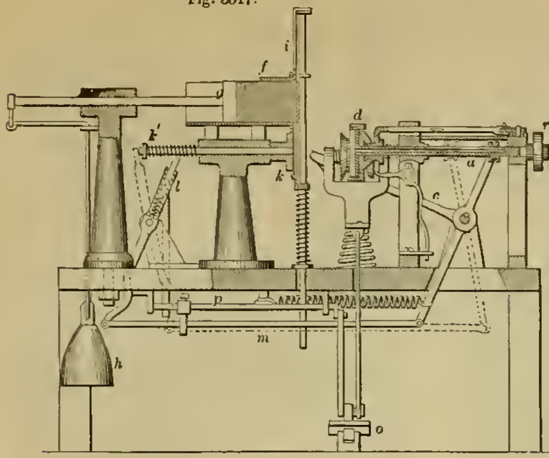
The head *d* is rotated by the pulley *r* on its shaft, and the treadle depressed; this throws the roller out of contact with the expanding head *d*, and also partially rotates the rock-shaft *p*, throwing the latch *l* into position to engage the plunger-rod *k'*. A box-body is slipped over the expanding head, which is then expanded. The lever *c* is depressed, thrusting out the disk within the expanding head and bringing it into position to receive one of the bottoms which has been pushed down by the plunger cut-off *i*. By an upward movement of the lever the box-bottom is pushed into contact with the disk, which, by the same movement, is withdrawn and brings the bottom into contact with the box-body on the expanding head; a slip of prepared paper, pasted on one side, is applied to the junction, the treadle is released, bringing the roller in contact with the side of the box, the rotary movement of which winds the strip around it, where it is fixed by the roller and vibrating fingers on an eccentric.

G. L. Jaeger, February 25, 1873. In this machine, an address or label is imprinted and the box cut out and formed at one continuous operation. The paper passes first between the impression-roller *a* and the type-roller *b*, which is supplied with ink from the trough *c* by inking-rollers *d*.

Circular knives and creasers on the roller *g* cut it into the shape shown on the plan view during its passage between that and the roller *i*. Paste is applied to its edge by the rollers *k l*, in connection with a smaller roller not shown. Proceeding onward, two of the flaps are turned up and secured by pivoted wings *m n*, the other two being similarly treated by other wings, leaving the end flaps to be folded in by hand.

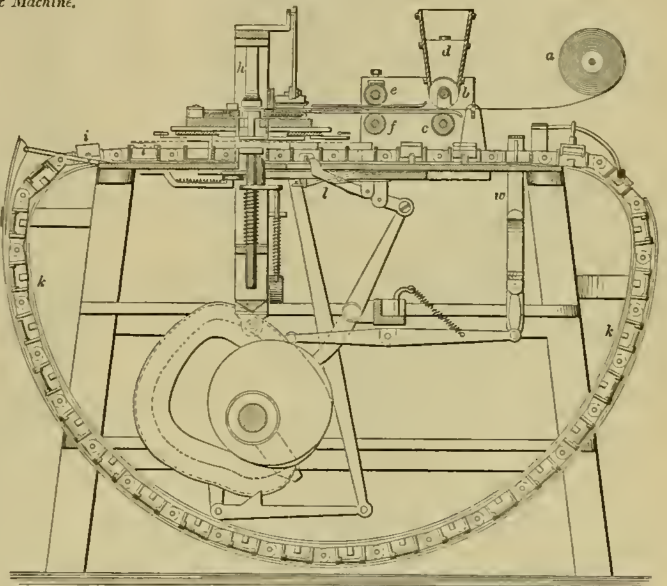
F. Gates, April 5, 1870. For making rectangular boxes. The

Fig. 3517.



Hatfield's Paper-Box Machine.

Fig. 3519.



Gates's Paper-Box Machine.

paper web from the roll *a* passes between the rollers *b c*, by the upper one of which paste from the trough *d* is applied to its edges. It is then carried forward by the feed-rollers *e f*, and the necessary slits cut by a vertically reciprocating cutter, after which it is subjected to the action of a plunger *h*, which shapes it by forcing it within one of a series of molds *i*, on an endless chain *k*, advanced intermittingly by a pawl *l* operated by an oscillating lever from the driving-shaft. The boxes are carried around by the endless chain until they successively arrive in a sufficiently dry condition at a point over an aperture, where they are forced out of the molds by a vertically reciprocating plunger *w*.

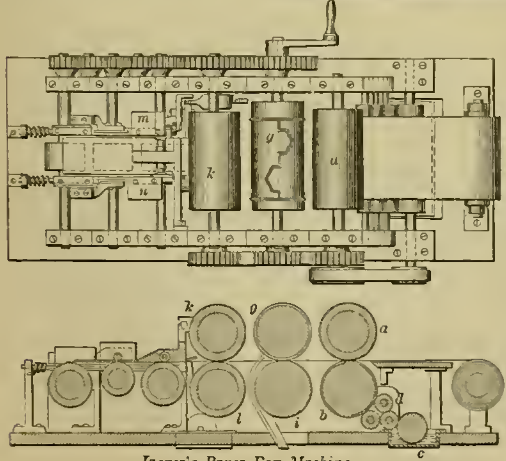
Foster, March 19, 1857. For making match and other tubular boxes. The previously cut blanks are fed upward by a follower, and pushed forward by a reciprocating feed-bar into the flaring mouth of a former, by which the paper is pressed into shape around the head of the feed-bar. It is drawn onward and delivered from the feed-bar by angularly placed rollers, which also turn down and finish the corners. The gumming or pasting is afterward done by hand.

Keating and Waymouth, June 8, 1869. For making and sanding match-boxes. The blanks, cut to shape, are advanced and gummed by means of a roller; each blank as it is gummed is carried forward to a die, through which it is forced by a descending plunger, uniting the gummed edges, and deposited in one of a series of receptacles on an endless conveyer, which carries it forward to a roller by which its bottom is gummed; it thence passes over a box containing sand, a portion of which is deposited on its bottom by a lifter, and is finally discharged by a plunger.

Heyl's patent, October 31, 1871, is for making and covering paper boxes, the flaps being secured by paste.

The pieces of pasteboard from which the boxes are to be made are placed directly over the machine in a box, from which they can be dropped one by one at each revolution of the machine, directly behind the crimping-frame or former, and in front of the reciprocating plunger. The plunger then moves forward, pressing the pasteboard through an opening in the *former*, which, being barely large enough to admit of its passage, bends the pasteboard close to the plunger, where it is held by a set of nippers attached to the plunger. The plunger then stops its forward movement a short distance in front of the *former* to receive the covering-paper. A strip of paper of sufficient length to go entirely around the box is inserted at the extreme right of the machine, and is caught by and carried around the pasting-wheel, which, in its return motion, transfers the paper to the pressing-wheel, pasted side out: from this wheel it is again transferred to the sides of the box by a forward movement of the pressing-wheel (until it rests against the box) and a revolution of a plunger. The box with the covering-paper around it is then carried forward by the plunger into the folding-frame, when the cover-paper is lapped around against the bottom of the box by a set of leaves or folders which move inward across the bottom as the box is pressed upon them. The plunger then returns to its first position, leaving the box in the folding-frame, which then rocks over into a horizontal position directly under the vertical plunger. The next operation is to fold the upper edge of the cover-paper over the top and down into the inside of the box. This is done by the inward and downward motion of the square-grooved feet of a vertical plunger as they pass down into the box. The label or square piece of paper for the bottom of the box is pasted by being laid upon the paste-roller, from which position it is thrown, pasted side out, up against a platform by a lifting-rack. Small

Fig 3518.



Jaeger's Paper-Box Machine.

nippers or fingers attached to the platform grasp the label at either end and hold it against the platform, while the latter turns upward and brings the label immediately under the box. The box is then pushed down through the folding-frame upon the label that lies under it, and the label is made to adhere to the box by a firm pressure of the vertical plunger. This completes the operation, and the vertical plunger returns to its original position, leaving the finished box upon the platform, which in proper time again turns down and casts the box out at the end of the machine.

Patent 132,077 is an improvement on this, and patent 132,076 is a pasting and sanding device for the ends of match-boxes.

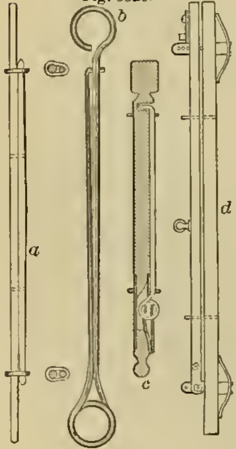
Heyl's patent for making wire-fastened paper boxes, October 8, 1872.

The machine is intended primarily for making boxes of paper or pasteboard without cement, the fastening being effected by wire staples, which are produced and applied by the machine which forms the boxes. The box-blanks are placed in a receptacle provided with a sliding bottom, which is drawn up by a weight and cord applied to a fusee-pulley adapted to graduate the power of the weight to correspond with the number and weight of the blanks remaining in the receptacle. The weight-pulley is detained by a ratchet, which prevents the drawing up of the sliding bottom, excepting when the said ratchet is retracted. The blanks are taken one by one from the top of the pile by a pneumatic or suction feeder provided with automatic valves to adapt it to seize and drop the blanks at the proper moments. The said feeder in its descent retracts the detent-ratchet and receives a slight upward pressure from the pile of blanks. As the feeder rises again with one blank, the detent, being released, catches the weight-pulley, so that, whether the quantity of blanks be greater or less, the top of the pile always rests at one level to receive the feeder. The blank, being deposited on a table by the feeder, is carried forward by a follower to a position over the mold, into which it is forced by a plunger, the bottom flaps being first bent up and the end flaps next folded over them as the plunger descends. The wire to form staples is in continuous lengths, contained on suitable reels, equal in number to the staples used in each box. The lengths of wire are cut off, bent into square form over suitable mandrels, which latter then recede, and the staples are, by sudden percussion, driven through the lapped sides of the box. Cavities in the plunger receive the inwardly projecting ends of the staples, which ends are then bent in opposite directions, either toward or away from each other, by slides working in the sides of the plunger. The plunger is then withdrawn, and its descent with a new box discharges that which was previously formed. The various parts are made changeable or adjustable, to adapt them for the manufacture of boxes of various sizes or forms.

Fig. 3516 is a view of a box so made, j being a sectional perspective view of the box and cover, j' a longitudinal section, j'' a plan of a paper blank adapted for the formation of a box, and j''' a plan of a blank adapted to form a cover.

Pa′per-clamp. A device for holding newspapers, sheet music, periodicals, etc., in convenient form for reference, and at the same time preserving them from injury by keeping them clean and flat.

Fig. 3520.



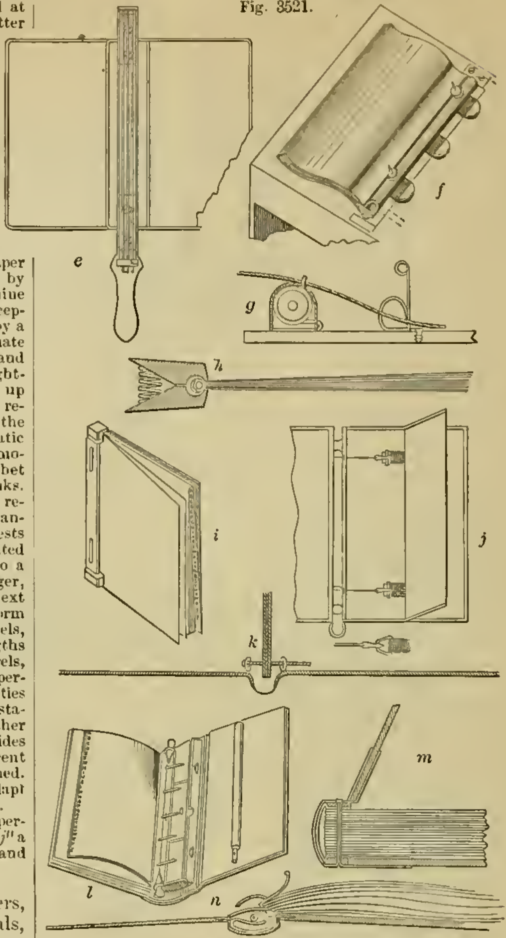
Newspaper-Files.

Of the various forms, some fulfill these conditions very imperfectly, being mainly intended to keep the issues of a newspaper together and keep them from being carried off or dropped upon the floor. Of these there are two kinds, the *portable* and the *desk-clamp*. *a b c d*, Fig. 3520, are portable forms, in which the folding edges of the newspapers are clamped between two bars or wires hinged together.

Fig. 3521 shows several forms, of which *e f g* are intended for desks.

h i j k l m n are all forms of temporary binders, in which the periodicals, papers, or sheet music are held by the folded edge, either by a simple clamp, as in *h i*; by cords, as in *j*; by impaling wires, as in the other figures, which need no lengthy explanation.

Fig. 3521.



Paper-Files and Temporary Binders.

Pa′per-clip. A clasp for holding papers together. A means of filing bills, letters, etc. It may be, —

A suspensible hook on which the papers are strung.

A wire on a stand or suspensible, on which the papers are impaled.

A pair of jaws grasping papers, as with the finger and thumb, and intended to lie on the desk or be suspended by a ring.

See also PAPER-CLAMP; PAPER-FILE, etc.

Pa′per Cloth. A fabric patented in England in 1843 by Henry Chapman. It is prepared by winding cotton, linen, or other cloth upon a roller, which is introduced between the third press-felt of a Fourdrinier machine; between this roller and the endless felt is placed a trough containing an adhesive solution, which is, by means of a roller in a trough, applied to the cloth; at the same time, the continuous sheet of paper formed by the machine in the usual manner is carried forward, meeting the cloth, and the two passing together through the pressing-rolls are caused to adhere. By reversing the cloth, a similar paper facing may be given to the other side.

Pa′per Col′lar. One made from paper in imitation of linen. Before the advent of the factitious article, made as an object of merchandise and so much worn, collars were occasionally made of paper, either as by Lord Byron, who affected a collar of peculiar shape, somewhat on the sailor pattern, or by mountebanks and wandering minstrels of the colored persuasion. The festive collars of "Brudder Bones" and his partner on the left wing were exaggerated turn-downs or chokers made from cardboard.

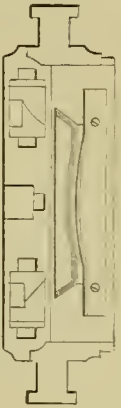
The first patent on a collar concerned its shape, and is somewhat curiously described. It was of fabric, and was called the "Belvidera" collar, patent to Cantelo and Kerrison, November 19, 1833.

> "The band has a breadth equal to the length of the wearer's neck. Its lower edge is cut curving down in the center, to cover the cricoid cartilage and the thyroid gland, and curving upward on each side to avoid pressing the clavicle and the sternocleido-mastoideus muscle. The upper edge of the band proceeds upward on each side from the center in a line corresponding with the inclination upward of the lower jawbone to a point under the angle thereof, and thence downward at a nearly equal angle, so as to avoid pressure of the mastoid process of the temporal bone. A small oval piece of a size according with the parts to be fitted is cut out of the center of the upper edge of the band, so as to give room for the angle of the thyroid cartilage or pomum Adami."

(Nothing like being precise!)

In 1854, Walter Hunt, after his unsuccessful suit with Howe in the matter of the sewing-machine, confidently asserted to an intimate friend, "I will make a machine which will imprint a stitch more perfect than that of the sewing-machine." The paper collar with an imitation stitch made by an indented tool was the result. Long experiments upon paper, its combinations with cloth and combined fabrics attached by means of paste, followed. The article he put upon the market consisted of thin white cotton muslin, coated upon both sides with a very thin white paper. The face was enameled and polished by calendering. The collar was cut out in several pieces, after the manner of the old cheek-piece standing collar, being in every respect similar, except in material and stitches. The collar was made, like its linen predecessor, in three pieces, united by eyelets, and was fastened by strings. It was coated with colorless, transparent, water-proof varnish.

In 1856, he united two thicknesses of cotton cloth, bleached, sized, and calendered, and fashioned into collars. He was also the first to produce a substitute for the linen collar which had the necessary rigidity, imitation stiffening embossed thereon, and holes punched therein, forming a merchantable article.



In 1857-59, W. E. Lockwood, having purchased the effects of Hunt, added the farther improvement of producing a paper-faced fabric having embossed upon its surface, by means of an electrotype die taken from the fabric itself, an exact imitation of the warp and woof of the fabric, and also of the stitches which constituted its embroidered pattern. This ornamented surface is produced upon all paper collars now in the market. Lockwood also printed fanciful designs on the face of collars, in imitation of calico fabrics.

In 1863, the button-holes, which had formerly been simply punctured, were reinforced by cloth patches by an English maker.

In 1863, Gray of Boston rolled a garrote collar from a single piece of paper, so as to make the standing lappel flare from the neck. He also turned a Byron collar upon a defined curved line, so that the outer portion would have the larger curve, and to avoid puckering the material, and also to provide for the neck-tie.

Evan, in the same year, improved the paper for collars by constructing it of long-fibered stock.

Lang, in 1866, made paper collars and cuffs in imitation of lace.

In the same year, Alden made them of the proper flaring form direct from pulp.

Lockwood, in 1869, embossed coarse cotton sized cloth by means of linen cloth under pressure.

Paper collars are made in several ways: —

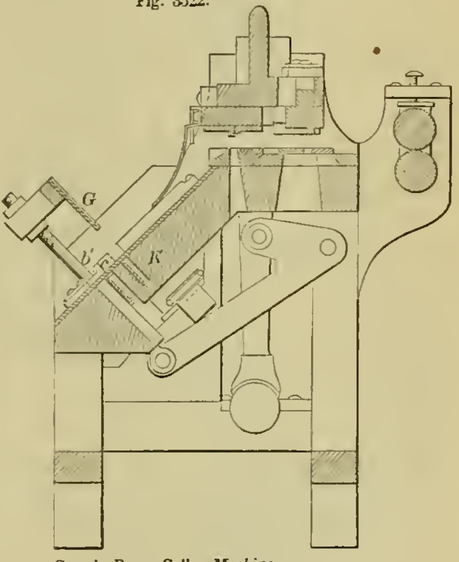
1. They are cut out of piles of sheets, in the same manner as envelopes, by means of a properly shaped knife in a platen press; the resulting blanks are embossed, button-holed, folded, and curved for the neck by other machines.

2. The collar is cut, button-holed, and creased for folding by passing through a pair of rotary compound cutters and dies.

3. The collar is made by machines which automatically complete the collar for wear from a web of paper. A good example of this is Snow's machine.

Fig. 3522 is a view of Snow's patent of 1865. The paper is intermittingly fed forward by rollers the width of a collar before each descent of the platen, which carries, arranged in proper relative position, (1) a set of end knives and end and middle button-hole punches, all adjustable to cut different-sized collars; (2) a die having serrated teeth to emboss imitation stitches, which is detachable; and (3) a knife, also adjustable, the front and rear edges of which may be of different curves, for cutting the upper and lower edges of the collar. The bed has corresponding intaglio cutting-dies and a duplicate embossing-die, so as to ornament both sides of the collar. As the ends and button-holes are being cut for one collar, that next in advance is being embossed with stitches, while the forward one is severed from the sheet and slides down the inclined table between end guides until it rests against the stop *b′*. In this position it is struck by the folding-blade *G* and pushed through a slot, resting on a

Fig. 3522.



Snow's Paper-Collar Machine.

shelf until it is carried endwise out of the machine by the belt K between it and one of the pressing-rolls c, which curves it and completes it for wear.

In finishing the blanks, in lieu of several machines performing individual operations, a machine made by Denison carries the blank through the machine, finishing it at successive stages.

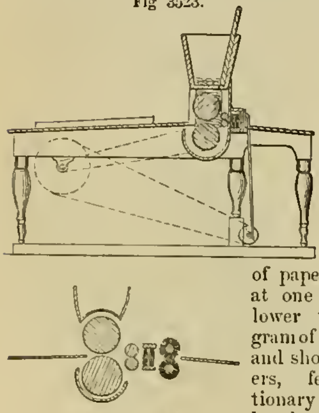
The proper points on the collar are moistened; patches are cut from glutenized cloth strips, and pressed on the moistened spots; through these re-inforced points the button-holes are punctured; the crease for folding is indented; the embossed stitching is impressed, and the collars ejected.

At the present time, Denison and Snow have in operation machines which cut the blanks from webs of paper without the slightest loss of stock; while Snow also produces by a novel machine nearly all of the combined cloth and paper used in the collar trade at the present time.

The principal manufactories are at Springfield and Boston, Mass., New York, and Philadelphia.

Pa′per-col′or-ing Ma-chine′. One in which the paper is fed in sheets between color-rollers which give it a coat of color. The example has an upper reservoir for the coloring matter, and another placed below the rollers, so that both sides of a sheet of paper may be colored at one operation. The lower view is a diagram of the moving parts, and shows the color-rollers, feed-rollers, stationary and revolving brushes, and a table, on the right, on which the sheets are received. By disuse of one reservoir the paper will be colored on one side only.

Fig 3523.



Paper-Coloring Machine.

Pa′per-cut′ter. 1. An ivory blade for cutting paper, the folded edges of uncut books, etc. A *paper-knife.*

2. A machine for cutting the edges of paper in piles. See PAPER-CUTTING MACHINE.

Pa′per-cut′ting Ma-chine′. A machine for cutting paper in piles or in sheets, or for trimming the edges of books, pamphlets, etc.

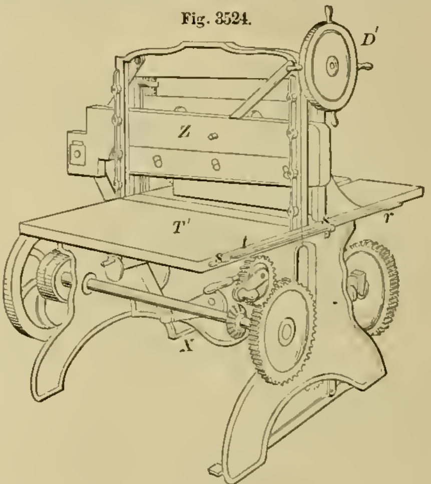
Owing to the sizing and coloring matter, paper is a very difficult substance to cut, and requires a strong knife to pass through any considerable quantity. The knife must also have a draw or shear cut, and requires frequent grinding.

One form of paper-cutter is a straight-edge and traveling knife. Another has a revolving traveling knife sliding on a bar parallel with a stationary knife which acts as one blade of a shears.

Another form has a knife hinged at one end, which descends on a pile of paper with a shear cut. See CARD-CUTTER.

Sanborn's paper-cutter (Fig. 3524) has a cast-iron frame which sustains the horizontal bed T' upon which the paper to be cut is placed. Working through vertical slots or guides, formed in the upper part of the frame just mentioned, is the knife-stock Z, which carries the knife or cutter, the latter being detachable, so that when required it may be removed for sharpening. The cutter-stock is suspended from a horizontal cross-piece at the top of the frame by means of two toggles or swinging-bars, which, when the cutter-stock is elevated, as shown in the engraving, occupy an inclined position. The cutter-stock is connected by a pitman with a crank arranged underneath the table, and rotated when the apparatus is in use by a belt-wheel operating through a suitable system of gearing, and arranged at one side of the frame; this belt-wheel being furthermore furnished with a suitable balance-wheel. The table is made adjustable under the cutter by suitable appliances worked by a crank, and has a gage $t\ s\ r$ arranged at one edge and in suitable proximity thereto, so as to guide the attendant or operator in regulating the position of the mass of paper upon the table and in relation to the cutter. The clamp for clamping the paper tightly in place upon the table, previous to and during the descent of the cutter, is operated by appropriate devices, to which movement is given by a hand-wheel D' arranged at the side of the upper portion of the frame.

Fig. 3524.



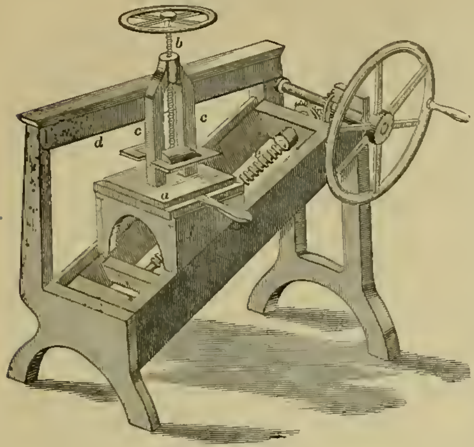
Paper-Cutting Machine.

The mass of paper having been properly placed upon the table and underneath the cutter, as just above indicated, the driving-belt is shipped to turn the driving-pulley and rotate the crank X which operates the cutter-stock. As this latter is drawn longitudinally inward by the action of the pitman, the suspending bars or toggles are brought into a more or less vertical position, thus forcing the stock and its attached cutter downward, and consequently giving a compound downward and longitudinal motion to the same, which insures the gliding cut essential to the perfect working of a machine of this character. As the crank completes its revolution the pitman is of course forced outward, thereby bringing the cutter-stock upward and outward to its original position, preparatory to a repetition of the cutting operation.

Soule's undercut machine has the knife below the bed, and the knife lifts with a shearing cut against a pile of paper held down on the bed by a clamp. The portion of the bed or table outside the knife is attached to the knife-carrier in such manner as to yield sufficiently to receive the part of the paper cut off. The knife moves only far enough to cut through the paper, instead of passing through its whole stroke, as in guillotine machines.

Semple's paper-cutter (Fig. 3525) is used for trimming the folded edges of books and magazines after the sheets are stitched. Two bundles of books are placed on platform *a* with their backs to the standards *c c*, and are held down by the screw *b*. The platform is then drawn up the inclined track by the action of worm-gear *c*, and the sheets are brought against the knife *d* with a drawing cut. Platform *a* is pivoted to carrier *f*, and revolves to present the top, bottom, and sides of the books to the knife.

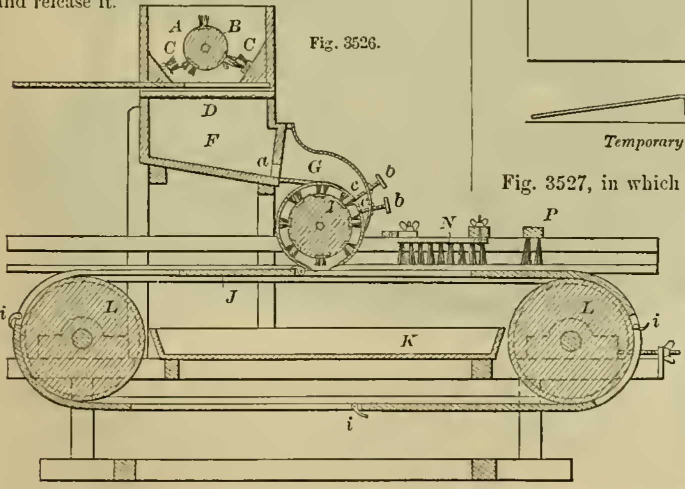
Fig. 3525.



Paper-Cutting Machine.

Pa′per-en-am′el-ing Ma-chine′. In Fig. 3526, the enameling mixture is thoroughly stirred within the chest *A* by stationary and revolving brushes *B C*; falling through the diaphragm *D* to the chamber *F*, it passes through the gate *a* to the spout *G*, whence it is admitted by the adjustable screw-valves *b c* to the brush-roller *I*, rotating within a cylinder baving an opening at its lower side, through which the brushes spread the enamel on the sheet of paper passing along on the endless belt *J*. This is revolved by two cylinders *L L*, having fingers *i i*, which clutch the sheet when presented to them, and after carrying it past the spreaders *N* and blenders *P* fall and release it.

Fig. 3526.



Paper-Enameling Machine.

Pa′per-feed′er. A device for delivering paper singly in sheets to a printing-press, ruling-machine, envelope-cutter, paper box or bag machine, etc.

Sheets are frequently fed to a press or ruling-machine by hand; the pile lies on a feed-board, and the sheets are thrust forward against a guide by a slight blow, the grippers or feed-rollers then seizing the sheet by its edge and carrying it over the guide.

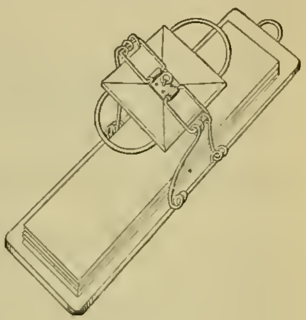
A form of pneumatic feeder has a number of suckers exhausted by an air-pump. The suckers raise the edge of the top sheet, when a puff of air prevents other sheets from following. The edge of the lifted sheet is brought parallel with the grippers, which then carry it to the press.

One form of feeder uses a revolving brush, which sweeps the top sheet from a pile against guides. As the pile diminishes in hight, it is raised by springs underneath.

File-cut fingers to draw a sheet by friction to positive grippers are also used.

Envelope and paper-bag machines sometimes seize their sheets by a gummed roller or claw. The gummed surface of the paper is utilized in the subsequent folding of the parts together.

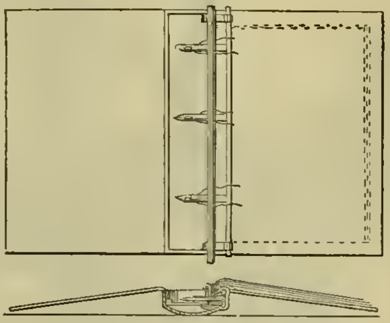
Fig. 3527.



Letter-File.

Pa′per-file. A device to hold letters or other papers in a pack. Among the many forms may be noticed: —

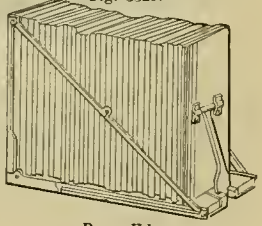
Fig. 3528.



Temporary Binder for Letters.

Fig. 3527, in which the papers are pressed upon a bottom board by a spring follower above.

Fig. 3529.



Paper-File.

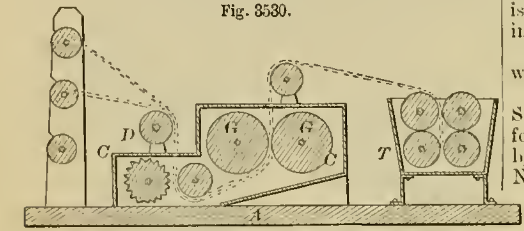
Fig. 3528, in which letters are impaled by their edges and held in a case or temporary binder.

Fig. 3529, in which the boards of the files are made to fold together, and are held at a right angle when opened, by a pointed brace. The follower is jointed to a bar whose lower end slides and clamps in a longitudinal, under-cut groove. See also PAPER-CLAMP ; LETTER-FILE.

Pa′per Floor-cloth. An artificial cloth, used as a substitute for oil-cloth for floor covering and other purposes. It usually consists of a thick sheet or associated sheets of paper treated with paints or varnish.

Fig. 3530 is a machine for converting two sheets of paper into parchment-paper by passing them through dilute sulphuric acid and uniting them so as to form a compound sheet suitable for floor coverings, belting, etc. The two webs pass conjointly over the roller *D* to a second roller working against a toothed perforator, which assists in uniting them, this part of the operation being completed by the rollers *G G* in the acid-box *C C*. It is afterward washed by passing between rollers in a water-trough *T*.

Fig. 3530.



Paper Floor-Cloth Machine.

Pa′per-fold′er. A bone knife used in folding paper, folding signatures for sewing, and feeding paper from the *bank* to the press.

Pa′per-fold′ing Ma-chine′. A machine for folding printed sheets preparatory to binding.

J. S. Gallaher completed a folding-machine in 1843, deposited a model in the United States Patent Office, and published a description in the Baltimore "Sun." It embodies a vibrating blade, folding a sheet through a slit in the feed-table into the bite of rollers, from which it is carried by endless bands to a second knife between a second set of folding-rollers, and finally deposited in a trough.

Birchall's English patent of 1847 shows mechanism for folding the sheet by a reciprocating knife into folding-rollers.

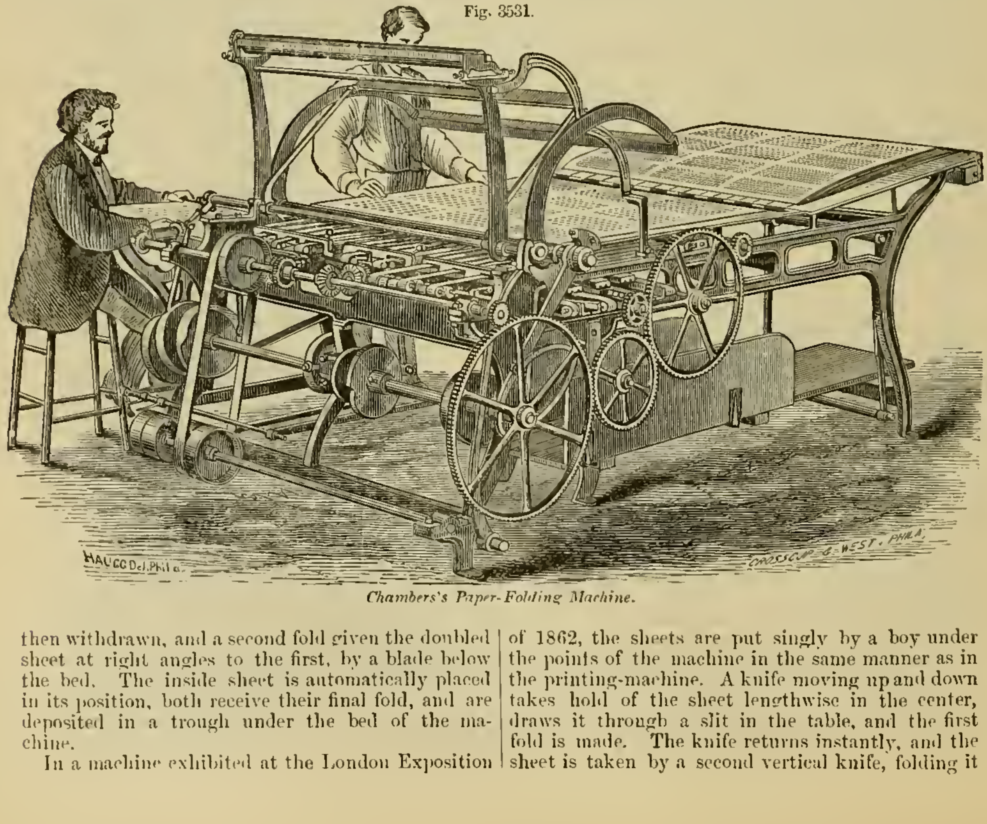
Black (English), 1850, had registering-pins, which were vibrated out of the sheet.

See also Smith's patent, November 27, 1849 ; Snow, October 15, 1850 ; English patent No. 13,315, for 1850 ; North's patent, October 15, 1856 ; Crosby, December 23, 1856 ; Smith, May 19, 1857 ; North, August 10, 1858 ; Endriss, March 8, 1859.

Chambers, 1856, had registering-pins to fit the perforations made by the printing-press. (See POINT.) These pins or points are adjustable, and, as the folding-blade descends, recede by a cam movement.

Chambers's machine (Fig. 3531) is adapted to fold large double-sheet papers. The sheet to be folded is spread upon the folding-table, and the register secured by points. The folding-blade overhead falls on the middle of the sheet and carries it down, doubled, through a slot in the table. The blade is then withdrawn, and a second fold given the doubled sheet at right angles to the first, by a blade below the bed. The inside sheet is automatically placed in its position, both receive their final fold, and are deposited in a trough under the bed of the machine.

Fig. 3531.


HAUGG Del. Phila.
CROSSCUP & WEST. PHILA.

Chambers's Paper-Folding Machine.

In a machine exhibited at the London Exposition of 1862, the sheets are put singly by a boy under the points of the machine in the same manner as in the printing-machine. A knife moving up and down takes hold of the sheet lengthwise in the center, draws it through a slit in the table, and the first fold is made. The knife returns instantly, and the sheet is taken by a second vertical knife, folding it at right angles to the first fold. Before the third fold is made the stitching operation commences; two needles, provided with hooks, passing through the middle of the sheet about an inch distant from each other, draw through the cotton unwound from a bobbin and cut to the required length. The sheet is then folded a third time by a knife acting at right angles with the second one, which takes hold of the sheet and pushes it between a pair of ribbed rollers, whence it passes directly to another pair of polished rollers, and is deposited on the table.

Ford's combination of a folding-machine with a printing-press (1872) is arranged so that the flyer of the press will deposit the papers upon tapes instead of on the ordinary tables, the papers being thence, by and upon the tapes, conveyed to the folding apparatus, and there folded as rapidly as they are printed. See FOLDING-MACHINE.

Pa'per-gage. (*Printing.*) An instrument for measuring the type-face or *measure* of printed matter and the width of margin. It is usually a squared stick on the sides of which are numbered columns of the different sizes of type.

Pa'per-hang'ing. The art of covering walls with decorated paper. The sheet of paper is unrolled, cut to a proper length, the edge trimmed, a coat of paste applied to the back and one end of the piece attached to the upper part of the wall, the lower part hanging suspended thereby; the workman then lightly dabs the face of the paper with a cloth, commencing at the top and working downwardly until he reaches the bottom, causing its adhesion to the wall and insuring a smooth surface. When the wall has been covered in this way, a narrow slip is pasted around its upper edge, concealing the ends of the pieces and serving for ornament.

The name is derived from the tapestry hangings, for which it forms a substitute.

The art originated in China, where it has been in use from time immemorial. England appears to have been the first European country into which it was introduced; Lanyer, 1634, having obtained a patent for a velvet paper surfaced with a short, dyed, woolen flock, which adhered to figures printed in glue on the paper. This invention was also claimed by several Continental inventors.

Among the kinds of paper-hangings may be cited: —

That simply printed in colors by stencils, blocks, or cylinders.

Flock paper, having a thick covering of woolen stuff, chopped fine and dyed. This adheres to the required portions, which are printed in glue.

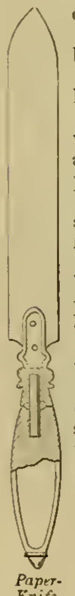
Metallic-dust paper, in which flattened specks of metal are caused to adhere to the figures on the paper. See WALL-PAPER.

Pa'per Hot-press. This was invented by Turnbull of England, who adapted the press then used for packing and hot-pressing cloth to the purpose of hot-pressing paper. Noticing the damp and uneven character of the printed work, he placed some circulars between the hot iron plates, and brought down the heavy screws upon them. He then started the business which his descendants retain.

Pa'per-knife. A blade of ivory, mother-of-pearl, or bone, used in cutting leaves of books, folding sheets of paper, etc.

The illustration shows one with an ivory blade riveted to a tang, which is socketed in a vulcanite handle.

Fig. 3532.



Paper-Knife.

Pa'per-mak'ing Ma-chine'. The history of paper is considered under the caption PAPER (which see). The making of paper by machinery commenced near the close of the last century. Previous to this time paper had been made in hand-molds of wire, which molds were made by hand of wires laid parallel and secured at intervals by a fine wire binding. This could be readily made of sufficient size for such sheets as were then required, and the paper of that day shows by its margin the mark of the *deckle.*

The following will indicate the succession and dates of the inventions in the line of paper-making machines. Some collateral points of interest are also noted: —

1750. Woven paper-molds introduced by Baskerville.

1759. The rag-engine introduced into England from Holland, where it was invented about 1750.

1790. The practice of bluing paper is said to have originated about this time from the circumstance of an English paper-maker's wife having accidentally dropped her blue bag into some pulp in an advanced state of preparation.

1798. Louis Robert, a workman in the establishment of Didot, at Essone, France, announced that he had discovered a way of making sheets of paper of large size by machinery.

1799. Paper in an endless web actually made by Robert.

1800. 8,000 francs awarded by the French government to Robert for his invention, and leave granted him to take his working model to England

1801. John Gamble, an Englishman, who had accompanied L. Didot from Paris with Robert's machine, obtained a patent therefor in England.

Matthias Koops made paper from straw, wood, and other vegetable matters without the addition of other paper stuff. He also discovered a process for extracting ink from old paper.

1803. Bryan Donkin produced a self-acting paper-machine on Robert's plan He had been employed by Didot and Gamble for this purpose, and appears to have made great improvements on the original.

1804. Henry and Sealy Fourdrinier of London purchased the patents of Didot and Gamble. From the improvements made under their auspices and their manufacture of it on an extensive scale, it received the name of Fourdrinier machine, by which it is generally known.

1805. Donkin altered the position of the cylinders, and by dispensing with the upper web simplified the machine and enabled it to perform a greater amount of work.

1806. Francis Guy of Baltimore obtained a patent for paper carpeting.

1809. The cylinder machine invented by Dickenson, an English paper-maker.

1817. High glazing introduced by Heath; also English card-board manufacture.

1819. The London Society of Arts and Manufactures awarded thirty guineas to Mr Fiosley for the invention of ivory paper.

1821. T. B. Crompton in England obtained a patent for drying and finishing paper by means of a cloth against heated cylinders, and the application of a pair of shears to cut the paper into suitable lengths as it issued from the machine.

1826. Canson in France applied the system of rarefying the air beneath the web, used in the Dickenson cylinder machine, to the Fourdrinier machine.

1827. Canson invented a method of sizing pulp in the vat, using wax as a basis; Delcambre in the same year employed a size having rosin as a basis; and Obry conceived the plan now generally adopted in France of using rosin and alum dissolved in a solution of soda and combined with potato starch, for the same purpose.

1828 George Dickenson patented an improvement in paper-machines, consisting in giving an up-and-down movement to the paper instead of the shaking lateral movement imparted to the wire web of the Fourdrinier machine, which tended to form longitudinal streaks or ribs in the paper.

A similar contrivance was also introduced by Donkin.

1828. Professor Cowper patented in England a paper-cutting machine which served as a basis for subsequent improvements.

Richard Waterman and G. W. Annis, of Providence, R. I., patented a method for making double paper by bringing a sheet previously formed in contact with the stuff on the belt and passing both between press-rollers; any number of thicknesses, it was claimed, might be combined in this way.

Crompton and Miller patented a method of cutting an endless web of paper lengthwise by means of revolving blades on a rotary shaft.

Mason Hunting, of Watertown, Mass., patented an improved top press roller, adjustable so as to form paper of any desired thickness by a single operation.

Marsden Haddock of New York obtained a patent for a machine for making paper by dipping, as in the hand-process

1829. W. Dobit, of East Hartford, Conn., patented a machine for cleansing and preparing rags for use in paper-stock.

Isaac Saunderson, of Milton, Mass., patented a horizontal whirl-wheel and sheet-forming rollers in connection with the cylinder machine, to cause a more uniform felting of the fibers, insure equality of strength in both directions of the paper, and enable thicker papers to be made

Reuben Fairchild, of Trumbull, Conn., patented an agitator, a semicircular cylinder in the vat vibrating transversely to the making cylinder, for the same purpose.

Thomas Cobb of England patented a method of tinting paper and embossing it during the process of making by passing it between engraved rollers, also surfacing paper with silk, velvet, or other fabric.

1830. A sheet of paper 13,800 feet long and 4 feet wide was manufactured at Whitehall Mill, Derbyshire, England.

Richard Ibotson patented a device for separating from the *stuff* the knots which had passed the strainer. These had previously been picked out by hand.

In England, John Hall patented a mode of introducing water to the vat, by which a considerable pressure was effected on the exterior of the cylinder, causing the pulp to adhere more firmly thereto.

John Wilks added a perforated cylinder to the Fourdrinier machine to facilitate the escape of water from the web previous to its passage through the pressing-rolls; and Dickenson patented a machine for forming a double-web paper by uniting the web in process of formation with a sheet previously formed. Thomas Barratt obtained a patent for a means of impressing the water-mark and maker's name in continuous paper, so as to resemble that made by hand Thomas and Woodcock, of Brattleboro', Vt., patented a pulp-dresser; and Thomas Gilpin, of Philadelphia, a paper-calendering apparatus

1831. J. J. Jaquir obtained a patent for making continuous paper with wire-marks similar to hand-made paper.

Edward Pine, of Troy, and E. N. Fourdrinier patented apparatus for cutting continuous paper into lengths; and Turner, a strainer designed to supersede the agitating vat of the Fourdrinier machine. Carvil, of Manchester, Conn., patented a screen with fans; and John Ames, of Springfield, Mass., introduced a wire cylinder for the purpose of cleansing rags.

1832. James Sawyer, of Newbury, Vt., invented a piston pulp-strainer; John Ames, a sizing-machine.

1852. G. W. Turner, London, England. Improved mode of applying an endless wire-web in a paper-machine; also, mode of passing the paper through a trough of size between two endless felts.

1853. Brown and McIntosh, Aberdeen, Scotland. Hollow perforated mold, covered with felt, to which the pulp is caused to adhere by rarefaction of the contained air.

1853. Machine patented in England for preparing wood for making paper.

1856. Horace W. Peaslee, Malden Bridge, N. Y. Drying cylinder for paper-machines, comprising spiral tubular heater, non-conducting cylinder, and exterior metallic casing.

V. O. Balcom, Bedford, Mass. Revolving pulp-tub with grooved grinding roller rotated therein at a different rate of speed.

Thomas Lindsay and Wm. Geddes of Connecticut. Varying the width of paper while the machine is in operation by forming the trough which delivers pulp to the web in two parts, sliding one over the other and varying the distance apart of the *deckle-straps*

1859. M. L. Keen, Roger's Ford, Pa. Paper-stock boiler for ligneous matters.

Martin Nixon, Philadelphia. Boiler for treating paper-stock under pressure by the action of upward current of steam and downward current of hot alkaline solution.

Crocker and Marshal, Lawrence, Mass. Combination of drying-cylinders, moistening apparatus, and calender-rolls for finishing paper.

1860. Jordan and Kiney (reissued patent). Conical grinder and case having induction and eduction pipes for rags and size.

C. S. Buchanan, Ballston Spa, N. Y. Rotary boiler with cylindrical concentric strainer and hollow trunnions, for treating paper-stock.

Gelston Sanford, New York. Pulper with conical ribs and serrated rubbers.

A. Randel, New York. Rag-machine with differential rolls, shredding cylinder, and spiked concave.

A. S. Lyman, New York. Separating fibrous matters by subjecting them in a close vessel to the action of an apparatus for beating, rubbing, grinding, or picking, and water at high temperature and pressure.

1863. E. G. Rutledge, Dayton, O. Creating a current in the vat in the direction of the pulp-cylinder.

J. F. Jones. Means for conveying away water from the interior of the *making* cylinders through hollow journals

John Cowper, England. Rag-mill comprising endless feeder which feeds the material to fluted rollers that deliver it to a toothed rotating cylinder.

J. F. Jones, Rochester, N Y. Machine by which a number of continuous webs may be made, or they may be united to form pasteboard.

M. L. Keen, Roger's Ford, Pa Pulp-boiler with perforated diaphragm, discharge pipe and valve for blowing out the contents under pressure

Ladd and Walsh, New York. Boiler for treating fibers with or without alkali, having a perforated diaphragm for keeping the mass submerged during the process.

The Fourdrinier machine, as improved by Bryan Donkin and subsequent inventors, is illustrated in Fig. 1, Plate XXXVII. That shown, built by George Bertram of Edinburgh, is what is known as an 80-inch machine, that is, the endless web of wire cloth on which the pulp flows is 80 inches wide and 33 feet in length, capable of forming paper over 6 feet wide after trimming the edges, and of indefinite length. The whole machine is about 68 feet long. The operation is as follows: —

Pulp from the beating-cylinder is admitted to the chest *a* through a strainer *b*, consisting of a sheet of metal through which strips are cut; it is here constantly agitated by a stirrer *c*, and is caused to flow into a second and smaller chamber provided with a similar stirrer, which delivers it (after passing over a channeled plate by which extraneous matters of greater specific gravity than the pulp are arrested) on to the endless wire web or apron *d*; to this a shaking movement is imparted, distributing the pulp-fiber evenly over its surface. It is supported on a series of small rollers, and the width of the paper is governed by deckle-straps *e* at each side, which are carried by rollers *f f*, their tension being regulated by the arrangement shown at *g*. *h* is a vacuum-box from which the air is partially exhausted by a set of air-pumps, and which withdraws in part the moisture from the paper as it passes over the box. It is then carried between the cloth-covered rollers *i i*, by the lower one of which and the rollers *j j j* the wire-apron returns to receive a fresh supply of pulp, the paper being transferred to the blanket felt *k*, which conveys it to the press-rolls *l l*; these are solid, and over the upper one is a thin edge-bar, which removes adhering particles of fiber from the roll, and also serves to arrest the progress of the paper should it stick to the roll, thus preventing injury to the blanket. These rolls are adjusted in their bearings by the screw *m*, so as to exert greater or less pressure. The blanket then conveys the sheet to a position where it may be received by the second press-rollers *n n*, which farther compress and expel the moisture from it, and the blanket returns by way of the rollers *o o o* to the point whence it set out. After passing the press-rolls, the paper is received on a second endless blanket, which carries it to the first of a series of steam-heated cylinders, 1 2 3 4 5, between which it is partially dried and conveyed between other pressure-rollers *s*, and thence to a second set of drying-cylinders 6 7 8, whence, after being subjected successively to the pressing and stretching action of the rolls *p p*, it is delivered on to the cylinder or reel *f*. Registering mechanism indicates when a certain quantity has been delivered on to the reel, which is then removed and a fresh one substituted

The number of drying-cylinders in a machine of this class may be indefinitely increased. In some cases more than 100 are employed, the object being to allow the sizing material to become thoroughly incorporated and to form a product resembling hand-laid paper in quality.

Dickenson's patent of 1847, improvement on patent of 1830, is for an arrangement so that the upper side of the double sheet, that which has not been in contact with the wire grating of the making-cylinder, shall be brought in contact with the metallic press-roll, and in the use of an exhaust-trough between the first and second press-rolls.

In Fig. 2, Plate XXXVII., *a a′* are the two making-cylinders; *b b′*, the couching-rolls. From these the paper is taken by the endless felt *c* to the first press-rolls *d d*, where it is slightly pressed between the felt *c* and another felt *e*, which revolves around the upper press-roll; the paper is then detached from the first felt and led upon another endless felt *f*, which conducts it to the second press-rolls *g g*, where it is farther slightly compressed, and after passing over the guide-rolls *h h* is carried to the third set of rolls *i i*, where a greater pressure is imparted, and thence to the steam-heated cylinders *j j′*, where it is dried and finally wound upon the reel *k*. *l* is the exhaust-trough; it is connected by a pipe with an air-pump, and has rollers for supporting the paper passing over it on longitudinal partitions adjustable to the width of the paper.

In the same patent Dickenson describes a modification of his machine for making triple-webbed paper, the face consisting of a ready-made sheet wound upon a reel to which the others were applied during their joint passage between the press-rolls.

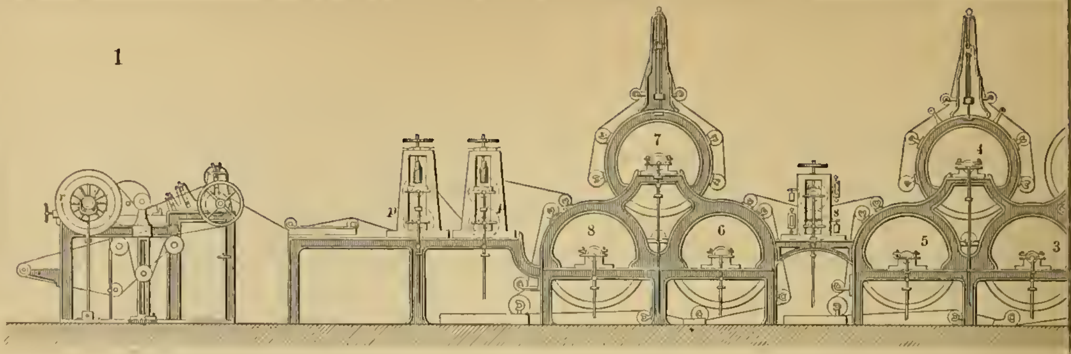
In Scanlan's paper-making machine, the cylinder and Fourdrinier machines are combined for the purpose of making a double-webbed paper. The two webs may be of different texture and color.

In Fig. 3, Plate XXXVII.

a a′, framework of Fourdrinier machine.

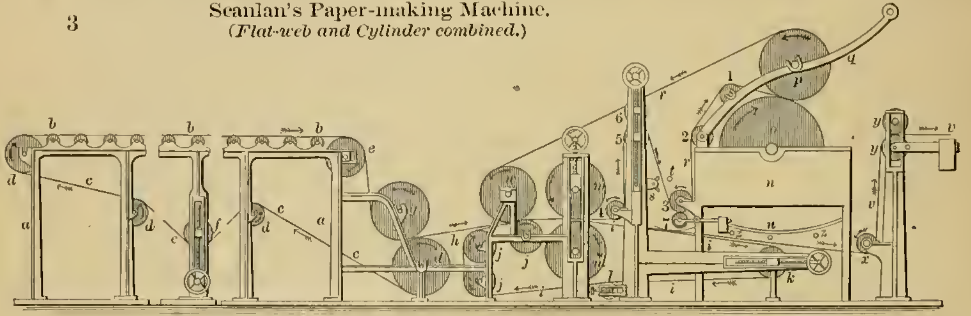
b b, rollers beneath the wire apron *c*.

1



3

Scanlan's Paper-making Machine.
(Flat-web and Cylinder combined.)



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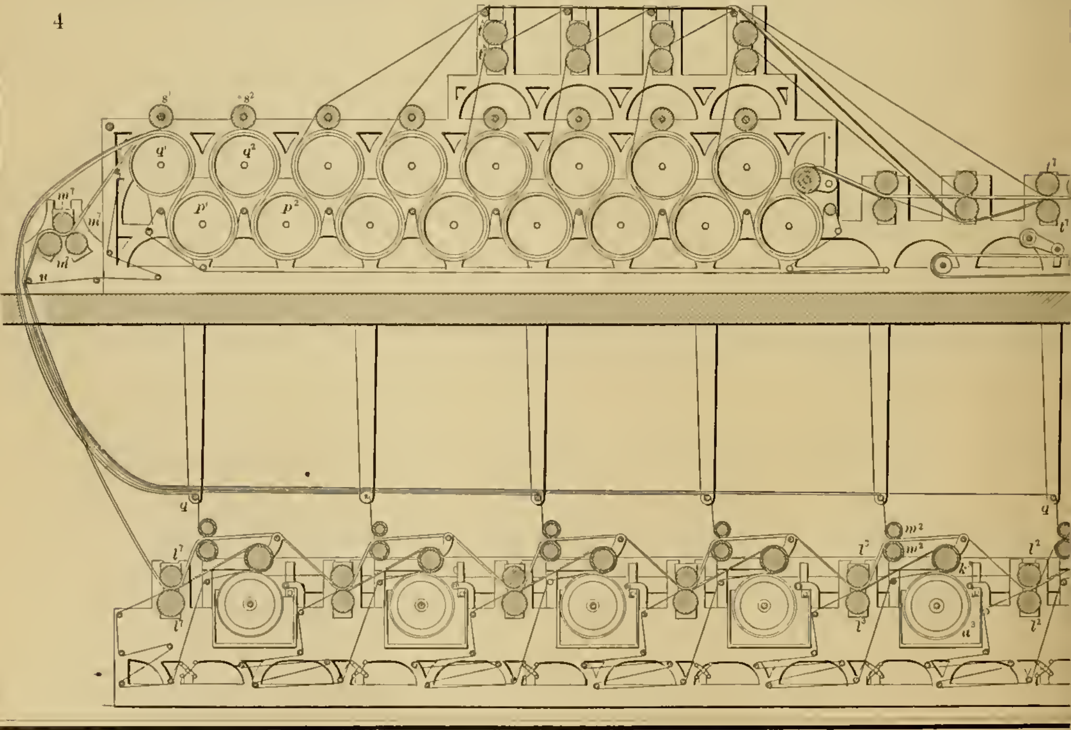

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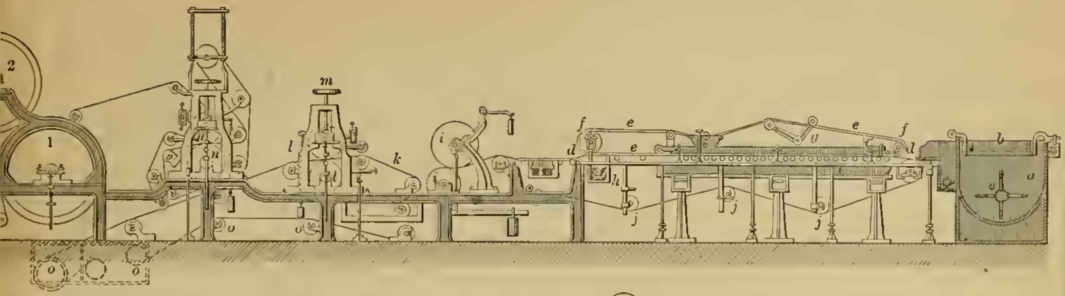
PLATE XXXVII

Fourdrinier Paper-making Machine.
(Flat web.)



Dickenson's Paper-making Machine.
(Cylinder.)

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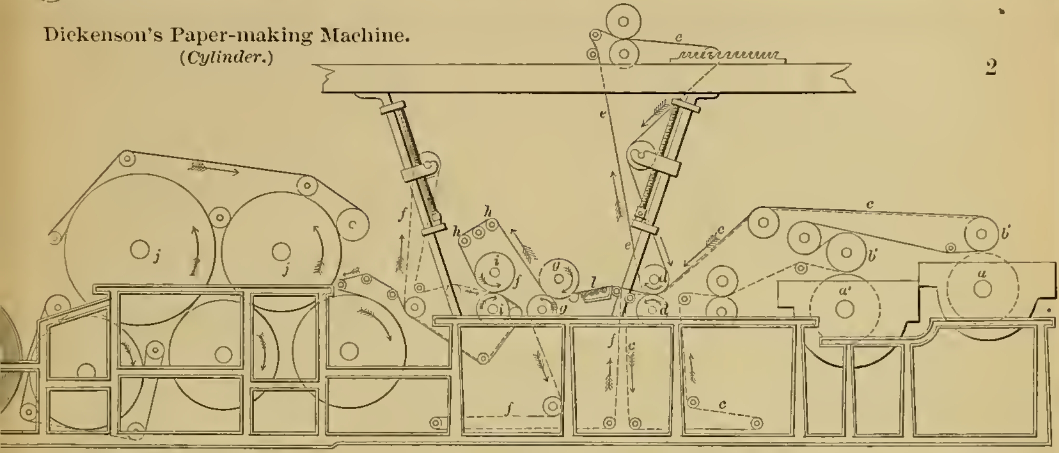
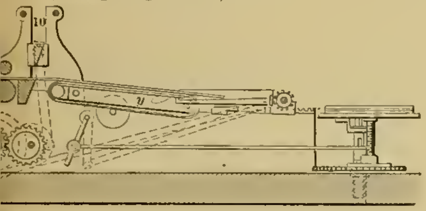


Jones' Pasteboard Machine.
(Multiple Cylinders.)



Field's Strawboard Machine.

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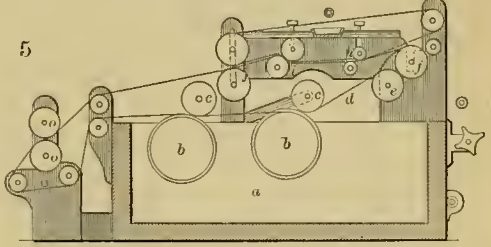
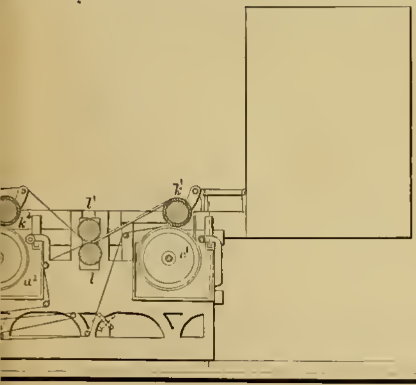
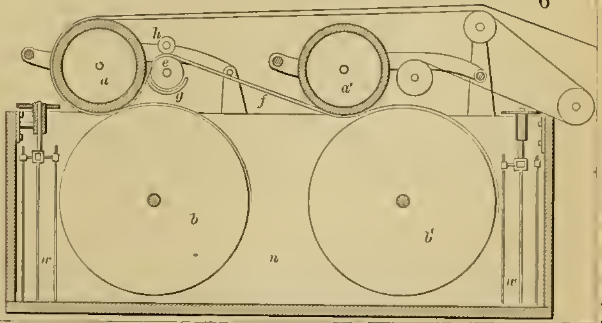




Harris's Double-cylinder Machine.

6



EBOARD MACHINES.

See page 1624.

d d, apron-rollers.
e, guide-roller.
f, tightening-roller.
g, coucher.
h, sheet of paper.
i, first felt.
k, tightening-roller.
l, guide-roller.
m m, first press-rollers.
n, pulp-vat of cylinder-machine.
o, making-cylinder.
p, coucher.
q, coucher-frame.
r, making-felt.
1 2 3 4, making-felt rollers.
5 6, tightening-rollers.
7, squeezing-rollers.
s, felt-washer.
t, shower water-pipe.
u, drip-water guard, heated by steam from *z z*.
v, junction felt.
x, guide-roller for sheet.
y y, second pressure-rollers.

The two webs pass from each machine in the direction indicated by the arrows between the rollers *j w*, and are united by the pressing-rollers *m m*, the final pressure being given by the rollers *y y*.

The advantages claimed are that a less quantity of pulp may be used, requiring a less vacuum under the wire apron of the Fourdrinier machine, and causing less strain upon it; that, the backs of the two sheets being united, an equally hard, smooth face may be formed on each side of the paper, and that any defective parts in either sheet are covered by the other.

Either the cylinder or Fourdrinier part of the apparatus may be separately used, if required.

In Jones's pasteboard machine (Fig. 4, Plate XXXVII.) the web formed by the first cylinders at k' passes the rolls l l', and first press-rolls m' m', and is united between the rolls l^2 l^2 with the web formed by the second pair of cylinders at a^2; the combined web passes through the rolls m^2 m^2, and is united between l^3 l^3 with the third web formed by the cylinders at a^3, and so on, successively taking up the webs formed by each pair of cylinders until the combined sheet passes through the press-rolls l^7 l^7, and is conducted through an opening in the floor above to the press-rolls m^7 m^7, which convey it to the drying-cylinders p' p', p^2 q^2 and calendering-rolls s' s^2, etc., on emerging from which it is carried between the final set of calendering-rolls t^7 to t^7, and thence to a cutting apparatus consisting of a fixed knife and a vertically reciprocating knife working in guides 10, which cut it into sheets. These are delivered singly by an endless band *y* on to a fly which deposits them one by one as fast as cut on a receiving-table. Each of the webs which combine to form the board may, if desired, be kept entirely separate from the others, by winding on the rolls *q q* after passing through its own press-rollers; or the thickness of the board may be varied by connecting together two, three, or more of the webs independently of the rest; or some of the making-cylinders and couchers may be thrown out of action.

Field's machine (Fig. 5, Plate XXXVII.) is of the cylinder class, and an endless wire belt is employed in combination with an endless felt. *a* is the vat, *b b* the making-cylinders, *c c* the couchers. The web passing between the cylinder and coucher is conveyed on the under side of the felt *d* to the squeezing-rolls *e f*, the lower one of which is arranged to the left of the upper, so that the water expressed from the web may not flow back and remove the pulp from the felt. The web, thus partially dried, passes under the wire-cloth and between the pressure-rolls *h i j*; the final pressure being applied by the rolls *o o*.

This invention is particularly designed for manufacturing straw-board and other thick papers.

In Harris's double-cylinder machine (Fig. 6, Plate XXXVII.), the left couching-roller *a* is placed at the left of the making-cylinder *b*, a gauze-covered roll *e* and solid roll *h* receive the single web from the right-hand cylinder *b* and coucher *a'*, from whence it passes by the apron *f* between the left-hand cylinder *b* and coucher *a*, and is united to the web formed thereon.

Vertical agitators *w* are provided at each end of the tank *n*, instead of horizontal agitators between the making-cylinders, as in the common construction.

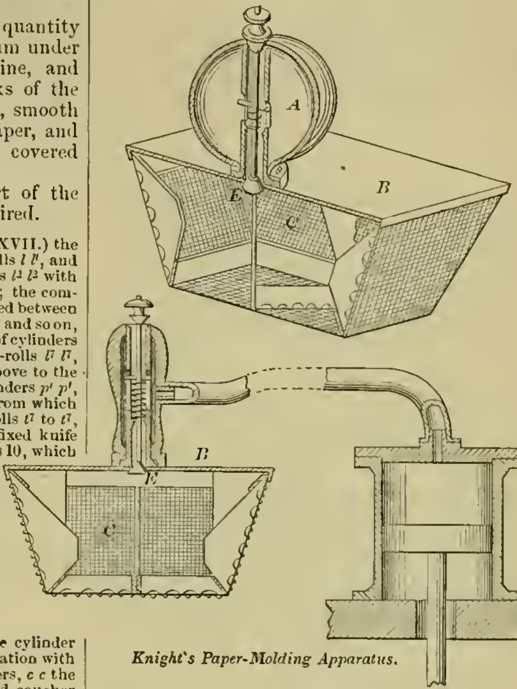
Pa'per-mold'ing Ma-chine'. One in which paper-pulp is molded to the form required, the *shape* being afterward dried. The object is then finished by sizing, varnishing, painting, or what not, according to its purpose.

Brown and Macintosh, English patent 14,131 of 1852, describes a mode of making paper and articles of paper in hollow molds or frames with permeable surfaces, and within which a partial vacuum is obtained. The mold has preferably a covering of felt, upon which the fiber is deposited while the water passes through, and this felt is removed from the *former* with its deposited paper envelope.

See also American patent of French and Frost, 1856; Brown and Smith, 1851; Hatfield, 1862.

Fig. 3533 illustrates the principle of action. A *former* of the shape required — in this case a rectangular lamp-shade — is made of wire-gauze *C* stiffened with internal strengthening plates. The figure shows a mold *B* with a hollow handle, connecting by a flexible tube with an air-pump. The pulp is collected upon the foraminous surface, through which the water passes as the air is exhausted from the interior of the *former*. The sheet of pulp is discharged by the internal pressure of air, the pump being worked as a compressor. The fiber of slightly felted pulp is received from the *former* by a felt cap which fits upon the film, and is from it transferred to a block on which it is dried.

Fig. 3533.



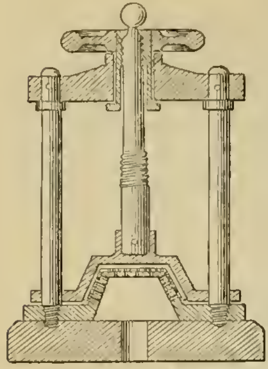
Knight's Paper-Molding Apparatus.

The machine just described depends upon an exhausting air-pump to draw water through the meshes of the wire-gauze which detains the fiber of the pulp, and the thickness of the film of pulp will depend upon the thickness of the pulp and the rapidity and duration of the stream of water passing the wire-gauze. The compression system, in which a quantity of pulp is driven through the meshes of a former on whose surface the fiber collects, has also been repeatedly tried. A third plan is that in which a displacing plunger descends into a molding-former and drives out the water, compacting the pulp against the sides of the *former*.

Fig. 3534 is a machine for pressing and compacting the molded article. The rigid, perforated frame, with the article formed in paper-pulp upon it, is removed and placed beneath a die which expresses the water from the pulp.

In another machine, the blanks are made from paper-pulp in shape suitable for forming boxes, etc. The creases made in the blanks facilitate the bending into form, and the notches in the corners obviate the

Fig. 3534.



Press for Articles of Molded Pulp.

necessity of cutting into shape. See also Kimball's patent, 1868.

In Smith's machine, 1868, the paper-pulp box is made by the sudden descent of a plunger into a perforated mold, which has a permanent perforated lining and removable bottom. The plunger is constructed to automatically admit air beneath its lower end just previous to its withdrawal from the cavity of the completed box or other hollow article. The bottom drops to discharge the molded box.

Leclère's machine, December 8, 1868, is designed for the formation of hollow paper articles from paper-pulp, and operates by employing over a pervious former a column of thin pulp, which in hight several times exceeds the hight of the article to be made.

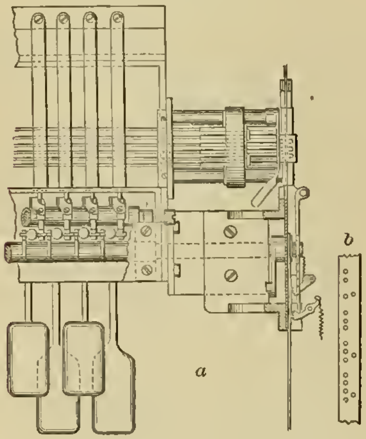
The pulp is condensed on the former and the water expelled therefrom against the atmospheric pressure by covering the pulp-covered *former* with a close vessel, and admitting air under pressure within the *former*. The paper is removed from the cap which received it from the former, and transferred to a receiving block by covering the block with the cap and admitting an air-blast into the latter.

Pa′per-mus′lin. (*Fabric.*) Glazed muslin used for linings, etc.

Pa′per-per′fo-rat′ing Ma-chine′. 1. A machine for perforating paper, as with postage-stamps in sheets, to make a weak line which may enable them to be separated by tearing.

2. (*Telegraphy.*) A machine to perforate strips of paper according to a code, the holes allowing the circuit to be closed, so that the circuit may be made and broken in a given sequence to indicate characters. Eddison's machine for this purpose is shown at Fig. 3535. *a* is the machine; *b*, a portion of a strip perforated for the use of an automatic telegraphing apparatus. A range of finger-keys is provided, and also a range of slide-plates operating upon punches. A presser-lever is connected by a cam with each finger-key, and contiguous thereto are projections upon such of the slide-plates as are to be actuated by the said finger-key; thereby, on striking the finger-key, the proper punches are actuated to punch the perforations necessary for the message complete; and on releasing the finger-key, the paper is drawn along the proper distance by a peculiar feeding mechanism, and the perforations are made in two lines, so that where three or more perforations are placed triangularly, a long pulsation may result from the metallic connection being made through these perforations successively, the contact being made through the second perforation before ceasing through the first, and so on. See also Little's patents, Nos. 91,240, 91,241.

Fig. 3535.

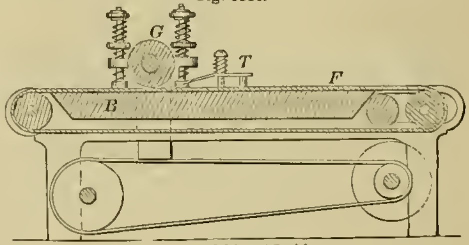


Eddison's Perforating-Machine.

Pa′per-pol′ish-ing Ma-chine′. A machine for surfacing paper by a burnishing action. A fine surface is given to paper by calendering and by pressure between glazed boards or hot plates. See CALENDERING.

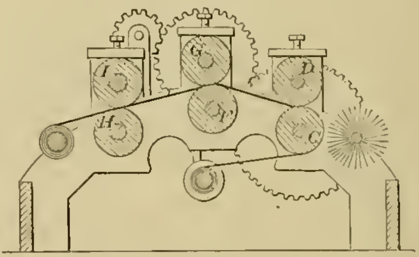
In Fig. 3536, the paper is carried on an endless belt *F* of rubber, velvet, or other material, passing over the table *B*. The burnishing-roller *G* rotates in the same direction with the endless belt, but with greater velocity, or it may turn in an opposite direction; it has also an endwise reciprocating movement. A spring presser-plate *T* keeps the paper down to the endless belt, and it or the table is made elastic.

Fig. 3536.



Paper-Polishing Machine.

Fig. 3537.

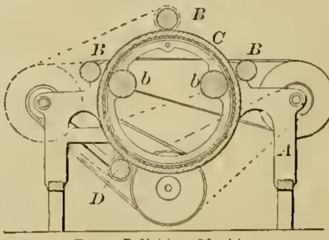


Machine for Polishing Enameled Paper.

Fig. 3537. The paper passes successively between the rollers *D C F G H I*.

The burnishing-rollers *G I* rotate faster than their fellows *F H*, and *I* has a greater velocity than *G*, so as to exercise a drawing action on the paper.

Fig. 3538.



Paper-Polishing Machine.

Fig. 3538. The hollow annular bed *C* is supported on rollers *b b* within its circumference, and has a reducing roll *D* revolving in contact with it to keep its periphery in true form. The paper is polished by passing between the rolls *B B B* and the hollow cylinder.

Pa'per-punch. An implement for making holes in papers for the purposes of filing, temporary binding, for the reception of eyelets, or for canceling. It is similar to the punches described under the titles of *ticket*, *conductors'*, *spring*, *leather* punches, etc.

Pa'per-rul'ing Ma-chine'. See RULING-MACHINE.

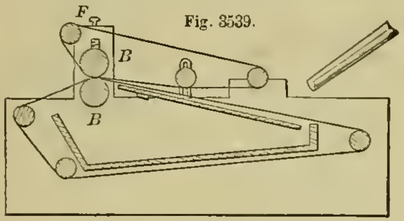
Pa'per-size. Writing-papers are sized with gelatine prepared from tanners', curriers', and parchment-makers' clippings. Plate-paper, when intended to receive impressions in colors, is sized with a clear solution of isinglass. These, or other gelatinous substances, as they impair the tenacity of the semifluid pulp, are applied subsequently to the formation of the paper into sheets or into a continuous roll. For printing papers, a compound of alum and rosin dissolved in a solution of soda and combined with potato-starch is generally used; this is mixed with the paper in the state of pulp.

Starch is also used, either in the form of a paste or as a clear solution.

Pa'per-split'ting. Two pieces of muslin are firmly cemented on the sides of the paper and dried. By a pull on each piece the paper is split open, a portion adhering to each piece of muslin. The halves are then loosened from the fabric by damping.

Pa'per-stock Bleach'er. The machine (Fig. 3539) is intended for expressing the bleaching material from paper-stock, without having recourse to the draining-vat.

Fig. 3539.



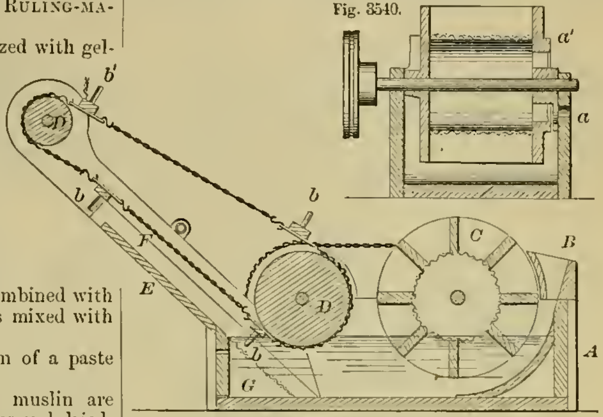
Paper-Stock Bleacher.

The stuff is delivered by a spout upon an endless apron, which is moved and kept tense by a series of revolving rollers, and passes between two rubber-covered rollers *B B*, adjustable to any desired pressure by screws *F*, which squeeze out the bleaching solution.

Pa'per-stock Wash'er. A machine for cleansing shredded rags preparatory to pulping.

The rags are fed into the hopper *B* and are drawn into the tank *A* and agitated by the arms of the wheel *C*. The axis of this wheel is surrounded by a wire-gauze drum, which permits the escape of the dirty water through the annular channel *a* in the end of the wheel *C* and aperture *a* in the tank, through which a current of water is continually flowing; the cleansed stuff is carried up the incline *E* and delivered at any required point by means of rakes *b b b b* attached to an endless chain *F*, passing around rollers *D D'*. The rake teeth are so long that they press with some force against the incline *E*, so that when released therefrom they straighten out with considerable energy, throwing off the stuff. A screen *G* separates gravel or other large particles accidentally intermixed.

Fig. 3540.

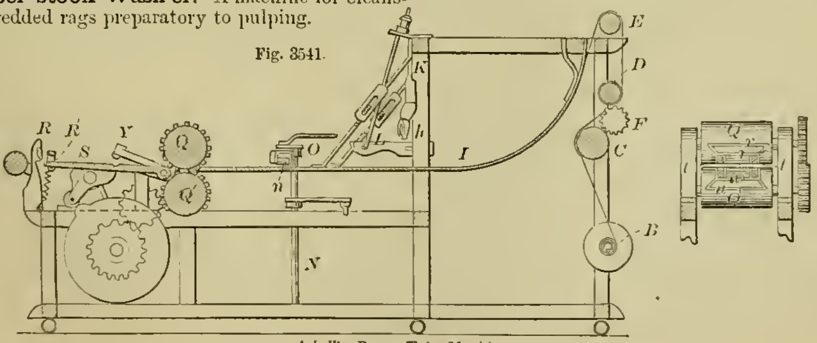


Paper-Stock Washer.

Pa'per-tube Ma-chine'. Fig. 3541 illustrates a machine for forming paper-tubes, which are severed into lengths suited for making bags, the bottoms being formed at a subsequent operation.

A continuous roll of paper is wound upon the flanged cylinder *B*, and is thence drawn upwardly on the roll *C*, passing between the furrowed roller *F*, which is partially immersed in a trough containing paste or mucilage, and the rubber-covered roller *D*, by which its edge is pasted; it thence passes over the guide-roller *E*, and is conducted downward along the curved plate *I*, which is concave on its upper side, the concavity gradually increasing as it approaches the blades *L*, one on each side; two pressure-rollers *h*, suspended from adjustable bars *K*, serve to hold up the edges of the strip until it is acted on by the blades *L*, which fold the edges over, the folding process being completed by a second pair of blades *n*, attached to adjustable arms *O*. It next passes between the rollers *Q Q'* geared together at one end, the upper one of which has a series of grooves *r r* corresponding to projections *u u* on the lower, which form creases in the tube, while at the same time incisions are made by the cutters *t t* at each side; the pasted edges are thus attached and the bottom shaped. The tube next passes over a loop or guide *Y* attached to pivoted arms by which the tension is regulated as it is presented to the action of the cutters *R R'*: one of these (*R*) is stationary and the other (*R'*) attached to a plate *S*, vibrated by means of a rock-shaft; between the two the tube is cut at the proper points into lengths suitable to form the bag. See also PAPER-BAG MACHINE.

Fig. 3541.

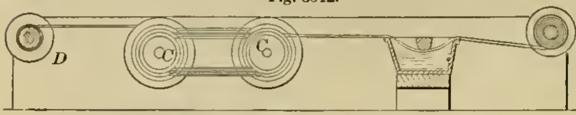


Arkell's Paper-Tube Machine.

Pa′per-twine. A kind of wrapping-twine prepared by twisting a long, continuous strip of paper.

In De Guinon's paper-twine machine, the strip is wound around a central spindle in a shallow circular pan revolving on journals, one of which is hollow and receives a tube through which the strip is drawn, being twisted at the same time by the revolution of the pan.

Fig. 3542.



Machine for Sizing Paper-Twine.

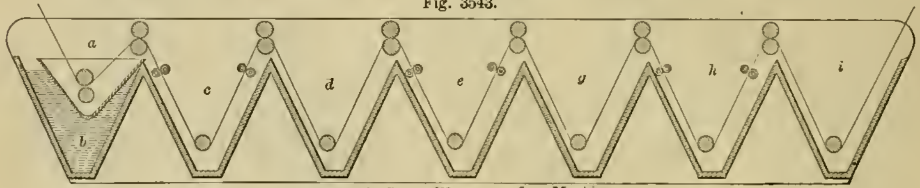
The twine is sometimes sized or varnished. This is effected by drawing it through a pan containing the sizing material. In the machine (Fig. 3542) it is at the same time caused to pass over cone-pulleys *C C*, gradually approaching their larger ends, so as to stretch it, and is then wound upon a reel *D*.

Pa′per Wa′ter-proof′ing Machine′. A machine for impregnating or surfacing paper with a water-resisting material.

Hudson's process of water-proofing paper passes it through a number of troughs containing chemical agents, by which it is acted upon successively.

Fig. 3543 shows a series of tanks used for this purpose. *a* contains a solution of sulphuric acid and water. To maintain this at a proper temperature, — about 60°, — a tank of ice *b* is placed underneath.

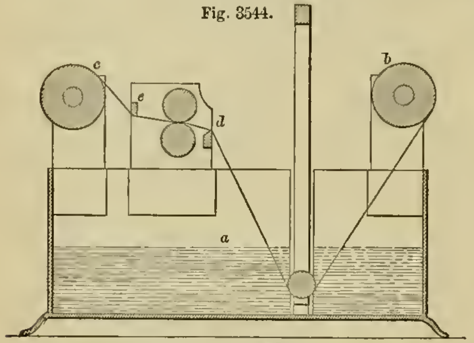
Fig. 3543.



Hudson's Paper Water-proofing Machine.

From the tank *a* the roll of paper is fed over a cylinder, passes between a pair of pressing-rollers, and down into tank *c*, filled with clear water. It then goes over another roller, and down into tank *d*, filled with dilute ammonia. It then passes over another roller, is again pressed, and goes through the vat of water *e*, where it is again washed. *g* contains lime-water, and after the roll of paper has passed through this, and been again washed in *h*, it is finally treated with glycerine in the vat *i*.

Fig. 3544.



Paper-Coating Machine.

A machine for coating paper with tar or asphaltum is shown in Fig. 3544.

a is a tar vat. *b* is a roll of paper, which is fed down into the tar, and is drawn out over the scrapers *d e*, and is wound upon the roll *c*.

Pa′per-weight. Paper-weights are made of various materials, as metal, ornamental stone, or glass. The former two are made by casting or cutting, but the latter, the most beautiful objects of their kind, are formed by arranging a series of small glass tubes of different colors so as to constitute the desired pattern within cavities in a thick disk; a layer of transparent molten glass is then applied, to which they adhere so as to be removable from the disk, after which a second layer of molten glass is applied to the opposite side; the whole is then heated and shaped by means of a moistened wooden concave spatula, and is afterward annealed and polished on the wheel. Figures or portraits made from refractory clay are inclosed in a similar way; but metallic objects, which would be injured by extreme heat, are merely inserted in a properly shaped cavity previously formed in the weight and secured by a cloth glued to its lower surface. See MILLEFIORE-GLASS. See also list under GLASS.

Pa′pier-maché′. A material composed principally of paper, to which other substances may be added to impart special qualities.

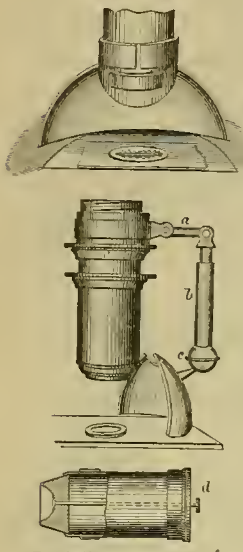
The art was probably derived from China. Paper-pulp was combined with gum or China clay by Montin, a German snuff-box maker, who is said to have learned the art from Lefèvre about 1740. In 1745, the year fatal to Lochiel, it was introduced into Birmingham, England.

The commoner varieties are prepared by pulping any kind or mixture of different kinds of paper into a homogeneous mass of a doughy consistence. Some earthy material may be mixed with the pulp, as well as chemicals, resinous substances, and glue to harden it and to prevent the attacks of insects. The pulp is rolled into thick sheets, and a sufficient quantity is taken to form the article of ornament desired; this is subjected to heavy pressure between cameo and intaglio dies and afterward dried. Its surface may now be gilt, painted with oil or size colors or varnished. The toughness and lightness of this material peculiarly adapt it for table-ware, table and desk furniture, interior architectural and other ornaments.

The papier-maché used for tea-trays and similar thin articles, which was introduced during the last century, and now forms an important department of industry, is made from sound whole sheets of paper of particular quality, somewhat resembling blotting-paper. These are pasted in successive layers, usually three, upon a metallic mold or pattern, and then dried, the exterior filed to give it a smooth surface, and another layer of three thicknesses applied by pasting; the whole is then again dried, three more sheets pasted on, and the alternate drying and pasting processes thus continued until the required thickness, usually 30 to 40 sheets, is attained. In some cases as many as 120 thicknesses of paper are employed. The article is now removed from the mold by inserting a knife under its edges, and its surfaces smoothed by the plane, the file, and the knife, after which it is colored and decorated. For this purpose, several coats of shellac-varnish are applied. Japan varnish is used for finishing the surface. This is generally highly polished, the very highest polish, it is said, being imparted by the friction of the hands of women. The final decorations in paint or gilding are in the commoner class of work laid on by stenciling, but in that of the finest quality the artist's brush or pencil is used, with inlaying of mother-of-pearl.

Par-a-bol'ic Il-lu'mi-na'tor. A reflector placed over an object beneath a microscope. Its shape is that of a half-paraboloid, the object being in the focus. The interior is silvered.

Fig. 3545.



Parabolic Illuminators and Reflectors.

Fig. 3545 shows Beck's illuminator with Couch's adaptor, *a b*; this is jointed to admit of free vertical movement, and its lower branch is sleeved so that it may be turned by the thumb-screw *c* to focus the reflector on the object. It is intended especially to illuminate opaque objects.

d is a *parabolic reflector.*

Par-a-bol'ic Re-flect'or. A cone of glass (*d*, Fig. 3545) with a paraboloidal depression which concentrates the illuminating rays upon an object placed in the focus. A small disk mounted on an axial pin forms a dark background behind the semi-translucent object, which is illuminated by an annular pencil of rays passing around the edge of the disk. See Spot-lens.

Par'a-cen-te'ri-um. (*Surgical.*) A small trocar for puncturing a dropsical eye.

Par-a-chute'. A device by which a descent is made from a balloon or eminence. It is a light structure, and affords a large area of resistance to the atmosphere.

Loubère, in his account of Siam published 200 years since, describes a machine of this kind used in descending hights.

It was not employed in Europe till 1783, when M. le Normand proved its efficacy by letting himself from the windows of a lofty house in the city of Lyons.

Blanchard, in a balloon ascension in August, 1785, let down a dog from a great hight by means of a parachute, without injury. He afterward applied it to descending from a balloon, in 1793, but, the machine failing to expand fully, he broke his leg in alighting.

The first successful descent by a parachute from a balloon was by Mons. Garnerin, in Paris, October 21, 1797; he descended again September 21, 1802, when on a visit to England for the purpose of practicing aërostation among the islanders. This parachute consisted of thirty-two gores of white canvas, formed like an umbrella of 23 feet diameter; at the top was a round disk of wood, 10 inches in breadth, having a hole in its center to admit short pieces of tape to fasten it to the gores of the canvas. About $4\frac{1}{2}$ feet below the top was a hoop 8 feet in diameter, attached by a string to each seam, and below the hoop the wicker-work car was suspended.

On this occasion, owing to one of the stays giving way, the parachute was caused to "wobble" during its descent, so as to assume a nearly horizontal position at times, and the aëronaut was thrown on his face and injured.

On the 24th of July, 1837, Mr. Cocking ascended in a parachute attached to Mr. Green's balloon for the purpose of making a descent in a machine of his own contriving. It was the reverse of Garnerin's, presenting its convexity downward, like an umbrella reversed, and was no improvement upon the Frenchman's machine. He thought that it would not be subject to the fearful swaying incident to the umbrella form, but would cleave its way directly, and so it did. He miscalculated the amount of resistance, also, and provided his car with a large quantity of ballast. When he detached his parachute, the balloon of Mr. Green ascended at a fearful rate, endangering the fabric; the gas poured down on Green, and might have suffocated him but for the precaution he had taken of having some bags of atmospheric air to support respiration.

Poor Mr. Cocking shot downward, his framework expanded at a bang, breaking some of the cords, which gave it unequal areas of resistance on the respective sides. This made it sway fearfully until some more cords broke, when down he went and was killed upon the spot.

The writer will hazard the prediction that the true form of the parachute will be found in a structure resembling the thistle-seed; a multitude of parts, each light and relatively weak, but opposing an extended and pliable surface to the atmosphere, the resistance of the parachute being the sum of the multitudinous resistances of the gauzy or fibrous portions. The present type seems to be the umbrella, or the pair of wings, — one, subject to destruction if a portion give way; the other, requiring skill in direction and change with varying circumstances and currents of air.

Par-a-chute'-light. A suspended light for use in war to illuminate an enemy's position.

It consists of a large muslin parachute packed in an iron hemisphere, and attached to a second hemisphere containing a light composition. The hemispheres are soldered together. The ball is fired at a high elevation from a mortar, and when the time-fuse explodes the hemispheres are separated, the composition lighted, the parachute expanded, and the light floats along, gradually descending, the flame issuing in a jet below.

Par-a-chute'-light Ball. A combustible ball projected from a mortar to discover an enemy. The heated, evolved gases impinge upon the under surface of the parachute and keep it suspended in the air.

Par'a-close. (*Architecture.*) A screen separating a chapel from the body of a church.

Par'a-dos. (*Fortification.*) A traverse covering the interior of a work from reverse fire.

Par'af-fine. A solid hydrocarbon, crystalline and white at ordinary atmospheric temperatures, discovered by Reichenback, in 1829, in the tar derived from the dry distillation of beechwood. It has since been obtained in large quantities from coal, from bituminous shale, and especially from petroleum, by distillation and rectification by treatment with solution of caustic soda, and subsequently with sulphuric acid. Several oily products analogous in composition but differing in appearance result from these processes, and are used for illuminating or lubricating purposes. The solid paraffine is derived from the densest of these oils; the paraffine crystallizing on standing a length of time. It is farther purified by the centrifugal machine and by treatment under pressure with a small percentage of sulphuric acid. Solid paraffine is employed, either alone or in combination with the fatty acids, for making candles. Its cognate hydrocarbon oils, the various derivatives from petroleum, are well known and largely employed for illumination, etc.

The name is from *parum affinis*, on account of the few substances for which it has an affinity.

The stronger acids, as nitric, sulphuric, or hydrofluoric, the former of which act energetically upon most of the metals and the latter upon glass, exert no destructive action upon paraffine; nor does aqua regia, a mixture of hydrochloric and sulphuric acids, by which gold is readily dissolved. It equally resists the action of alkalies, such as potash and soda, and is therefore adapted and used for the purpose of making joints which shall be impervious to acids and alkalies; for bottle-stoppers, which may be made of solid paraffine, or may consist of corks covered with it; and as a coating for labels and for surfaces exposed to acids or acid fumes. For this purpose it may be simply melted and applied with a brush. It may also be applied in a similar way to paper show-bills, etc.; permeating the pores of the paper, it renders it water-proof, and efficiently protects it against the effects of rain.

The process of obtaining paraffine on a large scale from coal or bituminous shale was discovered and patented by James Young about 1850. That employed in the works of Mr. Young at Bathgate and Addiewell, Scotland, is briefly as follows: The shale is broken small in a crusher and then placed in the retorts; these are commonly flattened cylinders of cast-iron, about 12 feet long and contracted toward the ends, which are open, the lower one dipping in a pan of water; heat is applied by a furnace until the middle part of the retort is at a red heat; at a temperature of 300° the hydrocarbons are disengaged in the form of gas, most of which is condensible, and is collected as an oil, which is again distilled and agitated with sulphuric acid in closed vessels, where a black tarry substance resulting from the combination of the acid with the impurities of the oil subsides to the bottom. The clear portion is similarly treated with caustic soda, and again distilled in combination with vitriol and soda, the result being a thin, light, and colorless liquid known as paraffine oil.

Solid paraffine is obtained from the heavier and thicker oil, of which about 20 gallons are derived from each 100 of the crude oil; this is refrigerated by a machine in which a stream of brine is cooled below 32° by a cold-air blast, when the paraffine assumes the solid form.

Par′a-gon. (*Printing.*) A size of type between Great Primer and Double Pica.

Par′a-gran′di-ne. An instrument to avert occurrence of hail-storms. See PARAGRELE.

Par′a-graph. A reference-mark (¶). Also used to indicate a new subject.

Par-a-grele′. A small lightning-conductor set up by means of a pole in French vineyards to aid in drawing off the electricity from the atmosphere over them. The intention is to prevent the occurrence of hail-storms. Arago proposed that the conductors should be raised and supported by small balloons connected by slender wires or chains with the ground. *Paragrandine.*

Par′al-lel. 1. (*Fortification.*) A wide trench parallel to the attacked work, for protecting the besieging troops. The parallels connect the approaches or zigzags by which advances are made on besieged works.

2. (*Printing.*) A reference-mark (‖).

Par′al-lel Bar. (*Steam.*) A rod in the side-lever engine, forming a connection with the pump-rods and studs along the center line of the levers.

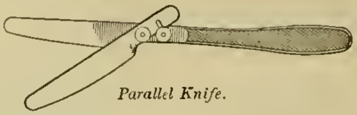
Par′al-lel File. One which has no taper, but preserves its size from tang to point.

One which is flat and strictly correct is known as a *dead-parallel* file.

A round file without taper is a *joint-file;* used for filing the apertures in snuff and musical boxes, hinges, etc., for the reception of *joint-wire.*

Par′al-lel Knife. Two knife-blades in one handle, set *parallel* to each other, with one or more screws to regulate their distance. Used for cutting thin sections for microscopic examination. A *Valentine knife* or *double knife.*

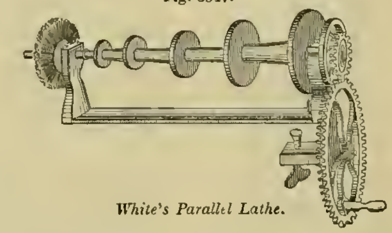
Fig. 3546.



Parallel Knife.

Par′al-lel Lathe. A small bench-tool for dentists', jewelers', and watchmakers' uses. As shown, it is capable of running five corundum stones, a brush, and a drill at the same time. It has a cast-iron frame, with steel spindle and axles, and weighs about eight pounds. It is adjusted to the table or work-bench by a screw-clamp. The collars that retain the grindstones are made of wood, and the lengths are proportioned according to the requirements of the operator.

Fig. 3547.



White's Parallel Lathe.

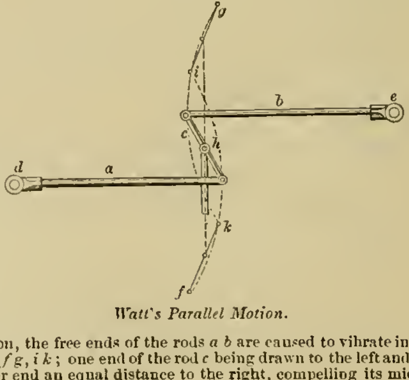
Par′al-lel Mo′tion. (*Steam-engine.*) The device and its name are the invention of James Watt. It is designed to connect the piston and pump rods with the working-beam in such a manner that the former shall move in straight lines.

The principle of the mechanism consists in the fact that in every parallelogram three angles being attached and revolving in arcs of circles, the fourth will continue nearly in a straight line of movement.

Fig. 3548 illustrates Watt's parallel motion.

The equal rods a b, connected by the link c, are pivoted at d and e; the piston-rod is connected to the middle point of the rod c. During the upward and downward movements of the piston, the free ends of the rods a b are caused to vibrate in the arcs $f g$, $i k$; one end of the rod c being drawn to the left and the other end an equal distance to the right, compelling its middle

Fig. 3548.



Watt's Parallel Motion.

point *h*, to which the piston-rod is attached, to reciprocate in a line which does not vary sensibly from a straight one, and which may for all practical purposes be considered such.

Fig 3549 shows various other devices for causing parallel motion *A* was used in Watt's original single-acting beam-engines; the piston-rod has a rack gearing with a toothed segment on the beam and working against a roller.

B is commonly used in stationary beam-engines.

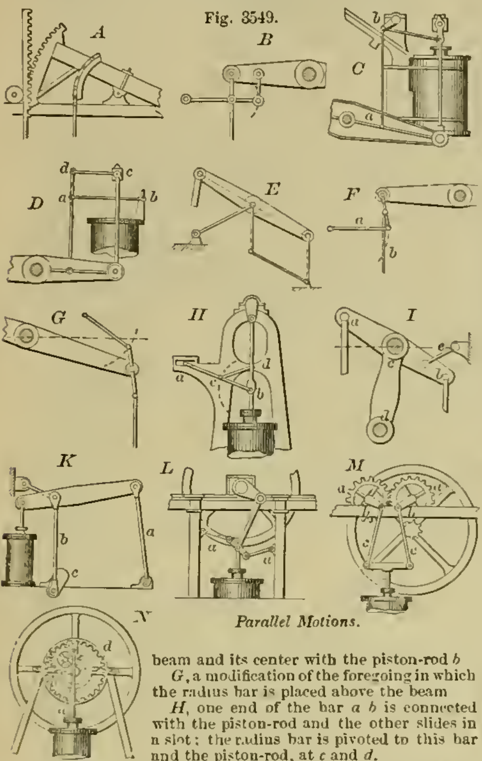
C is used for side-lever marine-engines; the parallel rods from the beam or side-lever *a* are connected with an arm on a rock-shaft *b*.

D, another parallel motion for side-lever engines; *a b* is the radius bar, and *c* the cross-head to which the parallel bar *c d* is attached.

E is used only in some particular cases.

F, the radius rod *a* is connected to the lower end of a short vibrating rod, the upper end of which is connected with the beam and its center with the piston-rod *b*

Fig. 3549.



Parallel Motions.

G, a modification of the foregoing in which the radius bar is placed above the beam

H, one end of the bar *a b* is connected with the piston-rod and the other slides in a slot; the radius bar is pivoted to this bar and the piston-rod, at *c* and *d*.

I, the beam *a b* is pivoted on a vibrating standard *c d*; the radius bar *e* produces the parallel motion.

K, "grasshopper" beam-engine; *a* is a rock-shaft supporting one end of the beam; the shaft *b* is placed as near the cylinder as the crank *c* will work, and in conjunction with the radius bar *d* causes the beam to reciprocate in a vertical line.

L, used in upright engines; *a a* are radius rods connected at one end with the framing and at the other with a vibrating piece at top of the piston-rod.

M, invented by Dr. Cartwright in 1787: the wheels *a a* have equal diameters and numbers of teeth; the cranks *b b* are of equal radius and are set in opposite directions, keeping the connecting rods *c c* attached to the cross-head of the piston-rod at equal obliquities during its upward and downward movement and causing the piston-rod to move in a straight line.

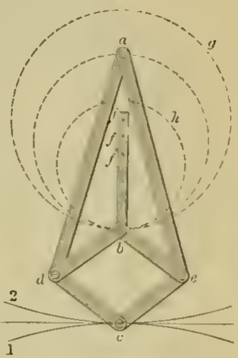
N. the piston-rod *a* is connected with a wrist on the cog-wheel *b*, which turns on a crank pin carried by a plate *c*, which is fast on the shaft; the wheel *b* revolves within a stationary internally toothed gear *a*, of double its diameter, giving motion to the crank-pin, by which means the piston-rod is kept upright.

A very original arrangement for causing a mathematically perfect parallel motion was invented in France, about ten years ago, by M. Peaucellier, an officer of engineers, but has only recently attracted the attention which its importance seems to demand. Professor Sylvester, who first brought it into notice in England, says:—

"It will give to the mechanician unlimited command over the means of transforming motion, and is an instrument that amounts to a new vital element of machinery; perhaps the most important addition to it since Archimedes's invention of the screw, about 250 [236] years B. C.; one that raises the theory of link-work to the dignity of a calculus, that enables the algebraist to fashion and write out in his study, by the rules of his science, a working plan for compelling a system to perform some of the most complicated movements that can be required for any purposes of the useful arts in their most refined and varied applications."

It consists of six pieces, *a d*, *a e*, *b d*, *b e*, *d c*, *e c*, jointed together, as shown in Fig 3550. At *a* is the fulcrum on which the apparatus turns. *b* is the point at which power is applied, and *c* the point at which it acts. At *b* a rod *b f* is attached to the rhomb *d b e c*, and this may be pivoted at any portion of its length; if pivoted at a point *f*, less than half-way between *a* and *b*, and power be applied at the point *b*, this will describe an arc of the circle *g*, exterior to *a*, while the point *c* will follow a curve 1 convex toward *a*; on the other hand, if the pivoted point be at *f''*, the point *b* will move in an arc of the circle *h* interior to *a*, and the point *c* will describe a curve 2 concave toward *a*. When, however, the arm *f b* is pivoted at a point *f'*, midway between *a* and *b*, the arc traversed by *b* will of course form part of a circle whose circumference passes through *a*, while the point *c* will move, not in a line approximately straight, as the head of the piston-rod does under the operation of the parallel motion of Watt, but in a mathematically straight line.

Fig 3550.



Peaucellier's Parallel Motion.

By varying the position of the pivotal point the point *c* may be caused to describe an infinite number of curves either concave or convex toward *a*.

By an amplification of the parts other curves may be described, as parabolas, hyperbolas, and other conic sections.

Par'al-lel Rul'er. A draftsman's instrument, consisting of two wooden or metallic blades, so joined together by jointed cross-pieces as to open to different intervals and yet retain their parallelism.

A still simpler form is a rolling cylinder *a*.

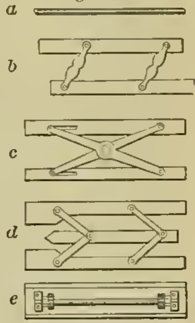
b is the ordinary form of two-leafed ruler with two links.

c is a two-leafed ruler with cross links.

d is a three-leafed ruler, the middle section being united by links to the main sections.

e is a flat ruler with a pair of grooved wheels, fixed on an axis, rotating in bearing-posts fastened to the ruler.

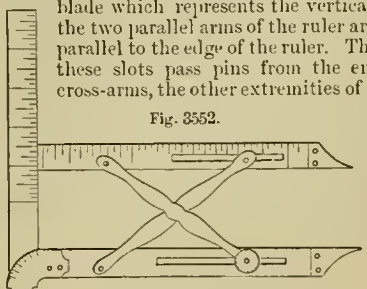
Fig. 3551.



Parallel Rulers.

Fig. 3552 is a form of ruler having a graduated ruling-blade moving in contact with a graduated blade which represents the vertical. In the two parallel arms of the ruler are slots parallel to the edge of the ruler. Through these slots pass pins from the ends of cross-arms, the other extremities of which

Fig. 3552.

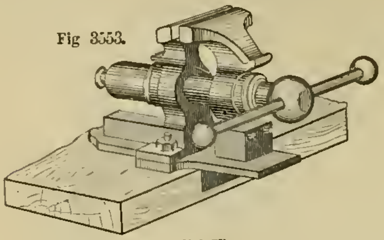


Parallel Ruler.

are pivoted to the two parts of the ruler; distances apart of the bars are measured on the vertical bar.

Par′al-lel Vise. A vise whose jaws move in exact parallelism, a bar on one slipping in a socket in the other; in contradistinction to the kind in which the shank of one jaw is pivoted to that of the other and moves in an arc of a circle.

Fig 3553.

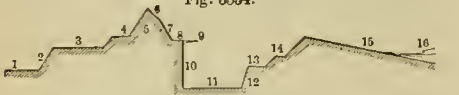


Parallel Vise.

Par′a-mat′ta. (*Fabric.*) A light twilled goods having a cotton warp and a merino-wool weft. *Paramatta cloth.*

Par′a-pet. 1. (*Fortification.*) A breast-high defense of earth or stone around a work for shielding troops from the enemy's fire. It is so formed that the earth of the excavation (*deblai*) is sufficient for the ramparts and parapets (*remblai*). Inside is the body of the place; outside are the ditch, glacis, etc.

Fig. 3554.



Earthwork.

1, interior.
2, interior slope.
3, terre-plein.
4, banquette.
5, parapet.
6, superior slope.
7, exterior slope.
8, berme.
9, fraize.
10, scarp or revetment.
11, ditch.
12, counterscarp.
13, covered way.
14, banquette of the glacis.
15, glacis.
16, abattis.

2. (*Architecture.*) A wall carried up on the brink of a quay, bridge, or house-top.

Par′a-sol. A sunshade, usually smaller than the *parapluie* or umbrella (which see).

Parasols and feather fans, large enough for sunshades were carried by attendants, and are shown in the ruins of Egypt, Persepolis, Nimroud (*Nineveh*).

Sylax, an ancient historian, asserted that there dwelt in India countrymen with feet of so large a size that they used them for parasols. (Philostratus.) Herodotus rejected the *yarn*, as also the statement repeated by Strabo, that the ears of some of these Indians were like winnowing-fans, and that they wrapped themselves in them to sleep.

The Chinese invented the folding parasol or umbrella. Their modern use dates from 1820, and their present form is said to have been devised by the Duchess of Rutland. The Chinese paper-parasols, called *kittysols*, are now largely exported. The gift of a parasol is said to be a mark of kingly favor in China.

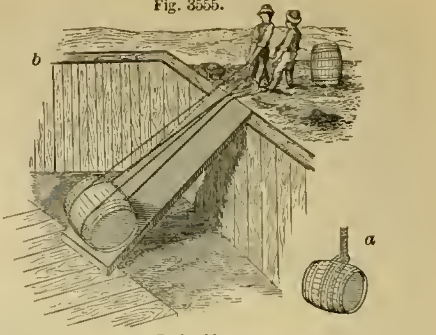
> "Artaxerxes gave to Entimus, the Gortinian, a couch with silver feet, and cushions for it, and a flowered tent surmounted with a canopy, and a silver chain, and a gilt parasol, and vessels of gold and silver, and 100 girls and 100 boys," etc. — ATHENÆUS.

Par′a-ton-nerre′. (*French.*) A lightning-conductor. See LIGHTNING-ARRESTER; LIGHTNING-ROD.

Par′buck-le. A double sling *a* made of a single rope, for hoisting or lowering a cask or gun.

A means for raising or lowering (*b*). The bight of the rope is placed round a post; the cask, spar, or gun lies in the double loop.

Fig. 3555.



Parbuckle.

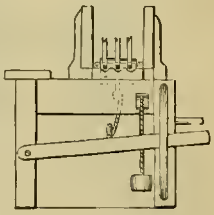
This plan is adopted in Captain Cunningham's mode of furling sails by rolling the yard. The latter lies in the bight of the chain, and is rolled as it is raised or lowered, the yard-arms resting in hoops slung from the *lifts*.

Par′cel. (*Nautical.*) A wrapping of tarred canvas on a rope to prevent chafing. It is cut in long, narrow strips, well tarred, and made up into rolls before commencing to lay it on the rope. Usually, the rope is *wormed*, then *parceled*, and then *served*. See under those heads.

Par′cel-ing-ma-chine′. 1. A press in which yarn, cloth, or wool, etc., is bundled up compactly for tying. See BUNDLING-PRESS, page 405; FLEECE-TYER; WOOL-PACKER, etc.

The example is a machine for bundling and tying fleeces. The fleece is laid upon the table, the slotted belt brought over it and attached to the treadle-lever, whose depression draws the belt and brings up the twine-carrying fingers through the slots in the belt and over the fleece.

Fig. 3556.

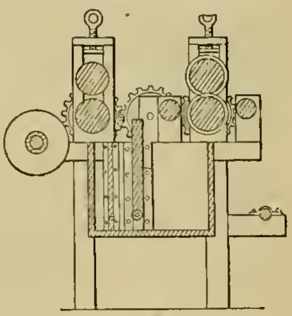


Wool-Packer.

2. A machine in which strips of canvas or cloth are dipped preparatory to wrapping around ropes or cables.

The example is for the manufacture of parceling or tarred canvas covering for ropes, seams, etc., in vessels. The machine consists of cutting and drawing and pressure rolls, in combination with an interposed tank for the tar in which the material is immersed, and bobbins or spools upon which the prepared canvas is wound in rolls.

Fig. 3557.



Parceling-Machine.

Parch′ment. Fine parchment is manufactured from the skins of young calves, kids, lambs; also from sheep and goat skins. Extra fine, thin parchments are made from the skins of still-born lambs, kids, and calves.

Coarse parchment for drum-heads, etc., is made from calves', wolves', asses', and he-goat skins. The ass's skin is said to be remarkably sonorous, and it is no wonder, seeing the amount of noise it has contained at various times. The Greeks found the bones of the ass to be a superior article for making flutes. The flute and drum, a rich asinine combination, which probably suggested the bagpipe, whose drone is the nearest to the paternal blare of anything artificial.

After removing the wool, the skin is steeped in lime and then stretched in a wooden frame; its face is then scraped with a half-round knife. The next process consists in rubbing the skin, previously sprinkled with powdered chalk or slacked lime, and scraping it with a knife. It is then rubbed with a lambskin having the wool on, to smooth the surface and raise a very fine nap; after which, if any greasy matter remains, it is again steeped in the lime-pit for a few days. The grain surface is then removed with a knife and the skin pumiced, if necessary, to give it an equal thickness.

In coloring parchment, a green color may be given by spreading with a brush a solution made with crystallized acetate of copper, 30 parts; bitartrate of potassa, 8 parts; rain-water, 500 parts; nitric acid, 4, added when cold.

The substance is said to have been invented by Eumenes, king of Pergamus, as a substitute for papyrus, on which an embargo was laid by Ptolemy Epiphanes as Eumenes was collecting a library in emulation of the famous one in Alexandria. After the library in the Bruehion was burned, during the siege of Alexandria by Julius Cæsar, Marc Antony presented to Cleopatra the rival library of Pergamus, consisting of 200,000 volumes (*volumen*, a scroll). It was subsequently destroyed, the Saracens burning what Theodosius had left. See PAPER.

Parch'ment-pa'per. Made by immersing ordinary unsized paper in sulphuric acid, diluted with about half its volume of water. It is withdrawn in a few moments, and on drying is found to have assumed a new character, resembling rather that of animal membrane than vegetable fiber, and its strength is nearly doubled. After the immersion it is washed in water, afterward in dilute ammonia, and if any of the latter remains it is removed by lime or baryta.

It was invented and patented in England by Mr. Gaine. Figuer and Pomarede made attempts in the same direction in France, 1846.

Karchiski, in 1860, subsequently treated the paper with glycerine, to give it suppleness. Stuart Gwynne made fractional currency of it about 1865 or 1866.

To avoid the imperfect penetration of the acid, J. J. Ott treated a number of thin sheets with the acidulous solution, and combined them into a homogeneous sheet.

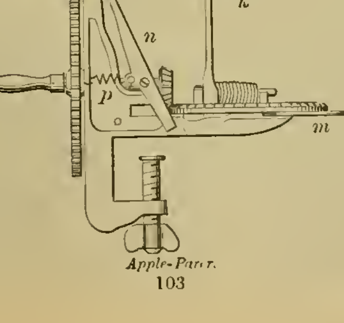
A. T Schmidt added the glycerine to the acid.

Thomas Taylor (England, 1869; United States, 1871) treated the paper with chloride of zinc. See, —

Hudson, March 16, 1869.
Hudson, September 27, 1870, two patents.
Sheldon, January 25, 1870.
Schmidt, April 4, 1871.
Hanna, October 31, 1871.

Par'close. (*Nautical.*) The limber-hole.

Fig. 3558.



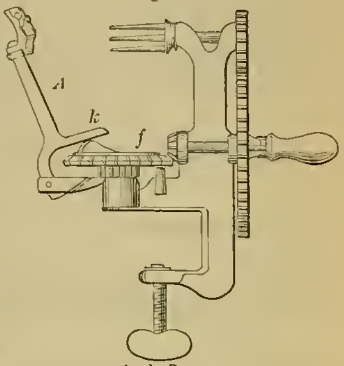
Apple-Parer.

Pa-ren'the-sis. A mark consisting of two curved lines face to face ( ). They inclose matter which is cognate to the subject, but which may be omitted without impairing the grammatical construction or the substantial meaning.

Par'er. In Fig. 3558, the apple, fixed on the rotary fork *c*, is pared by the knife *k*, also rotated by bevel gearing. When the knife makes a revolution, completing the paring operation, a projection *m* on the horizontal bevel-wheel strikes the foot of the pivoted lever *n*, throwing its upper end forward so as to push the apple from the fork. The lever is then brought back to place by a spring *p*.

In the apple-parer (Fig. 3559) the cutter is carried on an upright *A*, pivoted at bottom, having a projecting arm *k*, which is once during each revolution struck by an inclined cam on the upper side of the bevel-wheel *f*, causing it to make a partial revolution, and throwing the knife back so that the apple may be readily removed from the fork.

Fig 3559.



Apple-Parer.

Par'get. (*Plastering.*) *a.* A plaster formed of lime, sand, hair, and cow-dung, for lining the interior of flues. *Pargeting.*

b. A plaster-work executed in raised ornamental figures, molded or impressed by the trowel.

c. A stucco.

Pa'ri-an. (*Pottery.*) A variety of porcelain having the appearance of Carrara marble, and made by the substitution of soft feldspar for Cornish stone in the porcelain process.

It derives its name from the celebrated marble of Paros, and is much employed for statuettes and other works of art.

It is composed of about $\frac{2}{3}$ silica and nearly $\frac{1}{3}$ alumina, with a small proportion of soda, potash, lime, magnesia, and iron. These are finely ground and thoroughly mixed to a creamy consistence. The fluid is poured into a mold and afterward baked. Some of the articles made by this process consist of many pieces which require to be joined together. The inequalities of the joints are then obliterated and the work baked and annealed.

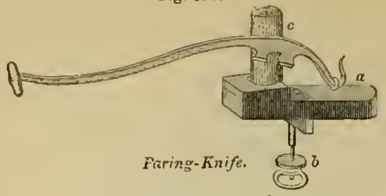
Par'ing. (*Bookbinding.*) Thinning the leather toward its edge so as to prevent a square projection at its terminating edge.

Par'ing-chis'el. A joiner's chisel having the basil on one side, used in fitting and finishing; not differing essentially from a *firmer*. Its name is derived from its being used by hand, with a paring action, in contradistinction to the *socket* and the *mortise* chisels, which are adapted for the mallet.

It is usually longer in the blade than a *firmer*-chisel and lighter than a *mortise*-chisel.

Par'ing-knife. 1. A knife used by wood-turners and others for roughing out work; it has a hook at one end passing through an eye-bolt in the block *a*, allowing considerable freedom of motion; the block is secured to a lathe or work-bench by screw attachment *b*; *c* is a piece of wood being pared.

Fig. 3560.



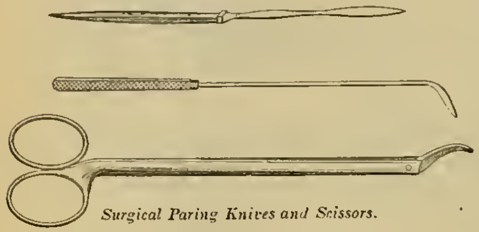
Paring-Knife.

2. One used for peeling fruit, having a guard to regulate the depth of cut.

3. A farrier's hoof-paring tool.

4. (*Surgical.*) A knife used in removing the cuticle or ragged edges of parts which are to be placed in apposition that they may grow together.

Fig. 3561.



Surgical Paring Knives and Scissors.

The examples are respectively, —

Upper one, Sim's knife for paring edges in the operation of vesico-vaginal-fistula.

Below it, curved knife for same operation and that of cleft palate.

Par′ing-ma-chine′. A key-grooving machine.

Par′ing-plow. (*Husbandry.*) A plow for cutting sods or turfs from the surface of the ground. A *sod-plow.*

Par′ing-scis′sors. (*Surgical.*) A scissors for trimming the edges of wounds, or freshening the edges of fistulous openings, in order that they may grow together when brought into apposition and secured.

Fig. 3561, lower cut, represents Dr. Emmett's double-curved scissors for paring edges in the operation of vesico-vaginal-fistula and cleft palate.

Par-is′ian Gold-col′ored Al′loy. A factitious gold. See OROIDE; also ALLOYS for jewelers, page 63.

Par-is′ian White-met′al. An alloy composed of copper, 69.8 parts; zinc, 5.5; nickel, 19.8; cadmium, 4.7. See ALLOY, page 63.

Pa-risth′mi-o-tome. (*Surgical.*) An instrument for scarifying the tonsils.

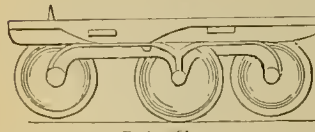
Park. A place of encampment of an artillery train.

Par′lia-ment-heel. (*Nautical.*) The position of a ship when careened.

Par-line. The mean or normal line of a barometer for a given station.

Par′lor-skate. A skate on rollers for use on a floor or carpet. (See SKATE.) In the one shown, the wheeling motion of the skater is facilitated by a middle driving-wheel which descends below a line drawn between the other two wheels.

Fig 3562.



Parlor-Skate.

Pa′ros-mar′ble. A semi-transparent white marble tinged with yellow.

Par′point-work. (*Masonry.*) Squared stones laid in *stretcher*-course and with *header*-courses at intervals of, say, 3 feet.

Par′quet-ry. An ornamental mosaic woodwork in the different colors of woods, or their different grains are so ordered as to form patterns. See also MARQUETRY; MOSAIC; BUHL; REISNER-WORK.

Par′ral. (*Nautical.*) The hoop or collar of greased rope by which a yard is shackled to the mast, at the slings, the *parral* slipping on the mast as the yard is raised or lowered.

Iron parrals are now in common use.

The parral is connected to sling-cleats on the yard, and has strung upon it *parral-trucks*, that is, small wooden globes to prevent friction or binding against the mast, in hoisting or lowering.

Par′ral-rope. (*Nautical.*) A single rope, well served, and formed into a collar around a mast for slinging an upper yard.

Par′rott-gun. (*Ordnance.*) A kind of rifled cannon invented by Captain R. G. Parrott of the Cold Spring Foundry, West Point, N. Y., and much employed in the United States service during the late civil war. The body of the gun is of cast-iron, and is reïnforced at the breech by shrinking on a ring of wrought-iron.

The calibers are, 10-pounder, 2.9 inches bore; 20-pounder, 3.67 inches bore; 30-pounder, 4.2 inches bore; 100-pounder, 6.4 inches bore; 200-pounder, 8 inches bore: corresponding respectively to 3, 6, 9, 32, and 64 pounder smooth bores. The number of grooves increased with the caliber of the gun, the 10-pounder having three.

Part. (*Founding.*) A certain portion of a mold or flask; as the *top part* or *drag*, the *bottom part* or *cope*, the *middle part* contained in the middle portion of a *three-part* flask, etc. (See FLASK.) The *false part* is a flask rammed up, generally a top part turned over, stricken off, and a cavity scooped in it to receive temporarily the bulge of a pattern while sand is being rammed upon the upper surface. The whole is then turned over, the *false part* destroyed, and the *parting* made.

Part′ing. 1. (*Metallurgy.*) Separating silver from gold by an acid.

2. (*Paper.*) Separating the moist sheets.

3. (*Nautical.*) Breaking cable, leaving the anchor in the ground.

4. (*Founding.*) The meeting surfaces of the sand rammed up in the *cope* and in the *drag.*

A powder is applied to the faces to enable them to separate readily. This parting may consist of dry sand free from clay or other tenacious matter, or of brick powder.

The *facing* is a material applied to the sand where the metal will come in contact with it. See FACING.

The *parting* of loam surface. See LOAM-MOLDING, page 1461.

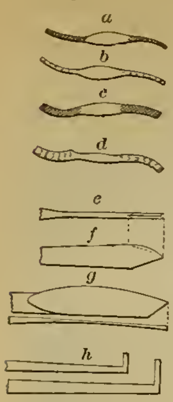
5. (*Comb-making.*) A mode of making combs to economize material, in which a pair of combs are made from a single slip a little over comb-width. A cutter has a vertical motion upon the blank, which has an intermittent feed beneath it, making a series of cuts, the teeth of each comb occupying the interdental spaces of the other. See COMB-MAKING.

Part′ing-line. (*Founding.*) The line upon a pattern as it lies imbedded in the sand, below which the *draw* of the pattern is upward, and above which it is downward. This line in the majority of cases is undulatory, and the surface of the sand-parting extends from it to the edges of the flask all round.

Part′ing-sand. (*Founding.*) Dry sand free from clayey compounds placed between the two members of a mold to facilitate their separation.

Part′ing-tool. 1. (*Marble-working.*) A rasp

Fig. 3563.



Parting-Tools.

of peculiar shape, coarse or fine in grain, and used by marble-workers (*a b c d*, Fig. 3563).

2. (*Turning.*) A cutting-tool used by wood and ivory turners for separating turned pieces from the block, turning out interior cylinders, etc.; *c f*, parting-tool for soft wood; *g*, for hard wood; *h*, inside parting-tool for removing rings from the interior of solid works, avoiding loss of material in shavings; it is also useful in some other under-cut works.

3. (*Carving.*) An angular gouge like a hollow graver, used for marking outlines, tendrils, stems, and markings of leaves, etc.

4. (*Joinery.*) A chisel with a bent edge.

Par-ti'tion. (*Carpentry.*) A division between rooms, etc.

The scantling in a partition is as follows: —

Sill, the bottom-piece.
Head, the upper plate.
Principal posts, the main uprights.
Quarters, the intermediate studding.
Braces, oblique ties.

Part'ner. (*Nautical.*) A framework or bushing in or around a hole in a deck to receive the heel of a mast, bitt, or pump, or to form a basis for the pawls of a capstan.

The framework consists of *fore-and-aft partners*, *cross-partners*, and *corner-chocks*.

Par'ty-gold. (*Metallurgy.*) Beaten or leaf silver with a coating of gold on one side.

Par'ty-wall. (*Building.*) A wall separating two adjoining tenements. Originally, it meant a wall built upon the lands of two adjoining proprietors which furnished support for the floors and roofs of the tenements on each side. Laws regulating this right of joint occupation are in force in Europe and America. It should run above the roof.

Par'vis. An area before the entrance of a church or around it. *Parvise.*

Pas-de-sou'ris. (*Fortification.*) A staircase from the ravelin to the ditch.

Pass. (*Rolling-mill.*) *a.* The shape produced by the grooves in the adjacent rolls of a rolling-mill. The *pass* is so formed as to give the required shape to the metal rolled therethrough. The most important and frequently occurring forms are rails, tires, angle-iron, deck or ⊤ and I beams, half-round forms, such as felly-iron, etc., and some of the principal varieties of spike and sash iron. See IRON, ANGLE.

b. A single passage of a plate or bar between the rolls.

Pas-sa-ree'. (*Nautical.*) A tackle to spread the clews of a fore-sail when sailing large or before the wind.

Pass-boat. A broad, flat-bottomed boat. A *flat* or *punt*.

Pass-box. A wooden box used for conveying cartridges from the magazine to the guns in forts and batteries. It is 7 inches in depth and width by 14 inches long, having a hinged cover and a handle at one end.

Passe-par-tout'. 1. (*Engraving.*) An engraved plate or block, forming a frame around an aperture into which any engraved plate or block may be inserted. This is common in wood-engraving, where an ornamental border may be made to do duty with changing central advertisements or labels.

It was also adopted a number of years since with the notes of the State Bank of Ohio, when such things were, the inserted blocks representing the names of the several branches.

Also understood to be adopted in the national bank-notes.

2. A frame or mat to go around a picture. Frequently a pasteboard border for a picture beneath the glass and within the frame.

Pass'ing-place. (*Railway Engineering.*) A *siding.*

Pass'key. One that will open several locks. A *master-key.*

Paste. A soft adhesive composition.

1. A mixture of flour, water, starch, etc., variously compounded in different trades, such as *bookbinders*, etc. The paste is sometimes strengthened by starch, and preserved from mold by carbolic acid.

Size is a thin glue, but many pasty compositions are called size in the trades, as in calico-printing.

2. (*Calico-printing.*) A boiled composition of flour, starch, or gum with water, used as a vehicle for *mordant*, *color*, *resist*, or *pudding*, or *discharge*. Also called *thickening.*

Sieburger's adhesive paste: Four parts, by weight, of glue are soaked for several hours in 15 parts of water, and then slowly warmed until a perfectly clear solution is formed. This solution is then diluted with 65 parts boiling water and thoroughly stirred. In the mean time, 30 parts of starch are stirred into 200 parts of cold water, so as to form a thin milky liquid, free from lumps. Into this is poured the solution of glue, stirring continually and heating. When cold, ten drops of carbolic acid are added. It is said to possess extraordinary adhesive power, joining leather, paper, pasteboard, etc. By keeping it in closed vessels, so that the water cannot evaporate, it may be preserved for years.

2. For attaching labels to glass or porcelain, gum tragacanth is generally employed. A small quantity of corrosive sublimate will preserve it, though this is seldom necessary. A solution of shellac in borax is also useful for this purpose. Dextrine, or British gum, is generally used for rendering labels adhesive, but does not adhere firmly to glass.

3. For leather-workers alum or rosin are added to the above.

4. *Chinese* paste is a cement of bullock's blood, quicklime, and water, for stone, earthenware, or wood.

5. *Furniture* paste is beeswax and turpentine.

6. *Polishing* paste, for metals, is made of materials of varying grit and vehicle, according to the need, — rotten-stone, emery, tripoli, bath-brick, soft-soap, olive-oil, lard, turpentine, etc.

7. *Shaving* paste is a perfumed soap.

8. Dough for pastry.

9. Certain confections, such as jujube.

10. (*Pottery.*) An earthy mixture for making ceramic wares.

11. (*Glass.*) A highly refractive vitreous composition of pounded rock-crystal melted with alkaline salts and colored with metallic oxides. Used for making factitious gems.

The kind known as *Strass*, from its inventor, is a highly refractive and pellucid glass. It contains a large quantity of oxide of lead, and frequently of borate of lead.

The art was known to the ancients, some specimens having been found in the Egyptian tombs. This wonderful nation also were possessed of the art of engraving gems. Among the Jews who made their exodus from Egypt was Bezaleel, of the tribe of Judah, who was able to cut, engrave, and set precious stones, to make the stones of the breastplate like "the engravings of a signet," each one with the name of one of the twelve tribes.

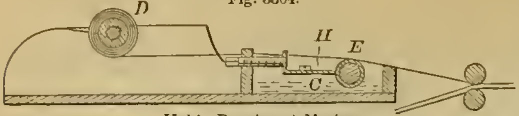
The art of making paste for gems was lost for many centuries, but was revived near the end of the fifteenth century by a Milanese.

12. Gypsum in water for plasterers.

Paste'board. A thick paper board, made by pasting together a number of sheets of paper. This is afterward pressed to remove the water of the paste, dried and calendered. See also CARDBOARD.

In Hale's machine for lining straw-board or thick paper with a thinner material, the thin lining-paper is wound on a roll *D*, and is caused to pass over a

Fig. 3364.

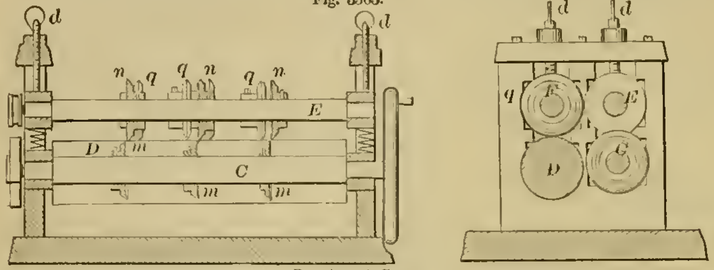


Hale's Pasteboard-Machine.

pasting-roller *E* in the trough *C*, provided with an adjustable knife or scraper *H*. The thick board is fed up from below and united to the lining by a pair of rolls, between which the two conjointly pass.

Paste'board-cut'ter. The machine (Fig. 3565) is for grooving and cutting pasteboard strips employed for making boxes. The board passes successively between the rollers *D F*, *C E*. The rollers *F* are provided with grooving disks *q*, which are opposed to the surface of the plain roller *D*, and may be adjusted to crease the board at any desired distance from the edges severed by the circular cutters *n n*; the roller *E* may be raised or lowered by screws *d d*, to cause more or less overlapping of the cutters *m n*.

Fig. 3565.



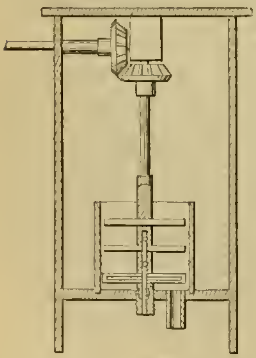
Pasteboard-Cutter.

Pas'tel. 1. A solid colored pencil made of fine pipe-clay, gum-water, and the required pigment. The executed work is called a drawing in chalk colors. It requires the protection of glass.

2. (*Dyeing.*) Woad. It gives its name to the vat in which pastel and indigo are used, the *pastel-vat.*

Paste-mak'er. A stirring-machine for mixing the components of paste. The vertical shaft is tubular at the lower end, and receives steam through its step-block, which is screw-threaded for coupling to the steam-pipe.

Fig. 3566.



Paste-making Machine.

Paste-points. (*Printing.*) Register-points on a tympan.

Paste-pot. (*Bookbinding.*) A vessel containing paste, which is laid on with a brush.

Pas'tern. (*Menage.*) A shackle for horses while pasturing.

Pas-tille'. An aromatic paste for burning as a fumigator or disinfectant. It is composed of gum benzoin, sandalwood, spices, charcoal-powder, etc.

Pat'a-mom'e-ter. An instrument for measuring the force of currents.

Patch. 1. A greased piece of cloth wrapped around a rifle bullet.

2. A reïnforce or strengthening piece on a fabric at a point of wear, or around a hole or eyelet.

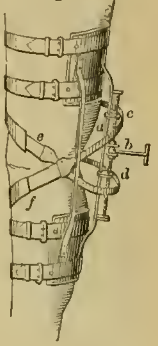
3. An additional or substitute piece in the covering or sheathing of a structure.

4. A binding or clamp on an emergency for a ruptured hose.

5. A block on the muzzle of a gun to do away with the effect of dispart; making the line of bore and line of sight parallel.

Pa-tel'la-ap'pa-ra'tus. (*Surgical.*) An apparatus for treating fractures of the kneepan. It consists of two curved plates of sheet-iron connected by two side rods and a back rod *a*, having attached a double reversed screw with a key *b*, by turning which the two projections *c d* are caused to approach or recede from each other. Two buckling straps are attached to each plate; these are applied to the lower part of the thigh and calf of the leg. The fractured parts are coapted, and strips of adhesive plaster *e f* applied above and below the kneepan; these are tightened by turning the key *b*, keeping the parts of the kneepan together.

Fig. 3567.



Patella Apparatus.

Pat'en. The plate which holds the wafer or consecrated bread of the communion service. It is sometimes made to fit the *chalice* or cup.

Pat'ent Leath'er. A varnished or lacquered leather used for boots and shoes and in carriage and harness work. It embraces a number of varieties and qualities. Black is the usual color, but it is also made of red, green, blue, and other tints.

The leather is specially prepared for the purpose, and is usually hemlock tanned; it is highly limed and treated with weak sour liquor, undergoing but a light *stuffing*. The hides are then split, some of the thicker ones being passed through the machine as many as five or six times; the skin and flesh side splits are usually sold to trunk-makers, the interior only being treated with the *sweetmeat*, as the lacquer is technically termed; this is principally composed of linseed-oil, with the addition of proper coloring matters. The skins, previously well dried and softened by beating and *boarding*, are stretched on frames, and the *sweetmeat* is applied in several coats; after each application the frames are slid into an oven heated by steam-pipes, where they remain until the varnish has set; any roughness that appears during any stage of the process is removed by polishing with pumice, and all traces of dust removed with a wet brush followed by a dry one. The entire operation requires from one to three weeks.

The variety known as *enameled* leather is finished by passing through a graining-machine having a heavy brass roller with a slightly corrugated face, and boarding in a peculiar manner by hand. See Leather.

Pat'e-ra. (*Architecture.*) An ornament on a frieze representing a round dish in bas-relief.

Pat'e-re'ro. (*Ordnance.*) A mortar for firing salutes.

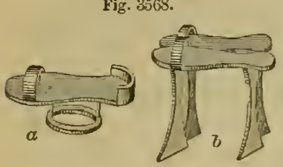
Pa′ter-nos′ter – pump. A *chain*-pump. So named from a fancied resemblance of the buttons on the chain to the beads of the rosary. The latter is an old invention of Central Asia, used by the Boodhists. See CHAIN-PUMP.

Pa′ter-nos′ter-wheel. A water-raising device having a number of buckets on a chain. Named from its resemblance to the rosary. See NORIA; CHAIN-WHEEL.

Pa′tio-pro′cess. The patio-process of amalgamation is practiced in Peru and Mexico. A *patio*, or *amalgamation floor*, is a large paved area, walled around to contain the *tortas*, or flat, circular heaps of ground ore, salt, magistral, etc., which are tramped by horses, treated by mercury, etc., as described under AMALGAMATOR, page 75 (which see). The process was invented by Medina in 1557, and was introduced into Nevada with but indifferent success.

Pat′ten. 1. A clog or sole of wood mounted on a frame to raise the feet of a person above a wet or muddy pavement. The support is usually an iron ring. They are much used in some countries where *sabots* are not in vogue. The Dutch wade round in *wooden shoes* in their dairies and sculleries. The English and French of the wealthier class use *clogs*; the more humble class in England use *pattens* (*a*); in France, *sabots*. The Oriental ladies patter round in their baths and paved courts, wearing *kŭbkobs* (*b*), to protect the soles of their delicate feet.

Fig. 3568.



Pattens.

2. (*Masonry.*) *a.* The sole for the foundation of a wall.

b. The base ring of a column.

Pat′tern. 1. A piece of card-board, sheet-metal, or thin plank corresponding in outline to an object that is to be fabricated, and serving as a guide for determining its exact shape and dimensions; such are employed by workers in leather, textile fabrics, and other thin materials for cutting out work, and also by wood-workers for laying off the outlines of objects of irregular form which are afterward shaped by the axe or saw. (See TEMPLATE.) Pattern-pieces or *gages* are largely used in making special machinery, such as rifles, sewing-machines, American watches, and numerous machines in which all the parts are made separately by gages and then *assembled*.

The system is known as *making by gages* and *assembling*. See GAGE; ASSEMBLING.

2. (*Fabric.*) A design of figures, woven in cloth or printed thereon.

3. (*Founding.*) The counterpart of a casting in wood or metal from which the mold in the sand is made. When dry-sand or loam-cores are used to form the cavities in a casting, projections of suitable size and shape are affixed to the pattern to secure such cores in place. See PRINT.

Patterns are often made in two parts, sometimes in several parts, held together by steady-pins or dowels.

Straight-grained pine or mahogany is preferred for patterns of this kind; screws rather than nails are employed for joining the pieces. Foundry patterns are made somewhat tapering in those parts which have to enter deeply into the molding sand or loam, in order to facilitate their removal; this taper may amount to $\frac{1}{16}$ or $\frac{1}{8}$ of an inch to the foot, and in some cases even more.

Ordinary iron shrinks about $\frac{1}{8}$ inch to the foot in cooling; brass, $\frac{3}{16}$ inch; and this must be allowed for in the pattern. For this purpose a contraction rule is employed, giving measurements about one per cent in excess of the true length; this avoids the trouble of calculating the extra dimensions to be given the pattern in each particular case.

Wooden patterns should be well oiled and varnished. This preserves them and assists their free delivery from the mold, which is farther insured by rubbing them with black-lead. In their construction, sharp interior angles should be avoided as tending to cause a breaking down of the mold at that point and weakening the casting. Patterns, especially for small castings, are sometimes made of metal. These have the advantage of being more durable, but if of iron require to be taken good care of to prevent rusting. See list under FOUNDING; MOLDING.

For machine for pattern-making, see numbers of *American Artisan* for May and June, 1874.

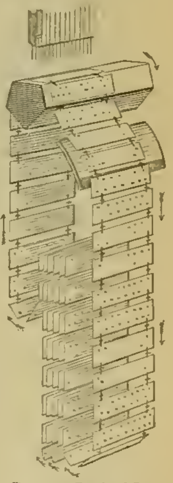
Pat′tern-box. (*Weaving.*) *a.* A box in a loom holding a number of shuttles, either of which may be projected along the shed, according to the pattern. The automatic means for operating the shuttles in due sequence is a PATTERN-CYLINDER or PATTERN-CHAIN (which see).

b. The box perforated for the harness-cards in the Jacquard figure-loom. See PATTERN-CARD.

Pat′tern-card. (*Weaving.*) One of the perforated cards in a Jacquard loom through which the needles pass; the perforations are according to the pattern.

Fig. 3569 shows the pattern-cards and pattern-box detached from the loom. The box is perforated with as many holes as there are warp-threads, and rods connected with each thread are suspended over it. The pattern-cards are perforated to correspond with the figure to be woven. As the box revolves, carrying the cards successively over its faces, the rods drop down whenever the holes in the cards and box coincide, each rod lifting its own warp-thread. The cards are hung together in an endless belt, as shown in the figure. See also pages 1356, 1357.

Fig. 3569.



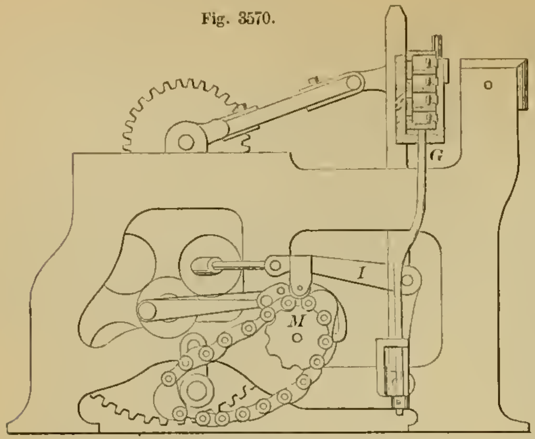
Pattern-Card of Jacquard Loom.

Pattern-chain. (*Weaving.*) A device for automatically bringing to the picker, according to the sequence required by the pattern, the shuttles in the shuttle-boxes at the ends of the race.

In Fig. 3570, the pattern-chain is shown passing over the wheel *M*. It has links of varying hight, which, as they pass beneath the roller on lever *I*, raise it to a greater or lesser hight, and with it the rod *G* and the shuttle-box at its summit, and so bring the required shuttle in position to be struck by the picker.

In Fig. 3571 the pattern-chain is shown beneath the levers *P*, from whose ends depend rods which control the movements of the lever *E*. This lever is connected by a link to a standard *F*, upon which latter the shuttle-boxes *B* are mounted, and is operated by two cams *H* and *I*, in such a manner as to raise or lower the standard upon which the series of shuttle-boxes are placed, so that any one of the boxes may be brought to the race from any position at every pick. The cams are actuated by a pawl and

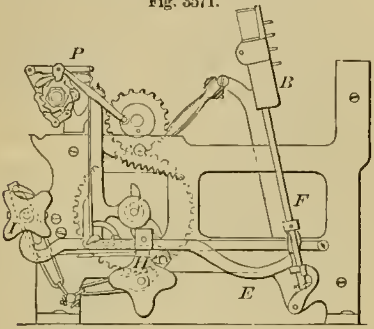
Fig. 3570.



Pattern-Chain.

ratchet connected by rods with levers *P* placed in contact with the revolving pattern-chain.

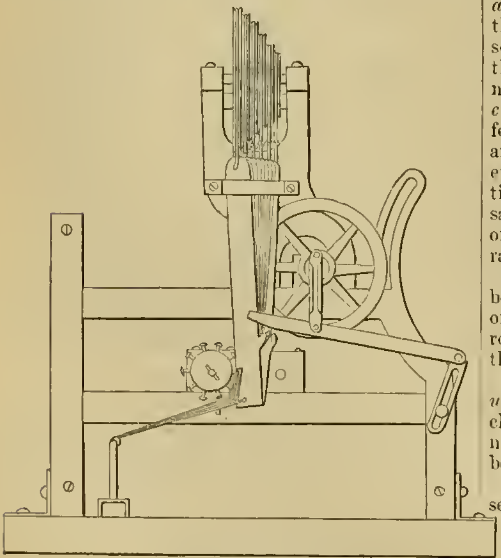
Fig. 3571.



Pattern-Chain for operating Shuttle-Box.

Pat'tern-cyl'in-der. (*Weaving.*) A means of operating the harness of a loom by means of a cylinder with projections which come in contact in due order of time with the respective levers which work the shed. In the example, the pattern-cylinder shaft is free at one end to admit of changing the cylinder readily for changing the pattern. The graduation in the sizes of the pulleys placed in series on the same shaft allows a true vertical pull upon each of the jacks, which are arranged side by side beneath.

Fig. 3572.

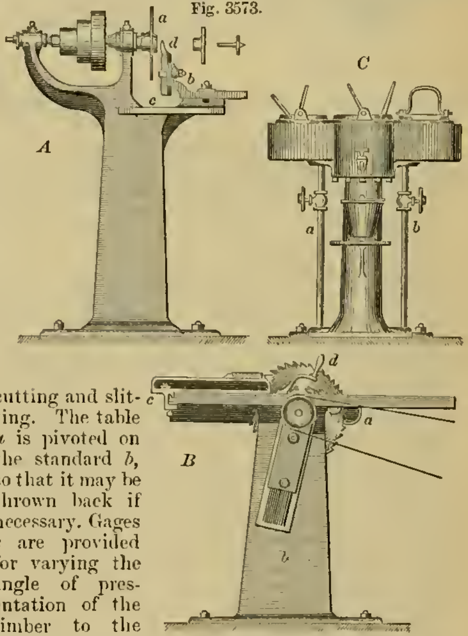


Pattern-Cylinder.

Pat'tern-mak'ers' Ap-pli'an-ces. These embrace various modifications of the tools and machines ordinarily used by the turner and joiner. Among others may be cited the *face-lathe* (*A*, Fig. 3573), for turning hubs, bosses, core-prints, etc. This is a compact machine, occupying a space of but two feet square; the cone-pulleys are of iron: the spindle of steel turns in brass bearings, and the face-plates *a*, of which two are provided, are capable of taking work up to 16 inches in diameter. The rest *b* is adjustable on the table *c* by a nut and screw, and the hight of the cutter *d* is also regulated by a screw.

B is a *blocking* and *cropping saw* adapted for cross cutting and slitting. The table *a* is pivoted on the standard *b*, so that it may be thrown back if necessary. Gages *c* are provided for varying the angle of presentation of the timber to the saw, the spindle of which may be raised or lowered by means of the wrench *d*.

Fig. 3573.



Pattern-Makers' Face-Lathe, Blocking-Saw, and Glue-Heater.

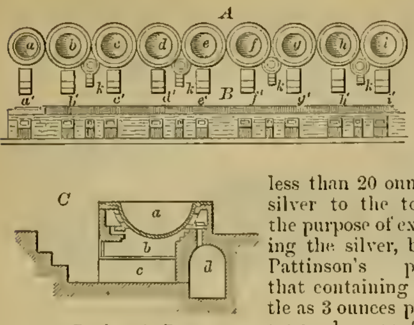
C is a *steam glue-heater*. The pots, three in number, have flanges resting on the smooth upper surface of the heater, which consists of a water-bath surrounded by a steam-chamber. *a* is the steam and *b* the waste-water pipe.

Pat'tern-wheel. 1. (*Horology.*) The *count-wheel* or *locking-plate* of the striking portion of a clock-movement. That which has notches of such number or such distance as will determine the number of blows in regular order.

2. (*Weaving.*) A PATTERN-CYLINDER (which see).

Pat'tin-son's Pots. (*Metallurgy.*) An arrangement invented by Mr. H. L. Pattinson of Newcastle-on-Tyne, about 1829, for separating silver from lead. Lead ores always contain a small proportion of silver. By the ordinary process of cupellation, it does not pay to treat lead containing less than 20 ounces of silver to the ton for the purpose of extracting the silver, but by Pattinson's process that containing as little as 3 ounces per ton may be profitably worked.

Fig. 3574.



Pattinson's Pots.

This process is based on the fact that the melting-points of alloys of silver and lead are higher in proportion to the amount of silver contained, and that if lead containing silver be melted and constantly stirred while gradually cooling, when it arrives at a temperature near the melting-point of lead, crystals will begin to form, which sink to the bottom, leaving the still fluid portion much richer in silver than the whole mass originally was, while, on the contrary, the crystallized portion has become poorer.

The apparatus consists of a series of eight or ten cast-iron pots set in a row, with fireplaces beneath. At the commencement of the operation one of the central pots, as *f*, is charged with lead from the calcining-furnace, which, when melted, is skimmed with a perforated ladle and the fire withdrawn; cooling is accelerated by throwing water on the surface of the metal, which is kept constantly agitated by means of a stirrer or slice. Crystals soon appear and fall to the bottom, whence they are removed by means of a perforated ladle and transferred to the pot *e* at the left; this operation is carried on until about two thirds of the charge has been transferred to the pot *e*, at which time, supposing the original charge to have contained 20 oz. of silver per ton, that remaining in the pot *f* will contain about 40 oz., and that removed to *e* but about 10 oz. per ton. The rich lead in *f* is then ladled into *g*, a fresh charge of calcined lead introduced into *f*, and the operation repeated, the richer metal being constantly transferred from one pot to another toward the right, while the poorer is passed from pot to pot in the reverse direction. In this way the crystals obtained from the pots to the left are gradually deprived of their silver, while those on the right are being continually enriched, the metal in the pot on the extreme right frequently being concentrated until it contains 500 oz. of silver per ton, while that in the pot on the extreme left should not contain more than 12 dwts. per ton.

A is the plan; *B*, the elevation; and *C*, a transverse section of the apparatus; *a* is the *market-pot*, from which the desilverized lead is ladled; *b c d e f g h i*, the *working-pots*; *a' b' c' d' e' f' g' h' i'*, their respective fireplaces; and *k k k k*, the *temper-pots*, in which the ladles are heated when they become cool.

In the section, *a* is a pot; *b*, grate; *c*, ash-pit; *d*, main flue.

The ladles, if operated by hand, are about 16 inches in diameter and 5 inches in depth; when cranes are employed much larger ones may be used.

Paunch. 1. (*Nautical.*) A thickly thrummed mat of sennit wrapped around a spar or rope to keep it from chafing.

2. The rim of a bell. The part against which the clapper strikes.

Paved Way. A tramway whose tracks are of stone.

Pave'ment. The hard covering of the surface of a road or foot-way.

According to Pliny (A. D. 79), "pavements are an invention of the Greeks." As usual, he forgets Egypt and is oblivious of India and China. Sosus of Pergamus (founded 283 B. C.) made ornamental mosaic pavements representing natural objects. The first Roman pavement in blocks of diamond (rhombal) form was laid in the temple of Jupiter Capitolinus during the third Punic war.

The Greeks invented (says the same author) terrace-roof pavements, and he gives the following directions for their construction: —

> "Begin with two layers of boards crossing each other and nailed together at their extremities, to prevent warping. Next place a layer of pounded pottery and lime; upon this place a layer of broken pottery with a large proportion of lime, one foot thick and rammed. Another layer of pottery three parts, lime one part, is laid down, six fingers in depth. Square stones, two fingers thick, are laid on this on a slope of 1½ inches to 10 feet. Then polish the surface."

Pliny gives a formula for pavement which has the ordinary appearance of the ground when in the rough, but may be polished to resemble marble: —

> Upon well-rammed ground place a layer of broken crockery, above this a layer of charcoal well trodden down with a mixture of sand, lime, and ashes, making the upper layer a depth of six inches.

Strabo informs us that the city of Babylon was paved at a very early date. The date assigned (2000 B. C.) is perhaps fabulous, though it was quite within the capacity of the builders of the city walls, palaces, and the bridge across the Euphrates, to pave the city in good style.

Isodorus says that the Carthaginians had the first paved streets, and that their example was soon copied by the Romans. Appius Claudius, the censor, constructed (312 B. C.) the road named after him, the Appian Way, which was, on account of its excellence, called the *queen of roads*. This was about ten years after the death of Alexander the Great. The time, however, when the streets of Rome were first paved cannot be determined with certainty. We are informed by Livy, that in the year of the city 584 (about 170 B. C.), the censors caused the streets to be paved from the ox-market to the temple of Venus.

The extravagant Heliogabalus caused the streets around the palace or on the Palatine Mount to be paved with foreign marble. Streets paved with lava, having deep ruts worn by the wheels of carriages, and raised banks on each side for foot-passengers, are found at Pompeii and Herculaneum.

Roman country roads were 8 feet wide on the straight lines, 15 feet at angles. Cattle might be driven on each side, if not fenced in.

Abderahman, the khalif of Cordova, Spain, caused the streets to be solidly paved, A. H. 236 (A. D. 950), and a man might walk after sunset ten miles in a straight line by the light of the public lamps. 700 years after this, London and Paris were unpaved and had no public lamps.

The capital of France was not paved in the twelfth century, for Rigord, the physician and historian of Philip II., relates that the king, standing one day at a window of his palace near the Seine, and observing that the carriages which passed threw up the dirt in such a manner that it produced a most offensive stench, his majesty resolved to remedy this intolerable nuisance by causing the streets to be paved, which was accordingly done. The orders for this purpose were issued by the government in the year 1184, and upon that occasion, it is said, the name of the city, which was then called Lutetia, on account of its dirtiness, was changed to that of Paris. In 1641, the streets in many *quartiers* of Paris were not yet paved.

Dijon, at that time reckoned one of the most beautiful cities of France, had paved streets as early as 1391; and it is remarked by historians that after this period dangerous diseases, such as dysentery, spotted fever, and others, became less frequent in that city.

The streets of London were not paved at the end of the eleventh century. It is related that in the

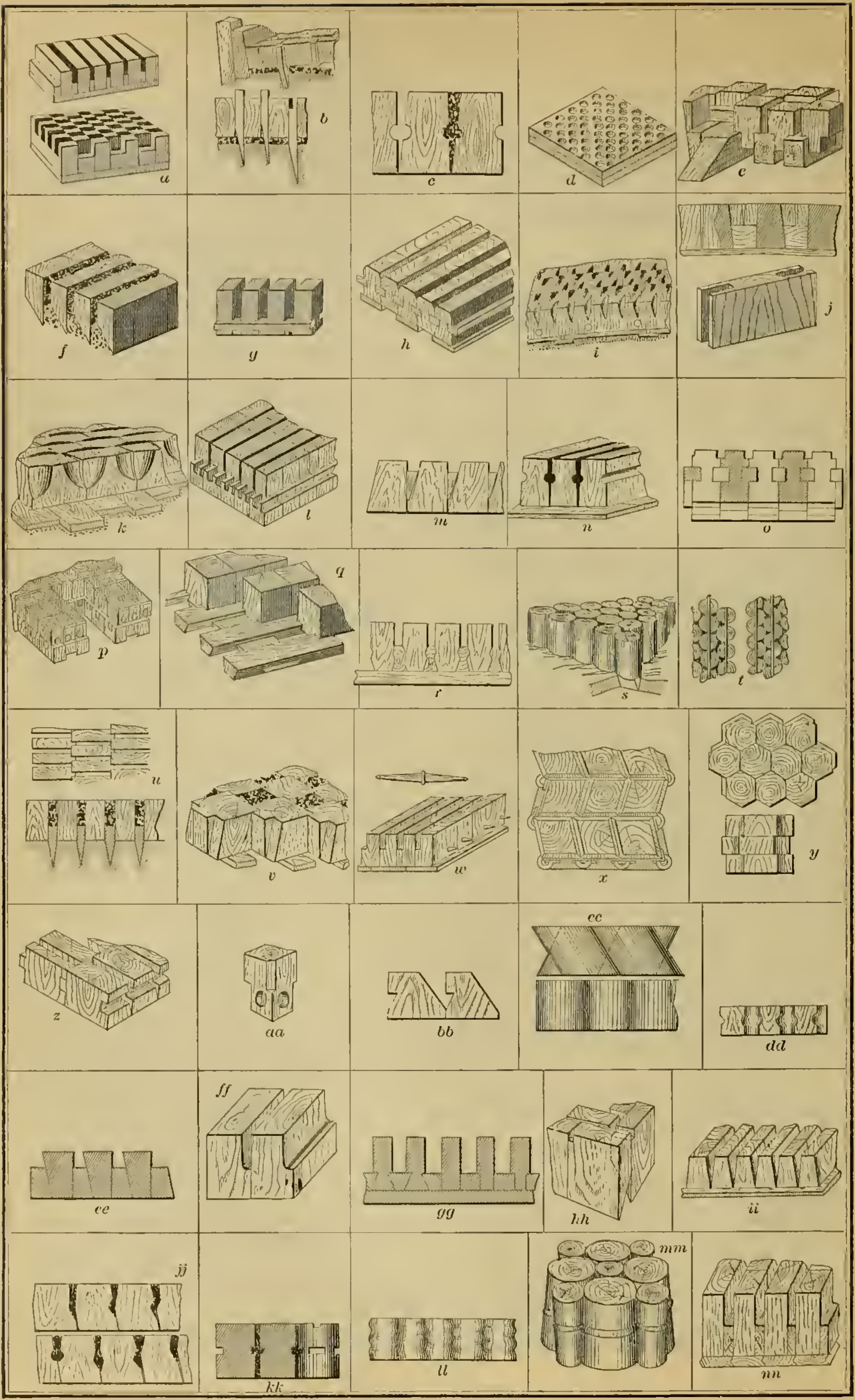


Plate XXXVIII. WOODEN-BLOCK PAVING. *See page 1639.*

year 1190 the church of St. Mary le Bow, in Cheapside, was unroofed by a violent wind, and that four pillars, 26 feet in length, sunk so deep into the ground that scarcely four feet of them appeared above the surface of the soft earth forming the bed of the street.

The pavements of this great city appear to have been gradually extended as trade and opulence increased, though the period of their first introduction is unknown. Several of the principal streets, among which was Holborn, were paved for the first time in 1417. Smithfield cattle-market was first paved in 1614.

Blocks of wood set endways are a common pavement in Russia and Germany. Blocks of wood or stone inclosed in iron frames were in use in England thirty or forty years ago.

In 1812, Loudon suggested laying cubic blocks on a foundation of flag-stones, or cast-iron plates on a bed of mortar.

George Knight (Loudon, P. 3720), London, 1829, suggested laying the granite blocks on a macadamized foundation. This, with grouting for rendering the pavement water-tight, and with under-drainage, is pronounced by Loudon one of the best modes of paving.

Lieutenant Brown (England, 1830) suggested a gravel foundation, dressed blocks of granite laid in mortar and grouted.

One form of the London pavement has granite blocks 6 × 4 inches on a bed of gravel, filled in with grouting, and solidified by a hot liquid cement of gas asphalt.

A part of Broadway, between Chambers and Warren Streets, was laid in 1835 with hexagonal wooden blocks. Various foundations were tried: cobble-stones, flagging, and macadam. The upper surface of the pavement was coated with a layer of tar and gravel.

An English patent, 1838, describes tapering wooden blocks boiled in tar and doweled together.

A subsequent English inventor aggregated his blocks in clusters in iron frames, which were fitted together.

In Parkin's English patent, 1840, the blocks are placed at angles of from 40° to 70°. The surfaces of the blocks were channeled, and they were cemented together in the pavement, their interstices being filled with pitch. Sand or ashes and tar was used in the foundation.

Previous to 1841, a system of foundation-boards was exhibited in New York, and in 1841 the blocks were interlocked by notched shoulders.

A pavement has been suggested, composed of iron perforated in such a manner as to afford a footing for horses, and to permit the sweepings to fall through upon a sub-pavement made of cement and depressed at the center, so that the offal can be swept therefrom to the sewers by simply flushing with water. It is said to have been put in operation in St. Louis. Cost, $3.66 per square yard.

Knight's patent consisted of blocks made of iron run into molds packed with hot granite fragments. This saved metal, which nevertheless could be run into form, and the granite gave the requisite roughness to the wearing surface.

Among the pavements now in common use may be enumerated: —

Ashlar, consisting of squared blocks of stone, generally granite, usually 12 inches deep, 8 to 12 long, and 5 to 7 wide.

Asphalt, a foundation of coarse broken stone and a top dressing of finer stone and perhaps sand or gravel, all cemented together by an asphalt.

Belgian, similar to ashlar, but of smaller blocks.

Bowlder, irregular stones brought to a comparatively even surface by resting on an uneven foundation of sand or gravel.

Cobble, stones naturally rounded, and of nearly equal size, rammed down in a bed of sand.

Concrete, similar to asphalt, except that tar or pitch is used, sometimes in conjunction with natural asphalt.

Granite, blocks of granite, either ashlars or irregular broken stones from the quarry.

Slag, refuse from the furnace, sometimes concreted; at other times run into molds to form blocks.

Wooden, blocks sawed to an even length, set endwise to the wear of travel.

Macadamizing was named from the inventor, and introduced in 1824. It consists in substituting broken granite for gravel as a top dressing, and is much superior to the latter for country roads, but will not stand the heavy wear of city travel.

Haussmann laid 1,250,000 yards of macadam in the streets of the city of Paris, as a substitute for the stone blocks, the material of barricades in revolutions.

In the *Snow* pavement no natural asphaltum is used; the raw coal-tar is treated with sulphuric acid, and mixed with lime and cement, and is said to produce a compound similar to the Neufchatel rock.

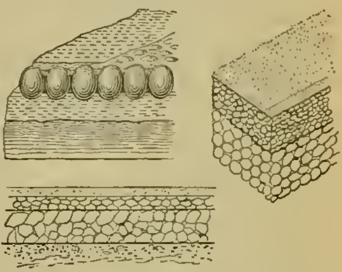
The *Scharff* pavement uses bitumen and the heavy tar-oils for the base, bitumen and a small quantity of natural asphaltum for the top courses.

The *Vulcanite* pavement makes Trinidad asphaltum the basis of the composition, treating the same with sulphuric acid or sulphur and cement.

The *Neufchatel rock* pavement has a base of a concrete of broken stone and bituminous or asphaltic compounds. This base being perfectly dry, a coating of that peculiar formation known as the Neufchatel rock, and which is a natural and intimately combined mixture of asphaltum with calcareous matter, is spread in a powdered state, well heated, and compressed by heating down with heated cast-iron pestles into a hard, smooth mass. The compression is completed by heavy rollers.

Fig. 3575 shows three varieties of concrete pavement.

Fig. 3575.



Concrete Pavements.

Solid concrete and asphaltum pavements are hard and elastic; are not affected by the alternations of heat and frost; they have no joints to encourage the growth of weeds and accumulation of filth; are therefore free from dust and mud. They dry in a few moments after a rain, are smooth, and yet not so even as to become slippery, especially when occasionally sprinkled They afford an easy, noiseless, and pleasant drive; decrease the cost of keeping the street in repair, by confining the latter to the top dressing; and effect a large annual saving in horse-flesh and wear and tear of vehicles.

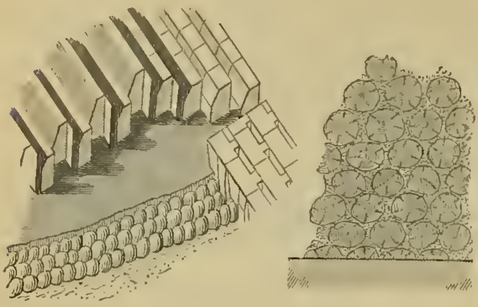
The *Nicolson* pavement, which was among the first wooden pavements used extensively in this country, consists of a foundation of boards laid flat upon the ground, and a superstructure of blocks sawed to an even length of 4 to 6 inches, and 2½ or 3 inches thick. The blocks are laid across the street, and secured by a thin strip of board nailed at the bottom, reaching not quite to the surface. The space thus left above the strip is filled with fine gravel, to afford a holding surface to horses' feet. The whole then receives a top dressing of tar. Another form has alternate short blocks, the spaces filled with gravel

Numerous varieties of wooden pavement have been patented in the United States, and some of them are very extensively used. Plate XXXVIII. shows forty varieties of patented pavement. The difference between them lies in the form of blocks, method of laying, foundation, and chemical treatment or otherwise of the wood.

The greatest enemy to wooden pavements has been dry-rot from below. The surface of a well-laid pavement soon becomes water-proof from dust beaten into the pores of the wood, and if sufficient incline is given to the surface rain will flow off as from a roof. Dampness from below is drawn into the blocks by capillary attraction, and the lower part of the blocks crumbles into dust while the shell on top remains perfect. To prevent this decay, compound pavements, which exclude the absorption of the moisture of the soil by means of a layer of asphalt, would seem to offer more chances for duration than any other system, especially if the wood has been chemically treated.

Of these compound systems used, two forms are shown in Fig. 3576, one employing square blocks and the other round blocks on a concrete foundation. See Wood, Preservation of.

Fig 3576.



Compound Pavements.

Pa-vil′ion. (*Music.*) Fr. *Pavillon*, from its tent-shape. The flaring mouth of a horn, trumpet, or wind-instrument of that class. The insertion of the hand into the *pavilion* of the French horn regulates the inflection of the sounds.

2. (*Architecture.*) *a.* An isolated building of ornamental character.

b. A turret rising from the general hight of a building.

c. A projecting apartment of a building.

d. A tent-shaped roof.

3. A tent; a marquee.

4. (*Gems.*) The part of a diamond or other gem below the *girdle* and between it and the *collet*.

Pa-vil′lon-chi-nois′. (*Music.*) An instrument having a number of small bells in a frame, which is agitated by striking the staff on the ground. It is especially used in marching music.

Bells, *high* and *low*, are used in military music, and occasionally for dramatic effects in operas.

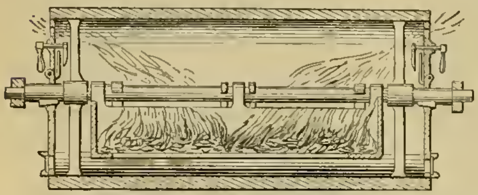
The *glockenspeil* is an instrument in which bells are rung by keys; in one case bars of steel are substituted for bells.

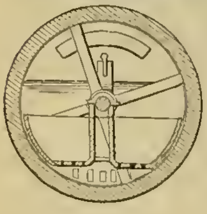
Gongs and *triangles* are but forms of bells.

Pav′ing-bee′tle. A rammer used by paviors.

Pav′ing-ma-chine′. A traveling rammer, like a small pile-driver, traveling over the surface of the pavement and ramming down the blocks, was invented about 1830 by Colonel Macirone, London.

Fig. 3577.





Paving-Roller

A steam paving-machine in use in Paris consists of a small steam-engine on wheels, drawn by one horse, to the rear of which is attached the pavior or vertical rammer, which is forced upon the ground with great force by a blow from the piston. It slides on a bar some six feet long, and can thus be directed by the driver to any stone which requires forcing home.

Lignier's machine (French) consists of a small Lenoir steam-engine, to the fly-wheel of which is attached a rammer of steel, smaller and heavier than the wooden one in general use. The operator simply guides the strokes of the machine.

Pav′ing-roll′er. A heated roller for compacting asphalt pavement. In the example, a cresset or fire-basket is suspended within the roller in such a way as to preserve its proper position during the rotation of the roller.

Pav′ing-tile. A flat brick for paving floors. Such are often of an ornamental character, enameled, encaustic, etc. See Tile.

Tiles employed in offices, kitchens, etc., are usually from 9 to 12 inches square.

Pa′vi-or. 1. A paving-brick.

2. A rammer for driving paving-stones.

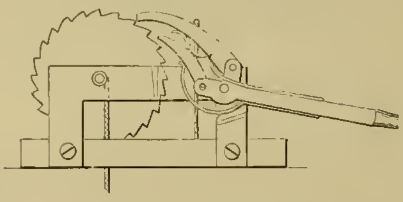
Pawl. A pivoted bar adapted to fall into the notches or teeth of a wheel as it rotates in one direction, and to restrain it from back motion. Used in windlasses, capstans, and similar machinery. The pawl acts by gravitation or by a spring.

The same device is called a *click* when acting in connection with a ratchet-wheel, as in the winding part of a watch.

It is sometimes called a *detent.* This is its office, but the thing has already names enough.

Figs. 3578, 3579, 3580, show three applications of the pawl, and many others may be found incidentally shown in connection with devices, such as *click*, *ratchet*, etc.

Fig. 3578.

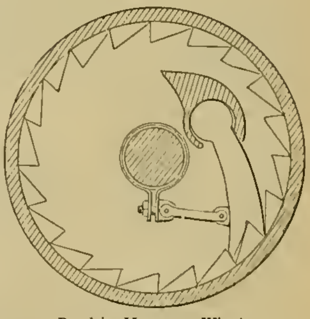


Pawl in Hoisting-Apparatus.

Fig. 3578 is a hoisting lever having a pair of pawls acting upon a ratchet on the shaft of a windlass.

Fig. 3579 shows the pawl and ratchet gear of the driving apparatus of a harvester. As the machine moves in a curve, one of the propelling wheels will revolve faster than the other, and the link which connects the pawl with the friction-band is silently disengaged from the teeth of the case on the outer curve. When the machine turns a curve in the opposite direction, the pawl is made to engage with the teeth.

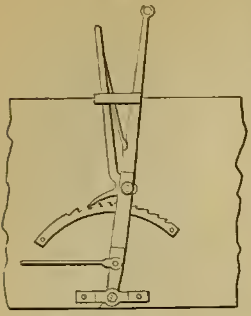
Fig 3579.



Pawl in Harvester-Wheel.

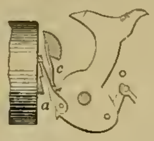
Fig. 3580 shows the application of a click and ratchet holding-device for a wagon-lock. A handle, which is secured to the pawl, extends upward and slides in a guard attached to the brake-lever. It is used to release the pawl from the ratchet.

Fig. 3580.



Pawl on Wagon-Lock.

Fig. 3581.



Feed-Motion of Colt's Pistol.

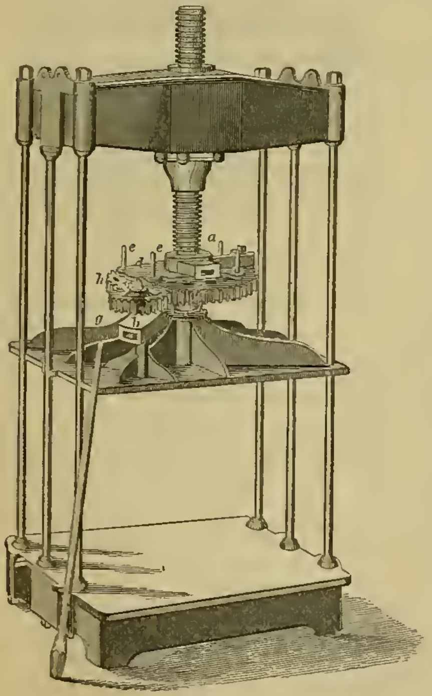
The mode of rotating the barrel of the Colt pistol is by means of a pawl pivoted to the lower part of the hammer, and acting upon a crown ratchet on the rear of the barrel. As the hammer is brought to the cock, the pawl *a* rises, being kept to its work by a spring *c*, which forces it into the interdental spaces of the ratchet. As the hammer falls, the pawl slips and takes hold of the next ratchet-tooth.

Pawl-bitt. (*Nautical.*) A timber opposite the middle of the windlass supporting the pawls which engage the ratchet of the barrel.

Pawl-post. (*Nautical.*) A timber to withstand the thrust of the pawls of a windlass. A *pawl-bitt.*

Pawl-press. A standing press used by bookbinders and printers for pressing sheets, etc. It is next in power to the hydraulic press, and is operated by a lever inserted into the sockets *a b*, and another not shown. The plate *d* has beveled pins *e*, which drop into the beveled slots *f* when the lever is turned, so as to produce a downward motion of the screw, and rise therefrom when it is turned in the opposite direction; pawls are also caused to engage the smaller wheels *g h*, each of which in turn serves as the driver, by inserting the lever into an appropriate socket, the smallest wheel when thus employed affording the greatest power.

Fig. 3582.



Pawl-Press.

Pawl-rim. (*Nautical.*) A notched cast-iron rim encircling the barrel of the windlass, and serving for the pawls to catch in.

Pay. (*Nautical.*) *a.* To cover or fill with a water-proof composition or substance, as the bottom of a vessel, a seam, a mast, yard, or rope. The materials used are tar, pitch, tallow, resin, etc., or combinations of them.

Weather-decks are *payed* with marine glue; a solution of caoutchouc and shellac with naphtha.

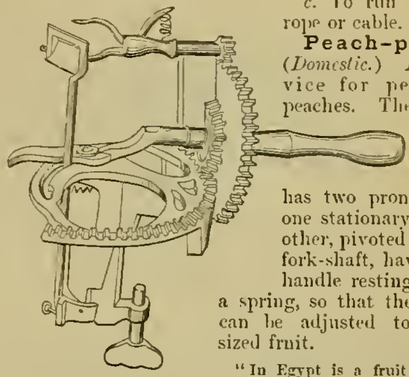
Decks are payed with a ladle; seams, with a ladle or mop; other surfaces with a brush.

b. To fall off from the wind.

c. To run out a rope or cable.

Peach-par′er. (*Domestic.*) A device for peeling peaches. The fork has two prongs, — one stationary; the other, pivoted to the fork-shaft, having a handle resting over a spring, so that the fork can be adjusted to any sized fruit.

Fig. 3583.



Peach-Parer.

"In Egypt is a fruit called *persica*, of wonderful sweetness. This was brought out of Ethiopia by the Persians when Cambyses conquered these places." — Diodorus Siculus (60 B. C.).

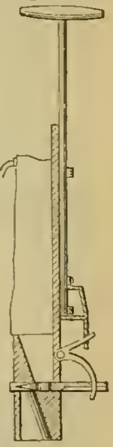
Rather say, brought by the Persians from home. They brought little with them from Ethiopia except disgrace. The peach (*persica*) is Persian. It was introduced from the East into Europe by the Arabs. Its congeners, the nectarine and apricot, are also natives of Asia.

Peach-ston′er. An implement for thrusting the stone out of a peach while holding the fruit; or, with free peaches, dividing the fruit, so that the pit may drop out. In one case, the peaches are fed between wheels with corresponding concave faces and drawn against knives, which open the peach and deliver the halves and the stones at different places.

Pea-drop′per. (*Husbandry.*) An implement for planting pease in hills. It resembles the corn-planter in material respects.

With the down stroke the elbow-lever is vibrated, pushing the slide and its contents over the dropping-hole, whence it falls into the ground. As the handle and implement are raised, the slide returns and is refilled.

Fig. 3584.



Pea-Dropper.

Peak. 1. (*Nautical.*) *a.* The upper, after corner of a *trysail*, *spanker*, or *sprit*-sail.

b. The upper end of a *gaff*. The national ensign is flown at the *peak*.

c. To *top* a gaff or yard more obliquely.

d. To raise the oars upright amidships.

e. The pointed *bill* beyond an anchor's *palm*.

2. The leathern front of a cap.

Peak-arch. (*Architecture.*) A pointed, or *Gothic* arch.

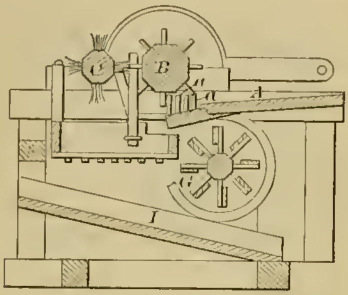
Peak-hal′yards. (*Nautical.*) The purchase by which the peak of a gaff is raised. The throat which rests against the mast has its *throat-halyards*.

Pea′nut-dig′ger. A kind of plow with trailing branches, which raises from the soil the vines with the nuts attached, and leaves them strung upon the surface of the ground, to be afterward gathered and picked by hand or by machine.

Pea′nut-pick′er. A machine for separating peanuts or the pods of leguminous plants from their vines.

These are fed down the incline *A*, and, in passing between the spoked cylinder *B* and upright teeth *a a*, the pods are torn from the stalks and fall upon a sieve to which a vibratory motion is imparted by a lever and a cam on the cylinder *B*. A strong blast directed from the fan *G* above and below the sieve blows away the vines, while the pods fall through upon the incline *I* and are delivered into a proper receptacle. A rotary brush *C* clears the spaces between the spokes on the cylinder *B*.

Fig. 3585.

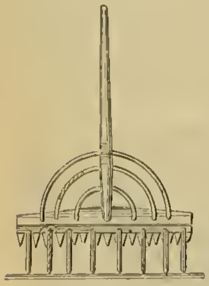


Peanut-Picker.

Pea-rake. A rake adapted for gathering the field pea.

The toothed cutter on the rake-head cuts off the vines which the rake has gathered.

Fig 3586.



Pea-Rake.

Pear-gage. A gage for measuring the exhaustion of an air-pump receiver. It consists of a tube open at bottom and held by a wire passing through the top of the receiver, so that after exhaustion it may be lowered into a cup of mercury, the degree of exhaustion being shown by the hight to which the mercury rises when the air is readmitted.

Pearl. (*Printing.*) A size of type between Diamond and Agate.

Diamond, 205 ems to a foot.
Pearl, 178 ems to a foot.
Agate.
Nonpareil, 143 ems to a foot.

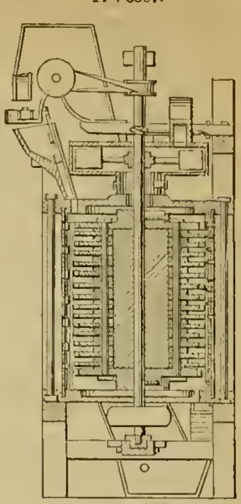
Pearl, Ar′ti-fi′cial. A hollow glass bead internally coated with a pearly film derived from the scales of certain fish.

Pearl-ash. A somewhat impure carbonate of potash obtained by leaching wood-ashes.

Pearl-bar′ley Ma-chine′. A machine for taking the hull from barley grains.

The grain is placed in one of the two hoppers, and passes through the annular space between the toothed cylinder and the case. The cylinder has horizontal toothed rings alternating with plain ones. The shell has holes with the burrs inside, and oblique slots which incline to the right and left, to operate when the cylinder is turned in either direction, according as the grain is furnished by one or the other hopper. An adjustable fan-blast removes the husks from the machine. From the elevator the grain passes over a screen which keeps back the unhusked grain, and the same is returned to the alternate hopper.

Fig. 3587.



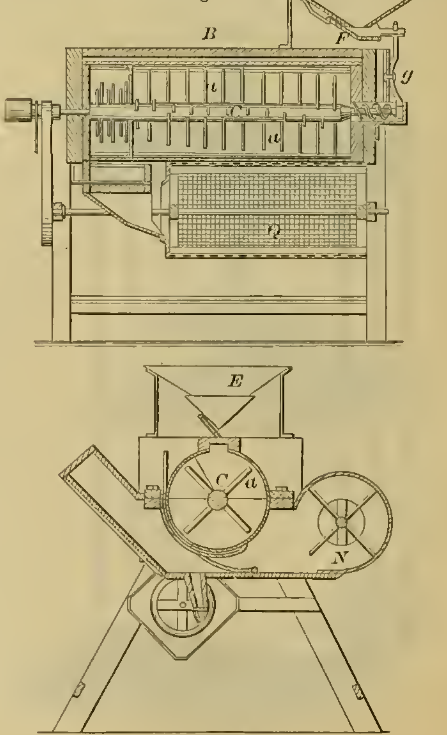
Pearl-Barley Machine.

Pearl-but′ton. A button made of a shell. The blanks are cut out by a revolving steel tube with a serrated end; it forms an annular saw, like a *crown* or *trepan* saw. The blanks are then split by taking advantage of the laminar structure of the shell, placed in a spring chuck, faced and backed by a turning tool, drilled, and polished by rottenstone and soft-soap.

Pearl′ing-mill. A mill for preparing hominy, pearling barley, etc.

The grain is fed from a hopper *E*, and passes down an incline

Fig 3588.



Pearling-Mill.

F into the spout *g*, whence a screw conveys it into the cylinder *E*, which contains a rotary shaft *C* provided with spiral arms *a a*, by which the grain is beaten and gradually conducted to an opening at the other end of the cylinder, where it is exposed to the action of an air-blast from the fan *N*. It thence passes down the spout *P* to the screen *Q*. See HOMINY-MACHINE.

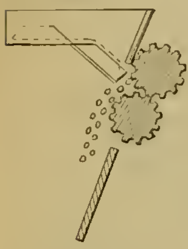
Pearl-pow′der. 1. A submuriate of bismuth, used as a flux for certain enamels.

2. A cosmetic of various compositions.

Pearl-white. A cosmetic. The submuriate of bismuth, obtained by precipitation from nitrate of bismuth.

Pease-meal. (*Foundry.*) Pease-flour, dusted on as *facing* on molds for brass-work. Used also sometimes to give tenacity to very weak sand when strong sand is not to be had.

Fig. 3589.



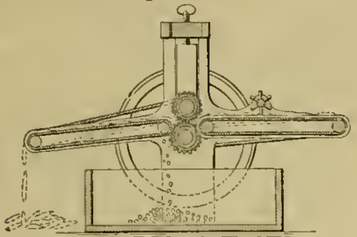
Pea-Sheller.

Pea-shell′er. (*Domestic.*) An implement for taking garden pease from their pods.

The sectional view (Fig. 3589) shows one form. The corrugated rollers grasp and burst the pod; the pease fly out, and the pod is carried away by the rollers. Brushes remove particles of pods from the rollers.

In Fig. 3590 the pods are fed by a belt between the elastic surfaces of two rollers, which burst them open, allowing the pease to fall into the tray while the empty pods are carried off by a discharging belt.

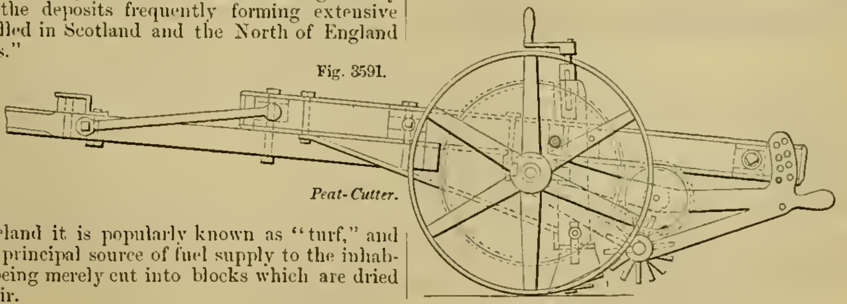
Fig. 3590.



Pea and Bean Sheller

Peat. A carbonaceous substance formed by the decomposition of vegetable matter when the conditions as to temperature and moisture are favorable. The better qualities contain, when dried, from 45 to 50 per cent of carbon, the remainder consisting of water and inorganic substances; about half the water is chemically combined with the peat. It occurs but in small quantities or not at all in countries where the summer heat is so great as to cause rapid decomposition, and is largely found in such countries as Ireland, Holland, and North Germany, where the summer temperature is low and the air generally moist; the deposits frequently forming extensive bogs, called in Scotland and the North of England "mosses."

Fig. 3591.



Peat-Cutter.

In Ireland it is popularly known as "turf," and forms a principal source of fuel supply to the inhabitants, being merely cut into blocks which are dried in the air.

The peat of Ireland is estimated at 4,000,000,000 tons, and is used for fuel and for the production of naphtha, paraffine, etc.

The peat of Holland is deposited on the bottoms of ponds and lakes, — this may be equally true of peat-beds in general, — and is dredged up and spread on the ground to dry. After draining, it is consolidated by the pressure of flat boards fastened to the feet of men who walk over it. It is then cut into blocks and dried for fuel.

Peat forms an ingredient in many of the artificial fuels, being associated with coal-screenings, coke-dust, charcoal, cinder-siftings, pitch, sawdust, spent tan-bark, tar, crude petroleum, asphaltum, wood-shavings, corn-cobs, and other ingredients, in various quantities. Excepting as to the machinery involved, the question is a little outside of our limits.

Peat is prepared for use as fuel, —

1. By drying it in stacks in the open air, or better in sheds, where it is protected from rain but has free access of air. Air-dried peat contains 25 per cent of water.

2. By kiln-drying.

3. By compression. This has the effect of rendering it more compact and increasing the heat yielded by a given bulk. The compression assists the drying. Owing to the fact that peat is not homogeneous, the process of compressing peat in its natural state is a difficult one. It is consequently usually ground and lixiviated with water, to remove the mineral impurities previous to pressing. Various modes of effecting this are practiced in France, Holland, and Germany. These effect a very considerable reduction in the weight of the prepared material, but are objectionable on account of the addition of water, which has again to be dried out of the mass.

In the dry-compression process of Gwynne and Exter, the material is first deprived of its natural excess of water by means of a hydro-extractor, then pulped and dried; the product is then ground into powder, which is molded by pressure, heat being at the same time applied.

In another process the peat is dried in the air, ground to a coarse powder, then stove-dried, and finally pressed and molded.

The Lester and Halstead artificial fuel is composed of 60 to 65 per cent of peat, about 20 per cent of anthracite dust, 10 per cent coal-tar, 5 per cent asphaltum, but varying in proportion for different purposes, whether metallurgical, domestic, or other. The peat, dug in the usual manner, is laid in the air to dry; and when dry enough to be mixed with the other materials into an amalgam, it is put into a press, and with one blow compressed. Next day it is ready for use.

Peat-burn′ing Fur′nace. Three furnaces adapted for this fuel as well as coal are Bennett's, Washburn's, and Stillman's, described under AIR-ENGINE, page 39.

Peat-cut′ter. An implement of the nature of a plow or excavator, used for paring peat from the upper surface of the stratum, for the purpose of treatment in the peat-machine.

The example shows a wheeled vehicle having a transverse slicing-knife 9, which, by the force of the draft, cuts and raises a broad belt of peat; this is delivered from the serrated rear edge of the apron behind the knife to the toothed breaker, which is revolved by gearing from the drive-wheels, and tears the peat to pieces.

Peat-ma-chine′. A machine by which peat, either alone or in combination with other inflammable materials, as coal-dust, is prepared for fuel.

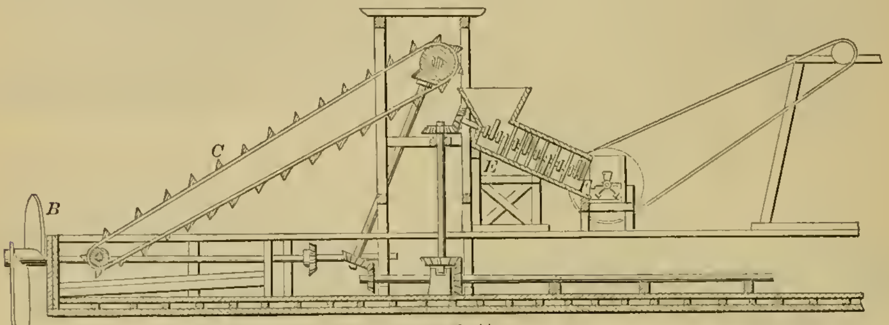
A large number of these machines has of late years been patented in the United States. These are more or less complicated, according to their special function, some being merely designed to cut the peat or to cut and break it, while others perform the whole series of operations by which it is delivered in the form of a densely pressed cake ready for drying and burning.

A few representative examples are shown.

Most of the peat-machines are merely grinders and pressers, which deliver the comparatively homogeneous and dry material in blocks. These machines are so like *brick-machines* that it would appear like duplication to repeat them here. See BRICK-MACHINE.

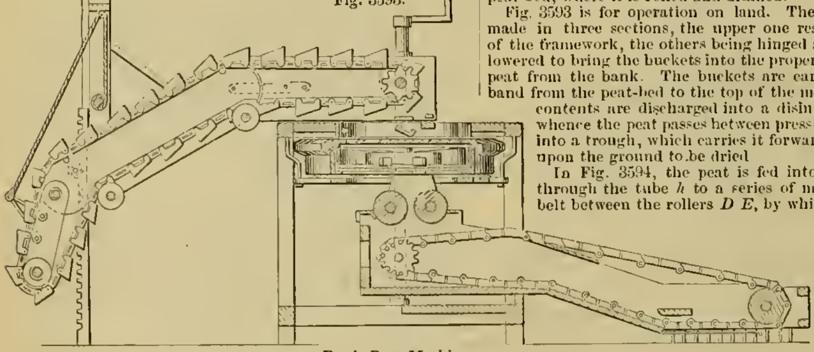
In Fig. 3592, the peat is cut by the screw-excavator *B* and delivered up to the endless belt *C*, by which it is carried to a hopper, where it is fed into the pulping-trough and separator *E F*. This is separated into communicating compartments, and has a shaft provided with radial arms by which the peat is comminuted, afterward passing into the pulping and distributing trough, which also contains a rotating shaft with radial arms, by which it is farther pulped, and deposited through an aperture at bottom, on an endless band, which conveys it to the peat-bed, where it is rolled and drained.

Fig. 3592.



Boat Peat-Machine.

Fig. 3593.

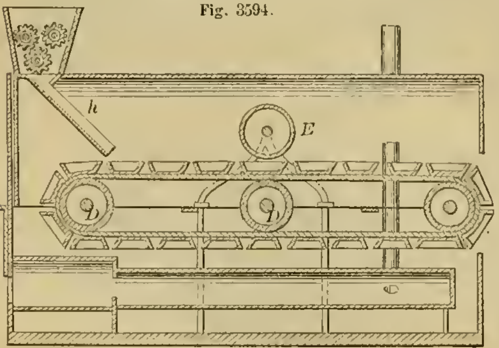


Bank Peat-Machine.

Fig. 3593 is for operation on land. The conveyor-frame is made in three sections, the upper one resting upon the top of the framework, the others being hinged so as to be raised or lowered to bring the buckets into the proper position to dig the peat from the bank. The buckets are carried by an endless band from the peat-bed to the top of the machine, where their contents are discharged into a disintegrating mill, from whence the peat passes between pressure-rollers, and falls into a trough, which carries it forward and distributes it upon the ground to be dried

In Fig. 3594, the peat is fed into a hopper, passing through the tube *h* to a series of molds on an endless belt between the rollers *D E*, by which it is compressed into cakes; these are delivered from the molds at the rear end of the machine.

Fig. 3594.



Peat-Molding Machine.

Peb′ble. By custom, a lens made of rock-crystal.

Peb′ble-pav′ing. Pavement laid with pebbles from 3 to 4 inches deep. When larger stones are used, it is known as *bowlder*-paving, and is from 6 to 9 inches deep.

Peb′bling. (*Leather.*) An operation to bring out the grain of leather and give it a roughened or ribbed appearance. Formerly, the skin was doubled upon itself with the flesh side outward, and the contacting surfaces rubbed to and fro upon each other until the desired appearance was obtained; or a ball of suitable material, grooved or ridged, was passed over the hair side in various directions.

In the *pebbling-machine*, the skin is subjected to the action of a roller with a surface the reverse of the grain or pebble to be produced. This grain may be an imitation of some more costly piece, and skins with a peculiarly fine grain are sometimes electrotyped, to transfer the design with more fidelity to the roller. The machine has the roller mounted on an oscillating arm, after the manner of the tool shown in LEATHER-POLISHING MACHINE (which see).

Peck'er. 1. (*Telegraphy.*) A *relay.* So called in England from the appearance of the earlier apparatus, which *pecked* like a bird.

2. (*Weaving.*) The *picker* of a loom. The shuttle-driver.

Peck'ings. *Place-bricks,* from the outside of the kiln and insufficiently burned. *Sandel* or *semel* bricks.

Ped'al. (*Music.*) A lever or key actuated by the foot. In the piano, the soft pedal shifts the *bank of keys,* so that the hammers do not strike all the keys of the *course of strings.* The other pedal raises the damper so as to allow a more sonorous vibration of the strings.

In the organ, the pedals open and close certain pipes. In the parlor-organ or melodeon, the pedal works the bellows.

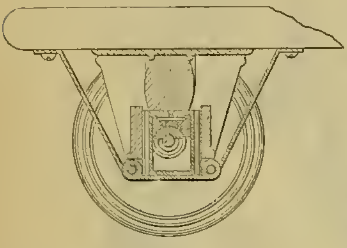
When it is used in machinery, as in working a lathe or a sewing-machine, it is called a *treadle.*

Pedals were first used on organs. (See ORGAN.) About the middle of the eighteenth century they were adopted as a means of working the *stops* of the harpsichord. These were known as the *forte, soft,* and *buff.* See STOP.

Ped'al-key. (*Music.*) The *pedal*-keys of an organ are worked by the feet, the *manual*-keys by the hand.

Ped'al-or'gan. (*Music.*) That part of a large organ which is played by foot-keys, enabling the larger pipes to be operated by the feet of the performer.

Fig. 3595.



Pedestal.

Ped'es-tal. 1. (*Machinery.*) The standards of a pillow-block, holding the brasses in which the shaft turns. See PILLOW-BLOCK.

2. (*Railroading.*) A casting secured to the truck-frame and having vertical guides for the journal-boxes of the axles, which rise and fall in the pedestals as the springs collapse and expand.

3. A pillar, post, or column.

4. A plinth, base, or foot for an object to be raised and displayed. When perfect in its parts, it consists of a *base, die* or *dado,* and *cornice.* A stylobate.

Ped'es-tal-cov'er. (*Machinery.*) The cap of a pillow-block, which is fastened down upon the pedestals and confines the *boxes.* See PILLOW-BLOCK.

Ped'i-ment. (*Architecture.*) A triangular structure at the termination of a roof, or over a portico, window, or doorway, differing from a mere gable in having a horizontal and two raking cornices, inclosing a tympanum.

Ped'i-ment-ba-rom'e-ter. A barometer whose case is surmounted by a pediment for the purpose of ornamentation.

Pe-dom'e-ter. A *pace-measurer.* An instrument to count the steps.

One form consists of a string with a piece of lead at the end, and knotted at distances of 44 feet apart. It is to be used in connection with a seconds watch. Forty-four feet bears the same relation to an English statute mile (= 5,280 feet) that $\frac{1}{2}$ minute does to an hour; that is, the knots are $\frac{1}{120}$ of a mile apart. Drop the lead and allow the string to pass through the hand, the number of knots slipping through the hand indicate the rate of walking in the number of miles per hour.

Small *pedometers,* to be worn on the person, consist of a train of wheels in a small case, and a dial which registers the number of impulses derived from a cord attached to the foot. In this form it becomes a register of the number of *paces.*

Payne's *pedometer* (English patent, 1831) was of the form and size of a common watch, having a pendulum which was swayed by the movement of the person in walking; the pulsations being registered in the usual way and shown on the dial. The patentee also attached his pedometers to an ordinary watch, in which case the train of wheels and other parts are placed under the dial-plate or face of the watch.

Pee. The point of an anchor-arm which penetrates the ground. The *fluke* or *palm* is the expanded portion which affords an area of holding surface. The *bill.*

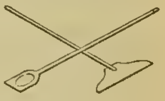
Peek. (*Nautical.*) The upper end of a fore-and-aft sail, sprit-sail, etc.; or the outer end of a gaff. See PEAK.

Peel. 1. (*Bakery.*) A wooden shovel with a long handle, used by bakers in putting in and withdrawing loaves to and from the oven.

2. A similarly shaped implement for hanging wet sheets of paper on lines or lath to dry.

3. (*Nautical.*) The *wash* of an oar. The end inside the gunwale is the *loom.*

Fig. 3596.

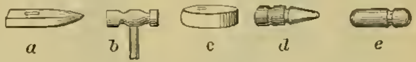


Peels.

Peel'ing-i'ron. A shovel-shaped thrusting-instrument whereby bark is loosened and pried away from the wood. See BARKING-TOOL.

Peen. The sharp point of a mason's hammer. Sometimes incorrectly written *pane.*

Fig. 3597.



Hammer-Peens.

a, narrow peen for riveting.
b, broad peen for machinists.
c, cross peen for coopers.
d, cone peen for chasing
e, ball peen; upsetting hammer for engravers.

Peg. A wooden nail or pin.

1. (*Shoemaking.*) A small pin of wood (maple) for securing the *upper* and *counter* to the *sole* of a boot or shoe; and for securing the extra *sole* to the upper one, or the *lifts* of the *heel-tap* to each other in *building-up* the heel.

Copper-wire pins have been substituted; also small pins of leather; also screw-pegs.

The term gives rise to many compound words, — pegging-awl, peg-making machine, peg-driver, peg-float, peg-cutter, etc.

Fig. 3598 shows a number of different kinds: —

a has pegs glued to paper, so as to admit of being fed in a ribbon.

b shows a plain and a notched peg, which is designed to be saturated with shoemaker's wax.

c is a peg-strip in which a ribbon of wood is cut out with one sharp edge, the pegs being separated therefrom in the pegging-machine by a chisel and driven by a blow.

d d' d'' d''' are pegs of condensed leather, nearly separated but adhering sufficiently to be fed as a strip.

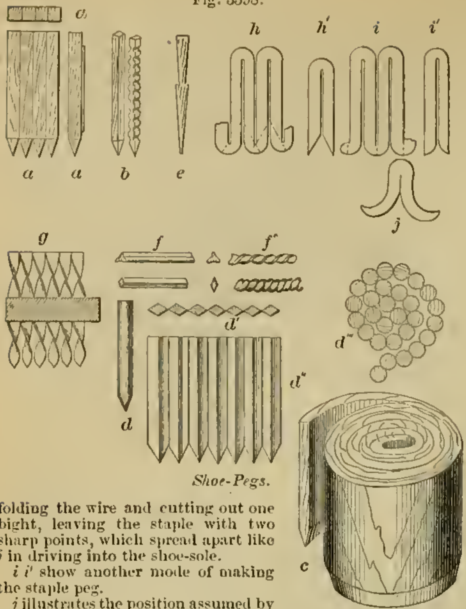
e is a barbed peg.

f f' are pegs made of wires of various angles and twisted.

g shows a row of cable-screw pegs soldered on to a metallic ribbon for feeding in a pegging-machine.

h h' are modes of making staple pegs for boots and shoes by

Fig. 3598.



Shoe-Pegs.

folding the wire and cutting out one bight, leaving the staple with two sharp points, which spread apart like *j* in driving into the shoe-sole.

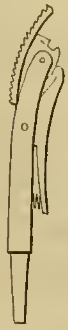
i i' show another mode of making the staple peg.

j illustrates the position assumed by the branches when driven by a blow from above.

2. (*Music.*) A turn-pin on which a string of a musical instrument is stretched.

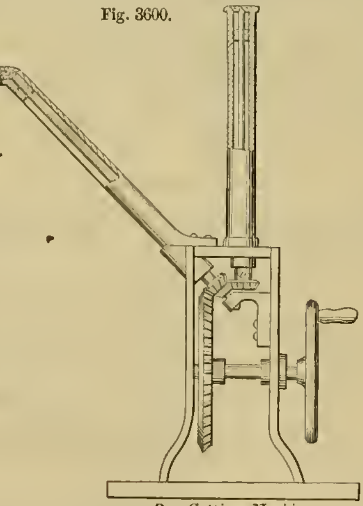
Peg-cut′ter. An instrument or machine for removing the ends of pegs from the insides of boots and shoes. A *float.* In the example this is pivoted in the stock and has a flange beneath, in one of whose notches the spring dog is engaged to maintain the *float* in the required angular position. The stock stands in a hole in a bench.

Fig. 3599.



Float.

Fig. 3600.



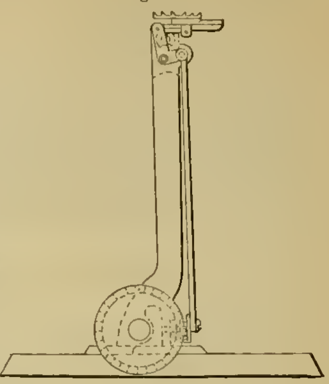
Peg-Cutting Machine.

In Fig. 3600, the cutters at the ends of the shaft have a rotary motion, imparted by gearing and a hand-crank.

Peg-float. An implement for rasping pegs from boots and shoes. In the example, the cutter, instead of being worked directly by hand, is reciprocated by a crank-wheel, connecting-rod, and elbow-lever.

Peg′ging-awl. (*Shoemaking.*) A stiff awl with a four-sided blade, approximating the shape of the peg which is to occupy the hole. It is driven by a hammer.

Fig 3601



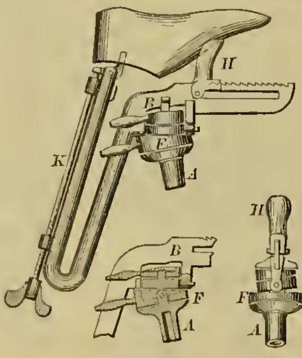
Float.

Peg′ging-jack. An implement for holding a boot or shoe and varying its position while being pegged.

In the example, the latter object is effected by varying the position of the curved arm on the standard *A* by means of cams with handles *B F*. The adjustable pad *H* supports the fore-part of the last, while the heel may be tipped by means of the threaded rod *K*.

Peg′ging-ma-chine′. An apparatus for driving the pegs which unite the soles and uppers of boots and shoes. The pegs are usually cut from what is called a peg-strip, which is a ribbon of wood, the grain running across the width of the strip, and fed to the parts which cut off a peg and then drive it.

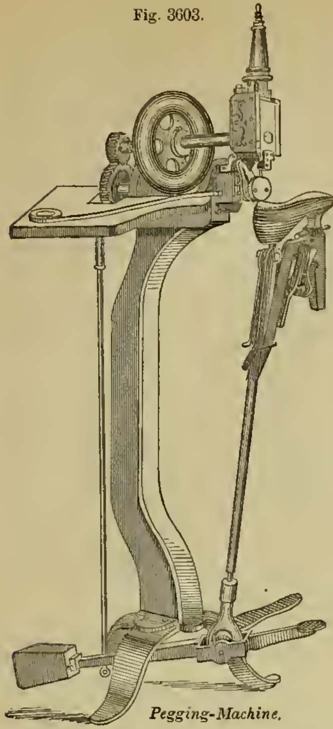
Fig. 3602.



Pegging-Jack.

In the illustration, the long jack-standard is hinged by a universal joint in the foot-lever, which is weighted at one end to hold the shoe in contact with the pegging and feeding devices, and at the other with a stirrup or foot-rest to disengage the finished shoe. The jack is capable of lateral and longitudinal motions upon the standard, to present the surface of the sole at the point of contact with the pegging-devices in a horizontal plane. The vertical plunger, carrying an awl and a driver, is operated by a cam and gearing. The rotary feed is immediately back of the peg-guide, and operated by a pawl and ratchet receiving motion from the main gearing in any suitable manner, ordinarily by a cam. The peg-strip is fed into the guide from a coil of practically indefinite length and from which a peg is cut

Fig. 3603.



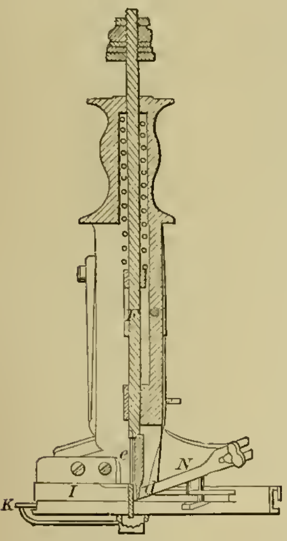
Pegging-Machine.

at each fall of the driver, by a lateral knife, immediately before being driven into the shoe. The long jack-standard brings the mechanism near the eye of the workman.

The two requisite conditions are that the point of contact of the shoe-sole with the pegging-devices must be the center of motion of the work for the time being; and, secondly, the surface of the sole at the point of contact with the pegging-machine must be kept in a horizontal plane.

In Goddu's (Fig. 3604), the awl *e* and peg-driver *d* are simultaneously operated by a spring actuating the plunger *F*, to which they are both attached. The strip of pegs, placed in a feed-trough *I*, is advanced by a follower *K*, and each peg is separated by a flexible knife *N*, which also holds it in position for being driven.

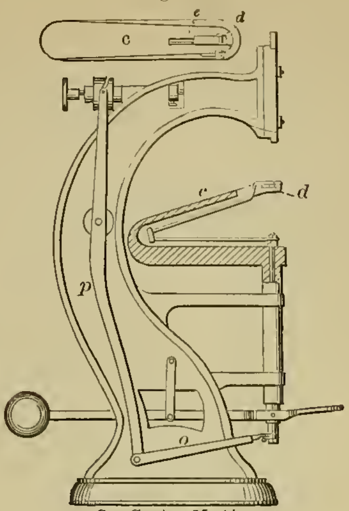
Fig. 3604.



Pegging-Machine.

The device, Fig. 3605, is for cutting off the projecting ends of pegs within the shoe during the process of pegging. The shoe-supporting horn *c* has a slot *d* in which works a knife *e*, operated by a combination of levers *o p*, the upper member of which has a projecting pin working in a slotted cam-shaft.

Fig. 3605.



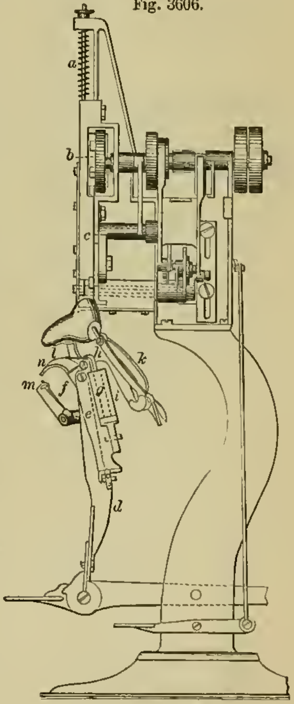
Peg-Cutting Machine.

Sargent's machine is particularly designed for shoes, of which the uppers and soles are united by screw-threaded wire cut to proper length during the operation of pegging. This is effected by a circular cutter connected with a rock-shaft. As the nails are cut off they descend through a peg tube, assuming a vertical position, and are driven home by a plunger actuated by a spring *a* and retracted by a pin on the wheel *b* engaging a shoulder on the plunger.

The shoe is advanced the proper distance to drive each nail, by a swing-plate *c*, whose foot is alternately lifted in and out of contact therewith, and is held at the moment of driving by the foot of the peg-tube.

The shoe is fixed on a jack mechanism consisting of: (1) a supporting upright *d* pivoted to the end of a weighted lever, and is so swiveled as to admit of movement both laterally and vertically; (2) jack-holder *c* joined to the upright by a pin *f*, its vibratory movement on the upright being restrained by stops so as to limit the tipping of the last. A spindle *g* projects from the holder on which the jack is mounted, and is supported on a socket piece, allowing free rotary movement of the jack on the spindle; (3) a last-holder *h*, supported directly over the spindle by a screw, and having a curved arm *i* to which the arm *k* carrying the heel-pin is jointed. It has a ratchet and pawl for forcing the last against the toe-piece *l*.

Fig. 3606.



Sargent's Pegging-Machine.

The arm *i* forms a handle by which the operator guides the shoe being pegged, and another handle operated by the other hand has connections which cause the pin *m* to engage a slot in the lip *n*, and serves to lock the shoe in stationary position relatively to the socket-piece, so that the efforts of the operator may be wholly directed to guiding the shoe without expenditure of strength to keep it in position.

Peg′ging-ram′mer. (*Founding.*) A pointed rammer for packing the sand in molding.

Peg-lad′der. A ladder with but one standard, into or through which cross-pieces are inserted. It is usually fixed.

Peg-strip. A ribbon of wood whose grain runs across the strip, and having one end sharpened, so that chisel-edged pegs may be split therefrom in the pegging-machine. The strip is coiled, placed in the machine, and the end fed into the guide. Invented by Sturtevant, 1858. See PEGGING-MACHINE.

Pein. The small end of a hammer. See PEEN.

Pei-ram′e-ter. An instrument invented by Macneil to indicate the amount of resistance offered by the surfaces of roads. It is a clumsy form of dynamometer, being dragged along on the ground. The power required to move it is indicated by a finger on a dial.

Pel′ham-bit. A bit having a flat, direct-acting joint and cheek-pieces, with bridle-rings at the mouth-piece, and a ring or loop upon the upper arm of the cheek and a loose ring on the lower one. It can be used as a curb or for a double cheek-bridle. This name is also given to bits having loose-jointed and port mouths with straight or crooked cheeks.

Pel′i-can. (*Ordnance.*) An old 6-pounder culverin.

Pel′le-tan-jet. An annular jet of steam used as a form of pump to induce a flow of liquid in an opening within or around the said issuing jet. It differs in principle in no substantial respect from the GIFFARD INJECTOR (which see). See also STEAM-JET; ASPIRATOR; EJECTOR.

Pe-lo′pi-um. Symbol, *Pe.* A rare metal.

Pelt. 1. The undressed skin of a beast with the hair on. They may be large or small, but are usually (not always) intended for furs or felting. *Peltry.*

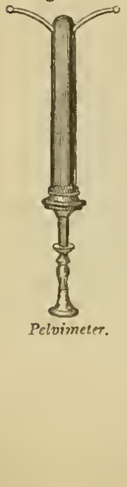
Buffalo, wolf, gray fox, etc., are for robes.

Mink, otter, lynx, marten, sable, black fox, etc., are for wearing furs.

Musk-rat, coypu, beaver, musquash, hare, rabbit, and others, for the fine hair nearest the hide, for the purpose of felting.

Sheepskins with the wool on are also called pelts. When the hair is removed they become mere *skins.* As *tanned pelts* they form mats.

Fig. 3607.



Pelvimeter.

2. The ball-leather used in making inking-pads.

Pel-vim′e-ter. (*Surgical.*) An instrument to measure the diameter of the pelvis, principally in the fore-and-aft direction.

The calipers of Bandelocque have blunt extremities, which are placed respectively on the symphysis pubis and the sacrum, about three inches being deducted for the thickness of the mons veneris, pubis, and the base of the sacrum.

Coutouly's instrument is like a shoemaker's foot-measurer, having a sliding lug. It is introduced into the vagina and then separated, so that one projection touches the promontory of the sacrum and the other comes behind the os pubis.

The cut represents King's pelvimeter with feelers half opened. It is introduced into the vagina with the piston drawn back. When in position it is pushed gently forward, which makes the feelers in front diverge, the extent of which is indicated on the piston-rod.

Pel′y-com′e-ter. A PELVIMETER (which see).

Pen. 1. Pens, if the term be held to include all writing instruments, are of two general kinds, those which scratch and those which use an ink. The former are the more ancient, and consisted of a stylus or bodkin made of bone or metal, and employed upon a leaf, a waxed tablet, a sheet of lead, a stone slab, etc.

The instrument by which an ink or pigment is applied consists of a pen or a brush. The pen was made forty centuries since of a reed (*calamus*), which held almost undisputed sway till the sixth century A. D., when the quill (*penna*) came into use. The materials on which the pen was used were bark, leaves (especially palm), linen, papyrus, skins, parchment, and eventually paper.

Job, chap. xix., seems to refer to the above-cited modes of writing. It is rendered in our version: —

> "Printed [inscribed] in a book."
> "Graven with an iron pen and lead."

Pliny remarks: "At first men wrote upon palm-leaves and afterward on the bark or rind of trees." The Latin words *volumen*, a scroll, *folio*, a leaf, *liber*, the inner bark, a book, are preserved in our language, indicating the form and the character of the material on which the writings of our distant predecessors were executed.

Writing on pieces of palm-leaves was a very ancient practice, and the Cingalese retain it to the present day. Oblong pieces are cut from the large leaf of the tree, and, being made of a uniform size, are neatly strung together with a cord. Many museums and libraries contain Hindoo, Burmese, and Cingalese books of this kind. The mode of writing upon these leaves was by a sharp instrument, a *stylus.* The point scratched through the external cellular matter, which shrank away from the incision, leaving a shallow groove which was made more plain by rubbing a black pigment into the lines so made.

We learn from Pausanias, a Greek topographical writer who flourished in the second century of our era, that the "Works and Days" of Hesiod, inscribed on *leaden plates*, were preserved at the fountain of Helicon in Bœotia down to his time, but were partly obliterated by the effects of wear and time. Hesiod lived about 900 B. C., but how long the plates had been engraved is another matter. Pliny mentions sheets of *lead* and *tablets*, and refers to their use in the remote past.

The Romans also used ivory tablets named *libri eborci* or *libri elephantini*, and Ulpian states that the transactions of the great were usually in a black color on ivory.

A number of engraved bronze tablets of Rome and Carthage are now in the British Museum. Eight bronze tablets were found in a subterraneous cabinet at Gubbio, Italy, in 1444. Seven of them bore inscriptions in Latin and one in Etruscan. The civil, criminal, and ceremonial laws of the Greeks were engraved on bronze tables. The speech of Claudius, on the same alloy, is preserved in the town hall of Lyons, France. The pacts between the Romans, Spartans, and Jews were written on brass. In many cabinets in Europe are discharges of Roman soldiers written on copper plates. The laws of the twelve tables at Rome were inscribed on oaken boards; then transcribed on ivory tablets and hung up *pro rostris*, that they might be read by the whole people; after approval, they were permanently engraved on bronze and deposited in the Capitol, where a large collection was melted upon the occasion of the conflagration occasioned by that edifice being struck by lightning.

The Cretans also used bronze records.

Among the ancient inscriptions on bronze yet extant are the "Scriptum de Bacchanalibus," Imperial Library; Trajan's "Tabula Alimentaria"; the helmet found at Cannæ with Punic letters, in the museum at Florence, and various others in the Italian museums, containing inscriptions in Etruscan and Latin.

A deed for land, engraved on copper in Sanscrit characters and bearing date about 100 B. C., was dug up at Mongheer in Bengal. The grantor was a Bideram Gunt.

Pliny informs us that such documents were rolled up like a cylinder. Two letters are still preserved which passed between Pope Leo III. and Luitbrand, king of the Longobards. Montfaucon notices an ancient book composed of eight leaves of lead, the outside two forming the cover, and the whole held together by a leaden rod passing through rings at the back of the plates. The book contained mysterious figures of the Basilideans, together with words in the Greek and Etruscan characters.

The writing of the ancient Assyrians was impressed by knives or stamps upon cylinders or prisms of soft clay very carefully compounded and shaped. Some of these are rough, others polished or glazed. The writing is the cuneiform, the letters one eighth of an inch long.

The cylinders of carnelian, chalcedony, etc., were engraved seals by which the terra-cotta records were verified. See Seal.

The use of wooden tablets covered with wax is closely allied to that of sheet-lead and a pointed stylus, but the product is of a more ephemeral character. The practice was very common in business and friendly correspondence, and also in official matters which did not require to be laid up for record. Such, for instance, is believed to have been the tablet presented by the Roman legate Popilius to Antiochus Epiphanes, ordering him to evacuate Egypt, which he did, as prophesied by Daniel 366 years previously (Daniel xi. 29, 30).

"Make it plain upon tables, that he may run who readeth it" (Habakkuk ii. 2). An allusion to the old system of relay couriers. Not "that he who runs may read," as often said.

The tables referred to by Isaiah and Habakkuk may have been of wood. The civil laws of Solon were recorded on wood, and placed in a machine constructed to turn easily, and called *axones*; such boards were called by the Greeks *schedæ* or *schedulæ*; when covered with wax, *pugillares cerei*. Pliny and other writers refer to the custom. When a number of such boards constituted a series of leaves, they were described as *cera prima*, *cera secunda*, *tertia*, etc. *Tabulæ* and *ceræ* are terms used by the ancient jurists as describing written statements and records. See also Book.

The reporters who wrote down the speeches in the forum preferred writing on waxed tablets, which required but a scratch of the stylus. No speed could have been effected with a brush and paint in following the Roman orators.

In the Abbott collection of Egyptian antiquities, now in the possession of the New York Historical Society, are a number of these tablets, made like our school slates and used for the same purpose. The middle portion was sunken to protect the writing, which was executed by a sharp bronze stylus upon a coating of black wax spread over the depressed surface. The latter was on both sides like our slates. The specimens were obtained from Abouseer, along with tee-to-tums, dolls, toys, and other evidences that the amusements of the children in the times of the Pharaohs were much like the modern.

Two ancient waxen tablets were discovered a few years since in gold-mines near and in Abrudbánya, in Transylvania. Each consisted of three tablets with raised margins (like a school slate) to protect the wax surface. The sections folded on each other; the middle one had two waxen surfaces; the outer ones but one each, on the inside. The Latin writing on one set of tablets was still visible, and was a copy of a document whose date determined it to be of A. D. 169. The inscription on the inner tablet was in Greek and nearly illegible.

For important purposes, such tablets were carefully inscribed and fastened consecutively by a cord; or for letters, the boards were covered with a linen cloth. In Hanover and Geneva schedules of this kind are yet preserved.

Leaves were also very generally employed in the early stages of society, and with some previous preparation are still in common use in the East.

In the University of Gottingen is still preserved a Bible containing 5,376 pieces of leaf, formed into 45 sheets. A large number of such books, principally Asiatic, are found in various museums.

The Syracusians and Athenians used olive-leaves for writing sentences of banishment upon, — a mode of punishment inflicted upon public men under a cloud in those turbulent republics.

The Balinese, the inhabitants of Bāli, an island of the Malay Archipelago, write with a steel point on the *lanter*-leaf.

The sacred books of the Brahmins and Buddhists are written on leaves of the talipát palm (*talipoin*, a priest), which is a mammoth variety, growing as much as 200 feet high and 4 feet in diameter. The sacred fans of the Buddhists are made of its leaves. It lives to the age of a century and blossoms but once. The bloom is thirty feet in length, and at maturity explodes and scatters its seed.

Sir Hans Sloane's museum had more than 20 manuscripts of palm-leaves written in different Asiatic languages.

To leaves succeeded the *liber*, or inner bark of trees; this was united together so as to form a continuous roll, *volumen*, upon which the matter was written.

Skins of animals, parchment, fish-skins, and bones have been used, as existing specimens testify.

Puricelli mentions a grant by the Italian kings Hugo and Lotharis to the Ambrosian church of Milan written on the skin of a fish.

In the history of Mahomet it is recorded that his disciples wrote parts of the Koran on the shoulder-blades of sheep, which they strung together. Arab poetry was not unfrequently inscribed on these *scapulæ*, probably trimmed for the purpose.

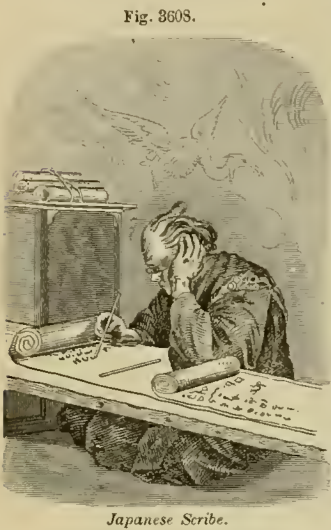
The Alexandrian Library contained the works of Homer written in golden letters on the skins of animals; and the Iliad and Odyssey, written in golden letters on the entrails of animals, collectively 120 feet long, were extant at Constantinople in the reign of the Emperor Basileus. Other instances are known of the use of entrails for this purpose.

Before papyrus became common, the Ionians used instead the skins of sheep and goats, "on which material," says Herodotus, "the barbarians are even now wont to write." Ctesias says he obtained the matter for his Persian history "from the royal parchments" or skins. The invention of parchment is, however, ascribed to Eumenes, king of Pergamos, about 200 B. C.

For notices of papyrus and parchment, see Paper.

The former instances particularly concern the use of the stylus. That of the *pen* proper will now claim our attention, after we have stated that the *brush* has been used for many centuries in Eastern Asia, and still holds its career of usefulness in forming the Chinese and Japanese letters. It has even been suggested that the brush preceded the pen, as the picture or ideographic writing preceded the phonographic; the language of symbols, that of arbitrary signs denoting sounds.

Fig. 3608.

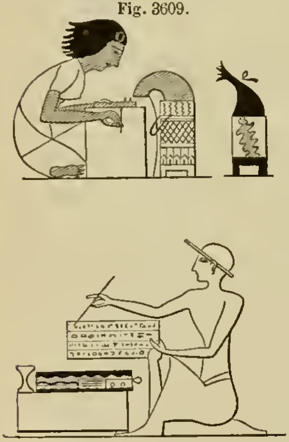


Japanese Scribe.

The characters of some written languages are well adapted for the brush, and the skill displayed by Chinese and Japanese gentlemen is curious and pleasing to us their neighbors, "upon whom the ends of the world are come," in a sense, for we meet directly by a reverse course the ultimate Orient of our predecessors, ourselves occupying the median line between the new civilizations of Greece, Rome, and their derivatives, and the far older and, to us, fantastic forms of Cathay and the lands thereto adjacent.

Fig. 3609 has two views from paintings at Thebes. The upper figure represents a scribe taking an account of the stock of an estate. It is a part of a much larger picture, in which the shepherds and groups of animals are shown. The scribe is writing upon a tablet; before him are two cases for carrying writing-materials. On his left is the inkstand with black and red ink.

Fig. 3609.



Egyptian Scribes (*Thebes*).

The lower figure shows a scribe with his inkstand upon the table. One pen is behind his ear, and he is writing with another.

The illustrative history of the Egyptians does not point to a time before the *reed* was used as a *pen*. The various paintings, palatial and sepulchral, show the scribes at work in their avocations, taking the tale of the hands and ears of slaughtered enemies, the numbers of the captives, the baskets of wheat, the numbers of the animals, the tribute, the treaties and public records.

The Egyptian pen of the time of Joseph was a reed, and the scribes used red and black inks, contained in different receptacles in a desk. When this Hebrew viceroy had a small army of clerks and store-keepers employed throughout Egypt in his extensive grain business, his scribes carried their writing-implements in boxes with pendent leather tops, and with handles at the sides. As the scribe had two colors of ink, he needed two pens, and we see him on the monuments of Thebes, busy with one pen at work, and the other placed in that most ancient pen-rack, behind the ear. Such is represented in a painting at Beni Hassan.

It is said that the best reeds for the purpose formerly grew near Memphis, on the Nile; near Cnidus of Caria, in Asia Minor; in Armenia and in Italy: those of the latter being of relatively poor quality. A place yet famous for them, and which may have supplied the ancient demand in part, is in the vicinity of the Persian Gulf, "in a large fen or tract of soggy land supplied with water by the river Helle, a place of Arabia formed by united arms of the Euphrates and Tigris. They are cut in March, tied in bundles, laid six months in a manure-heap, where they assume a beautiful color, mottled yellow and black." (Chardin.) Tournefort saw them growing in the neighborhood of Teflis in Georgia. Miller describes the cane as "growing no higher than a man, the stem three or four lines in thickness, and solid from one knot to another, excepting the central white pith." The incipient fermentation in the manure-heap dries up the pith and hardens the cane. The pens are about the size of the largest swan's quills. They are cut and slit like our pens, but have much longer nibs.

A little bundle of ancient pens from Egypt, with the stains of the ink yet upon them, may be seen in the museum of the Historical Society of New York, corner of Second Avenue and Eighth Street. Beside them is a bronze knife used in making the pens. In the East, the reed is yet the ordinary implement for writing.

"When he had finished, he dried the *bamboo-pen* on his hair, and replaced it behind his ear, saying, '*Yak posé*' (That is well). '*Témou chu*' (Rest in peace), we replied; and, after politely putting out our tongues, withdrew." — *Abbé Huc at Lha-Ssa.*

The Christian monks of the land once known as Assyria still use a reed for writing the Chaldean character; the ink has a fine glossy character, the paper resembles parchment, and the scribes dispense with a table or desk, resting the paper on the knee.

Reeds are still used by the Arabs; their ink is thick and gummy. Reed pens are also found in Herculaneum. The ancient ink was of a viscid nature; some of it was found in a closed glass bottle in the examination of the city just mentioned.

The quills of birds came into use as pens in the sixth century A. D.; so we learn from Isidore (died A. D. 636) and others. Previous to this time, the writing-implement is spoken of as *calamus*, a reed; after this we read of *penna*, a feather: the reed, however, was a favorite in many quarters among the literati of Europe for five centuries after the first introduction of the quill. In an illuminated manuscript of the Gospels, executed in the ninth century, the evangelists are represented with quills in their hands. The quills of the swan, goose, eagle, owl, and hawk were used. The preference soon settled on those of the goose for obvious reasons, size and accessibility.

In the sixth century the quill-pen is also mentioned by Aldhelmus, a Saxon poet, who wrote a Latin poem entitled "De Penna Scriptoria."

But a century or so afterward paper was introduced into Europe by the Saracens; first as a curiosity, known as *Charta Damascena*, afterward manufactured in Spain and in Constantinople. See Paper.

The list of devices by which characters were legibly portrayed by a scratching implement may be thus recapitulated: —

The *tabula* or wooden board smeared with wax, upon which a letter was written by a stylus.

The Athenian scratched his vote upon a shell, as did the lout when he voted to ostracize Aristides.

The records of Nineveh were inscribed upon tablets of clay, which were then baked.

The laws of Rome were engraved on brass and laid up in the Capitol.

The decalogue was *graven* upon the tables of stone.

The Egyptians used papyrus and granite.

The Burmese, tablets of ivory and leaves.

Pliny mentions sheets of lead, books of linen, and waxed tablets of wood.

The Hebrews used linen and skins.

The Persians, Mexicans, and North American Indians used skins.

The Greeks, prepared skins, called *membrana.*

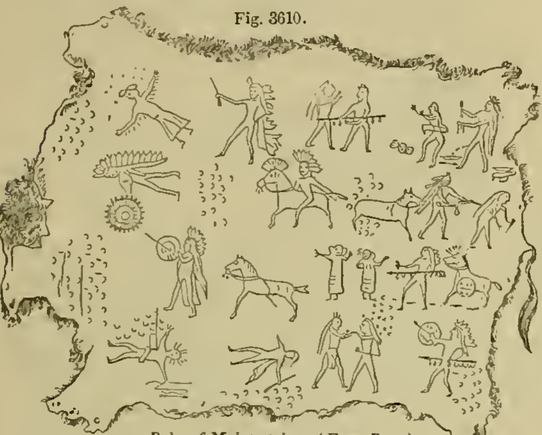
The people of Pergamus, parchment and vellum.

The Hindoos, palm-leaves.

The first attempt at recording was probably what is termed picture-writing. This combines pantomime and numeration, and is found among many savage nations. Instances might be cited from Schoolcraft and from Catlin, and one remarkable example is given from the works of the latter author.

Fig. 3610 shows the robe of Mah-to-toh-pa, the head chief of the Mandans, which consisted of the skin of a young buffalo bull with the fur on one side and the battles of his life emblazoned on the other, by his own hand. It is shown in Catlin's work on the "North American Indians," Vol I. p. 148, and is a good specimen of picture-writing.

Fig. 3610.



Robe of Mah-to-toh-pa (*Four Bears*).

It has twelve battle-scenes, showing various fights with Sioux, Riccarees, Cheyennes, and others.

The Egyptian temples and tombs abound with pictures too conventional to be artistic, but so admirably executed that they are bright and sharp even now The peculiar atmosphere of the country has had something to do with their singularly perfect preservation Three different forms of writing were used in that wonderful country, — the hieroglyphic, hieratic, and the demotic or enchorial. The first was probably the direct growth of picture-writing, but the characters had attained a certain arbitrary value at the time when the earliest yet existing records were made.

After what we may assume to have been the lapse of many ages, when the phonetic principle was introduced, an alphabet was framed, in which the sound of the first letter of the name of each object was represented by the object, as A by an eagle (*akkem*), M by an owl (*moulag*). etc. The Phœnician alphabet was similarly founded: A, *aleph* (a bull): B, *beth* (a house); G, *ghimel* (a camel), etc. These representations, in the earlier periods of their use, may have been executed with such skill as the artist had at command, and varied according to the talent and taste of the limner; but they afterward became conventional, variations were suppressed, and the portraits of the objects became simmered down to mere symbols.

In Fig. 3611, *a* is a view of a glass bead found by Captain Henvey, R. N., at Thebes. The drawing shows it about two thirds the real size; the inscription is developed on the right, and contains the name in hieroglyphics of a monarch who reigned about 1500 B. C.

b, Fig. 3611, is a remnant of the ages in the shape of a song. It was discovered by Champollion in a tomb at Eilethyas, and is interpreted by him as follows. It reads from right to left, and at the end of the first and third lines occurs the *dacapo* sign, to repeat the line: —

> "Thrash for yourselves
> Thrash for yourselves
> O, oxen!
> Thrash for yourselves
> Thrash for yourselves
> Measure for yourselves
> Measure for your masters."

The most enduring of all records is the third in Job's recitation of the modes of writing which may be rendered: —

Written on leaves.
Marked with an iron pen on lead.
Cut into the rock forever.

For many centuries travelers have looked with amazement upon the sculptured buildings of Egypt, Nineveh, Phœnicia, and Persepolis, and upon the inscribed rocks of Behistan, on the frontiers of Media, and the precipice of Van, in Armenia. The solitary monument of Cyrus in the Murghâb, the records of Babylon and Nineveh, of the caves of India, the monuments of Lycia, the tombs of Etruria, the truncated pyramids and portals of Palenque and Uamal in Yucatan, and the broken tablets of Umbria and Samnium, all present riddles of more or less complexity to the students of language.

The setting up of memorial stones was the usual mode of celebrating an achievement or witnessing a pact. Two rival tribes or families set up an altar or build a pile of stones to determine the mutual boundaries of their pastures. A successful warrior made a memorial of his victory in the same manner The warlike Osymandyas or Sesostris recorded the memory of his marches and exploits. The obelisks of Heliopolis rise to celebrate the return of manly vigor to the convalescent king. Phallic monoliths over the Nile land decently perpetuate the symbols of their religion, and are inscribed with the names and deeds of those who erected them.

Famous in olden times of these lithic monuments are the pillars erected by the children of Seth, as recorded by Josephus, and those erected by the Phœnician Hercules in the environs of Cadiz, monuments of his expedition into Spain. In the time of Demosthenes there was still remaining a column of stone on which the code of laws was engraved. The decalogue was carried in the ark for forty years, and thereafter remained for several centuries in various places, till it was placed in the temple of Solomon. The stones were thence carried as trophies to Babylon.

Engraved gems of the times of the Pharaohs are found among the ruins of the past, and the breastplate of Aaron had twelve stones engraved with the names of the tribes.

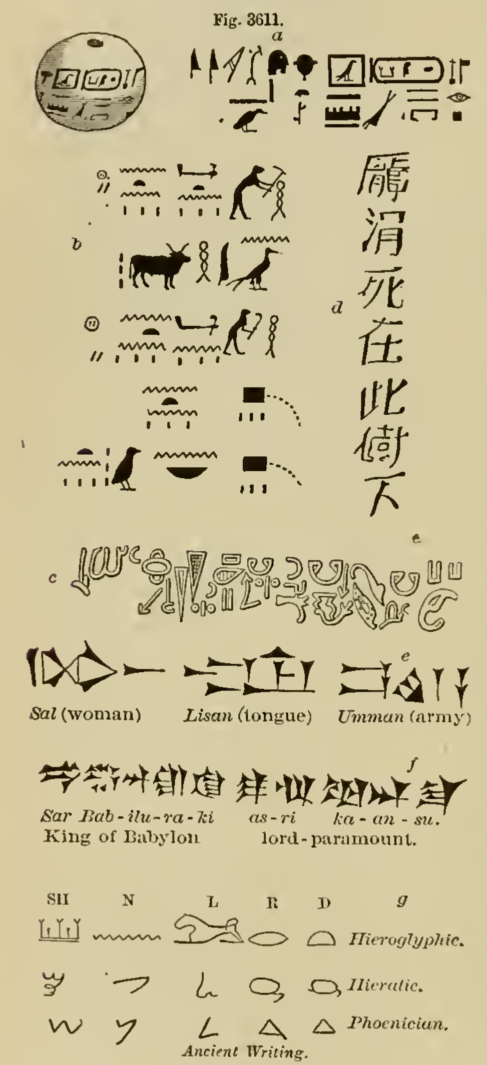
The mania for engraving on stones and setting up inscriptions in the wilderness is not dead yet. Missionaries start from the Lama monasteries, year after year, "chisel and hammer in hand, and traverse field, mountain, and desert, to engrave the sacred formula, *Om mané, padmè houm*, on the stones and rocks they encounter in their path." They thus carve in Thibetan, Landza, or Tartar characters a prayer of the ages, the yearning of their great religious teacher, Sakya Muni, known as Buddha, the Enlightened, who raised his protest against Brahmanic intolerance on the plains of Nepal some twenty-four centuries since. The formula is from the Sanscrit, which had ceased to be a spoken language in the time of Alexander of Macedon. Its metaphor has been diligently resolved by Klaproth, and, being rendered into English, it means, *O that I may attain perfection and be absorbed in Buddha! Amen.*

The invading hosts of the Chaldeans left their pictured records on the rocks of Dog River, the ancient Lycus, in Palestine, which here impinges against one of the lofty and abrupt spurs of the mountains of Lebanon. These figures of men are ascribed to the time of Sesostris, and are associated with more recent inscriptions in Persian, Greek, Latin, and Arabic, indicating the presence of the various conquering races by which that country has been successively subjugated. Central Asia contains memorials of conquerors of various dynasties.

c, Fig. 3611, is a portion of an inscription discovered at Hamath in Northern Syria. The "entering in of Hamath" is celebrated in the itineraries of these surging nations. No theory of interpretation has yet been advanced for it. In it have been recognized by some, features of the hieroglyphic, cuneiform, and cursive, suggesting that it was a melange of the three, indicating a transition period.

The symbolic writing seems to have taken on two forms: one, the *ideographic*, in which each character comes to represent a word, as in the Chinese, *d*, Fig. 3611 (which is said by Du Halde to have developed into orderly characters by 2300 B. C., which is before the time of Abraham); and the most ancient Babylonian, *e*, which Sir Henry Rawlinson calls the Scythic or Accad alphabet. The other variant of the symbolic consisted of cursive expressions of the signs which stood for simple sounds, as stated above of the hieratic Egyptian.

Fig. 3611.



Ancient Writing.

The Scythic is among the earliest known of the *cuneiform*, so called from the resemblance of their characters to arrow-heads. It prevailed in the countries watered by the Euphrates and Tigris, from the earliest historic period down to the conquest by Alexander.

The cuneiform evidently sprang from picture-writing, pictorial representations of objects being made to stand for certain words, eventually without regard to their original ideal signification. From this arbitrary but convenient arrangement came the still farther division by which characters were selected to form a syllabic system, a fixed sign being employed for each connection of a consonant with one of the vowels. There were many hundreds of these signs, representing the consonant and vowel combinations. A phrase is represented at *f*. The varieties of the cuneiform illustrate the progress of the ideographic to the syllabic; the Assyro-Babylonian is principally ideographic, as at *e*; fewer of these signs are in the cuneiform of the second period (*f*), and its derivative the Armenian; the Persian cuneiform is substantially syllabic. The Hebrew and other languages destitute of vowel indications, as they long were, were practically syllabic.

The cuneiform inscriptions of the Persian monarchs have been resolved by the skill and persistence of Grotefend, Burnouf, Rawlinson, and others. At first they seemed to modern eyes "a mere conglomerate of wedges, engraved or impressed." We have now several translations, editions, grammars, and dictionaries of these inscriptions.

The cuneiform writing runs from left to right.

g, Fig. 3611, shows the *hieroglyphic*, *hieratic*, and Phœnician characters representing the sounds D, R, L, N, SH, respectively. The reading is from the right to the left. Points of similarity and relationship are at once apparent. Some of them are fair illustrations of the statement that conventional elisions and modifications have taken place, until the mutilated figure is changed from a portrait to a symbol.

The *hieratic* writing is a short-hand pictorial script, in which the figures are somewhat disguised, and is the basis of true alphabetic writing, in which signs stand for vocal elements.

h, Fig. 3612, is a portion of the inscription on the Moabite stone. This is the oldest Semitic lapidary record of importance yet discovered.

In the summer of 1868, Mr. F. A. Klein, an agent of the Church Missionary Society, made a journey to Kerak, over a country seldom visited by Europeans. On his arrival at Dibân, the ancient Dibon, he was informed by Sheikh Zattam that, scarcely ten minutes from their tent, there was a black basalt stone with an inscription on it. This stone he soon found; it was 3 feet 5 inches high, 1 foot 9 inches wide, had thirty-four straight lines of writing about an inch and a quarter apart, and was rounded to nearly a semicircle at the top and bottom. Mr. Klein took a sketch of a few lines, and went his way, determined if possible to get it removed to the Berlin Museum.

M. Ganneau obtained a few squeezes of the face of the stone before it was broken up by the Arabs, who discovered that it had a market value; strange to say. They made a fire under it and then poured water on it, the villains.

Herr Nöldeke says: "It is *the most ancient memorial of pure alphabetical writing*, much older than any in the Greek. It is the only *original document on the history of Israel* before the time of the Maccabees, and throws light on the relations of Israel with a neighbor much spoken of in the Old Testament."

Until the discovery of this stone, the sarcophagus of Eshmunazar (about 600 B. C.) was considered the most ancient inscription of any length. Here we have a long specimen of the earliest Phœnician character, — the alphabet from which the Greek, the Roman, and all our European alphabets are derived. As Count de Vogüé says, these are the very characters which, before 700 B. C., were common to all the races of Western Asia, from Egypt to the foot of the Taurus, and from the Mediterranean to Nineveh; which were used in Nineveh itself, in Phœnicia, Jerusalem, Samaria, the land of Moab, Cilicia, and Cyprus. It disproves the assertion of Aristotle and Pliny that Cadmus only brought 16 or 18 letters from the East into Greece, and that the Greeks invented the rest, for the whole of the 22 are found on this monumental stone.

The Rosetta stone is of 700 years later date. It was found in 1798 by a French engineer in digging the foundations for a fort near the Rosetta mouth of the Nile. It is a tablet of basalt, with an inscription of the year 196 B. C., during the reign of Ptolemy Epiphanes. The inscription is in hieroglyphic, demotic, and Greek.

It was deciphered by Dr. Young, and formed the

GOD "hath made of one

ACTS 17TH CHAP. 25TH VERSE

AUS

PUNDCYL MARMAN MONCUN TINDEE CANBOON KEELI

FRENCH.
Dieu a fait d'un seul sang tout le genre humain.

SWEDISH.
Gud hafwer gjort allt menniſko ſlägtet af ett blod.

DUTCH.
God heeft uit eenen bloede het gansche geslacht der menschen gemaakt.

ARABIC.
الله خلق كل اجناس البشر من دم واحد

SPANISH.
De una sangre hizo Dios todo el linage humano.

HINDUWEE.
ईश्वर एक लोहू से समस्त मिनाओं के मनुष्यन को उत्पन्न किया है

HUNGARIAN.
Az-Isten az egész emberi nemzetséget egy vérböl teremtette.

WALLACHIAN.
Лꙋмнезеꙋ а фькꙋт лінтр' ꙋн сінџе тот неамꙋл оменеск

GUJERATTEE.
પરમેશ્વર શરવે માણશોં અજાત માં નેજ લોહીથી કીધે

BOHEMIAN.
Bůh včinil z gedné krwe wſseckо lidſké pokolenj.

SPANISH BASQUE.
Jaungoicoac odol batetic eguinsuen mundu gustico gendea.

MODERN ARMENIAN.
Աստուած բոլոր մարդկայ ցեղը մէկ մարմինէն ըրաւ

ROMANSCH.
Dens ha faig or dad ün sanng tut la schlatta d'ils carstiauns.

MODERN GREEK.
Ὁ Θεὸς ἔκαμεν ἀπὸ τὸ ἴδιον αἷμα πᾶν γένος ἀνθρώπων.

MANKS.
Tha Jee er yannoo jeh'n un uill ooilley ashoonyn sheltnaue.

PERSIAN.
خدا از یک نوع خون تمام اصناف خلق را آفرید

NEW ZEALAND.
A ka oti i te Atua te hanga ki te toto tahi nga iwi katoa o nga tangata.

COPTIC.
Ⲫϯ ⲁϥⲑⲁⲙⲓⲟ ⲛ̀ϣⲗⲟⲗ ⲛⲓⲃⲉⲛ ⲛ̀ⲧⲉⲛⲓⲣⲱⲙⲓ ⲉ̀ⲃⲟⲗϧⲉⲛ ⲟⲩⲁⲓ ⲉⲛⲟϥ.

SIAMESE
บุพิริศ พระ ทรงเย บังเกิด นี้ง แต่เลือด ที่แล้ว.—

BENGALEE.
ঈশ্বর এক রক্তহইতে তাবৎ জাতীয় মনুষ্যের সৃষ্টি করিয়াছেন ।

ANGLO-SAXON.
Goꝺ ᵹeƿorhte of anum bloꝺe ealle manna þeoꝺa.

CINGALESE.
දෙවියන්ව හන්සේ එකු රුධිරයෙන් සියළු ජාතීන් එක වංශයෙන් මැව්වේය

RAROTONGAN.
Na te Atua i auga i te au tangata katoa i te toto okotai ra.

IRISH.
Do rinne Dia ᵹaċ uile ċineul daoine d'aon ḟuil aṁáin

BECHUANA.
Morimo rihile merahe eotle ea bathu ka mari a manue hèla.

SYRO-CHALDAIC.
ܥܒܕ ܡܢ ܚܕ ܕܡܐ ܟܠܗ ܥܠܡܐ ܕܒܢܝܢܫܐ.

INDO-PORTUGUESE.
Deos ja faze de hum sangue to do naçaos de gentes.

AMHARIC.
አምላክ ፡ ባንድ ፡ ደም ፡ አሕዛብን ፡ ሁሉ ፡ ፈጠረ ።

MALACASSE.
Andriamanitra efa nanao tamy ny ra iray hiany ny ombelona rehetra.

CANARESE.
ದೇವರು ಒಂದೇ ರಕ್ತದಿಂದ ಮನುಷ್ಯರ ಸಕಲ ಜಾತಿಗಳನ್ನು ಉಂಟು ಮಾಡಿದನು.

MALAY.
الله ترلد سواتو جوك داره اي سده منجاديكن سموا بغس مانسي

ESQUIMAUX.
Gude innagaseksuil kinguvangukattiget tamaita pingortilaukpeit aungmn attautsemit

LAPPONESE.
Jubmel tattam ſårt almalja ſlajab attaĝ warrast

CHINESE
上帝使人類皆從一血出。

CALMUC
[illegible]

VIGHUR
[illegible]

COCHIN-CHINESE
德主𡗶罷沒泖每𠊛包孕年

GE
Gott hat von einem Blute

Duw a wnaeth o un g

Богъ отъ одной крови пр

[illegible]

TA
Na te Atua i hamani i

TCH
Икъ виркичь Юма п

J.
[illegible]

O
[illegible]

Hatalla djari membelom

Jumala on tehnyt kaiken ihmiſt

ईश्वर एकरक्तात सर्व

M
Alla ye molu - bey deda

כָּל־מִשְׁפְּחוֹת בְּנֵי אָדָם

Dion ha fait d

பராபரனவ ஒரே இரத்

தோன்றி

GOÞ GASKÓÞ ALLA

TIBET
[illegible]

Wacinaci amurreta goba lok

S.
[illegible]

AN
Ὁ Θεὸς ἐποίησε ἐξ ἑνὸς α

Gud heſur gert af einn b

Yalla bindone na yaran

[illegible]

[illegible]

ਈਸੁਰ ਇਕ

ANCIE
[illegible]

Deus fecit ex uno san

ईश्वरानें मनुष्यांचा प्रत्येक

FRE
Jaincoac odol bate

A PASSAGE OF SCRIPTURE IN ON

PLATE XXXIX.

blood all Nations of Men".

IN 103 LANGUAGES.

IAN.

UNMARKO KOOLCINGEBA BACROOK BAR HOMERCEEK

Menſchen Geſchlechter gemacht.

hob cenedl o ddynion.

ль всѣхъ человѣковь.

[illegible]

n taata i te toto hoe ra.

IAN.

ЭЛЭМВ.ЛЯМЬ ИИИтЭИЬ.

K.

[illegible]

N.

ისხლისა ყოველნი ნათესავნი

ი.

o ldjä sekarä djelahad olo.

utnunan yhdestä wereſtä.

IT.

मनुष्याणां निर्ममे।

O.

iling menolu be dunyato.

W

אֱלֹהִים עָשָׂה מִדָּם אֶחָ

ag tui li hom.

[illegible]

S ΑΓ. ΑΙΝΑΜΜΑ ΒΑϘΦΑ.

A CHAT)

[illegible]

K.

makwa ikirikia abur ite orea.

AN.

[illegible]

REEK.

ος πᾶν ἔθνος ἀνθρώπων:

IC.

llar þióðer mannanna.

itte ak benne rek derrete.

[illegible]

AN.

[illegible]

KE.

[illegible]

AVONIC.

[illegible]

omne genus hominum.

TA.

[illegible]

QUE.

indu guicon gueiac.

JAPANESE

Manchou

[illegible]

デウスツイチヒトノチヨリキミジンヨゴクナサレタ。

Buriat

[illegible]

JAPANESE Hiracana Chn:

[illegible]

ITALIAN.

Iddio ha fatto d'un medesimo sangue tutti gli uomini.

DANISH.

Gud haver gjort al Menneſkenes Slægt af eet Blod.

FLEMISH.

Godt heeft uyt eenen bloedt het geheel menschelyk geslachte voortgebragt.

TURKISH.

الله بتون انسان جنسني بر قاندن ياراتدي

PORTUGUESE.

Deos de hum sangue fez toda a geraçaõ dos homens.

NEPAULESE.

ईश्वरले एक लोहूदेखि सबै जातका आदमियोंलाइ पैदा गया

POLISH.

Bog uczynit z iedney krwi wszystek rodzay ludzki.

SERVIAN.

Отъ крови єдинова произвео Богъ савь родъ человѣческій.

BULGARIAN.

Кѫ созда́лъ ѐ ѿ ѐдна̀ крѫвь сичкїатъ ро́дъ человѣ́ческїи

LITHUANIAN.

Diewas dáre iss wieno kraujo wissû zmonû gimminès

ENCHADINE.

Deis ha fat our d'un medemm saung tuot la generatiun humana.

BURMESE.

ဘုရား သခင် သည် ။ လူ အမျိုး မျိုး တို့ ကို တ သွေး သည် နှင့် ဖန်ဆင်း

GAELIC.

Dia rinn e dhaon fhuil uile chinnich dhaoine.

HAWAIAN.

Na ke Akua no i hana i na lahui kanaka a pau i ke koko hookahi.

OJIBWAY.

Kishemanitoo kukinn beshik miskooing ogiojioshiun kukinu ininiwun.

HINDUSTANI.

خدا نے ایک لهو سے آدمیون کی سب جاتون کو خلق کیا هي

MALTESE.

Alla myn demm uĭ fied namel koll gens ta bnydmin.

BUGIS.

[illegible]

WENDISH

Boh je czinil ſo wot jenehe krwje ſchittich czlowjekow narod

TIBETAN (SAMYIK CHAT)

[illegible]

PIEDMONTESE.

Iddiou a l ha fait d'un sang soul tutta la specie umana.

MALAYALIM.

ദൈവം ഒരു രക്തത്തിൽനിന്ന മനുഷ്യരുടെ സകല ജാതികളെയും ഉണ്ടാക്കി

ALBANIAN.

Περντία πὲρι γκὰ νιἔλιὰκ λἴθε φυλἴτ' ἐ νιέρεζετ.

BRETON.

Done grëd deus eus a ur goâd hep-ken an holl boblou a dud.

ANCIENT ARMENIAN

Եւ արար ի միոջէ արենէ զամ ազգս մարդկան.

SURINAM NEGRO.

Gado ben meki ala naatsie komopo na da wan broedoe.

ETHIOPIC.

እግዚአብሔር፡ገብረ፡ኵሉ፡ አሕዛብ፡ እምአሐዱ፡ ደም ።

CAFFRE.

U-Tixo wayedalite gegazi linye zonke izizwe zabantu.

TELOOGOO.

దేవుడు ఒక రక్తముతో సమస్త జనులను కలుగ చేసెను.

ESTHONIAN.

Jummal on teinud ühheſt werreſt keik innimeſte ſuggu.

GREENLANDISH.

Gudib attautsib áuanit pingort i kei iunuperksuit nunamiut tamása.

BULLOM.

Foy ka hallë pang ú bull úkong ah pokan boleing.

UNDRED AND THREE LANGUAGES.

See page 1655

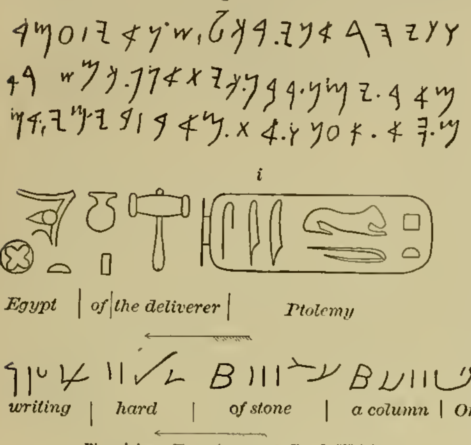
key to the reading of the hieroglyphic characters. It was captured by the English on the defeat of the French forces in Egypt, and is now in the British Museum.

The hatchet, mallet, chisel, square, and saw, all occur among the hieroglyphic characters. *i*, Fig. 3612, shows small portions of the hieroglyphic and demotic inscriptions, respectively.

The "Canopus" stone has since added to the fund of knowledge on the subject, and has afforded additional means and subjects for comparison.

> "It was through the commercial intercourse of the Ionians with the Phœnicians that the Greeks received the characters of their alphabetical writing, which were long termed Phœnician signs. According to the views which, since Champollion's great discovery, have prevailed more and more respecting the early conditions of the development of alphabetical writing, the Phœnician and all the Semitic written characters, though they may have been originally formed from pictorial writing, are to be regarded as a *phonetic alphabet*, i. e. as an alphabet in which the ideal signification of the pictured signs is wholly disregarded, and these signs or characters are treated exclusively as signs of sound. Such a phonetic alphabet, being in its nature and fundamental form a syllabic alphabet, was suited to satisfy all the requirements of a graphical representation of the phonetic system of a language." — HUMBOLDT.

Fig. 3612.

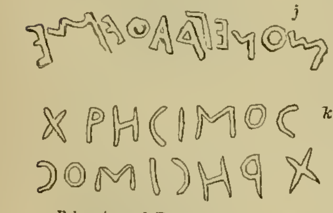


Phœnician, Egyptian, and Greek Writing.

"Phœnicia, mother of the arts,
Letters to learned men imparts."
CRITIAS, *quoted by* ATHENÆUS (A. D. 220).

The ancient Pelasgic, assumed to be the immediate parent of the Greek, was written from right to left, like the Phœnician, whence it came. *j*, Fig. 3613, is an inscription, [Τι]μων ἔγραφέ με. The letters are Phœnician, as used in early times in Greece. It was found in the island of Thera.

Fig. 3613.



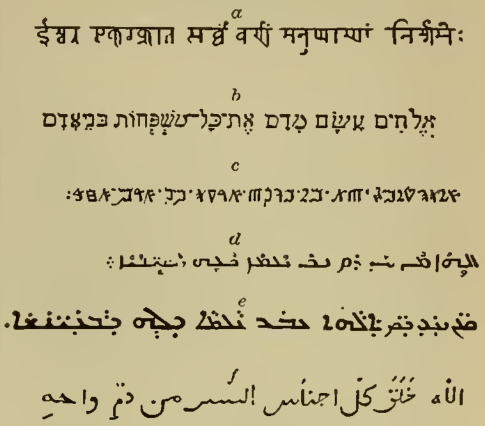
Pelasgic and Boustrophedon Greek.

k, Fig. 3613, is an illustration of the writing *boustrophedon* (as oxen plow), right to left and left to right alternately, χρήσιμος — σομισήρχ. It is from the temple of Bedesish, Egypt.

Plate XXXIX. represents the passage, "*God hath made of one blood all nations of men*," in one hundred and three languages.

Fig. 3614 shows the same passage in six Asiatic languages. The first of these is written from left to right, the other five from right to left.

Fig. 3614.

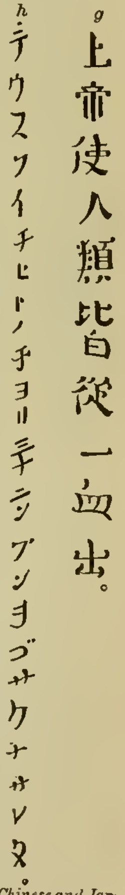


Asiatic Writing.

a, Sanskrit. *b*, Hebrew. *c*, Samaritan. *d*, Syriac. *e*, Syro-Chaldaic. *f*, Arabic.

Fig. 3615 shows the same passage in two Turanian languages; the lines are vertical. *g* is Chinese; *h*, Japanese.

Fig. 3615.



Chinese and Japanese Writing.

The Hebrew Scriptures were written upon the skins of ceremonially clean animals or even birds. These were rolled upon sticks and fastened with a cord, the ends of which were sealed when security was an object. They were written in columns, and usually upon one side only. The writing was from right to left; the upper margin was three fingers broad, the lower one four fingers; a breadth of two fingers separated the columns. The columns ran across the width of the sheet, the rolled ends of which were held vertically in the respective hands. When one column was read, another was exposed to view by unrolling it from the end in the left hand, while the former was hidden from view by rolling up the end grasped by the right hand. The pen was a reed, the ink black, carried in a bottle suspended from the girdle.

The Samaritan Pentateuch is very ancient, as is proved by the criticisms of Talmudic writers. A copy of it was acquired in 1616 by Pietro della Valle, one of the first discoverers of the cuneiform inscriptions. It was thus introduced to the notice of Europe. It is claimed by the Samaritans of Nâblus that their copy was written by Abisha, the great-grandson of Aaron, in the thirteenth year of the settlement of the land of Canaan by the Children of Israel. The copies of it brought to Europe are all written in black ink on vellum or cotton paper, and vary from 12mo to folio. The scroll used by the Samaritans is written in gold letters. (See Smith's "Dictionary of the Bible," Vol. III pp. 1106–1118.) Its claims to great antiquity are not admitted by scholars.

Previous to the tenth century, the manuscripts were written in capital letters, and without a space between the words. The three most important and valuable of them are the Sinaitic, the Vatican, and the Alexandrian, many of whose various readings are given by Tischendorf in his Leipsic edition of the English New Testament. The Sinaitic manuscript, critically marked *Aleph*, written on parchment, was discovered by Tischendorf, February 4, 1859, in the convent of St. Catharine, on Mount Sinai, in Arabia, and published by him in fac-simile in 1862, and in the common type in 1865. It contains the entire New Testament, and is deposited in the Imperial Library at St. Petersburg. It was printed in Leipsic for the Emperor of Russia, to be a memorial of the thousandth anniversary of his kingdom. It is in uncial characters, apparently of the fourth century. The Vatican manuscript, marked B, also written about the middle of the fourth century, has been published only since 1857. It is in the Vatican Library at Rome. The Alexandrian manuscript, marked A, written about the middle of the fifth century, was first published in 1786. It is in the British Museum, at London. The Ephraim or Royal Paris manuscript, marked C, of the fifth century, and the Cambridge manuscript, marked D, of the sixth century, are next in value.

These marks are agreed upon by scholars to designate certain manuscripts.

The enumeration of some of the modes of writing may be interesting : —

The *Mexican* writing is in vertical columns, beginning at the bottom.

The *Chinese* and *Japanese* write in vertical columns, beginning (Fig. 3615) at the top and passing from left to right.

The *Egyptian* hieroglyphics are written in vertical columns or horizontal lines according to the shape and position of the tablet. It is said that with the horizontal writing the direction is indifferent, but that the figures of men and animals face the beginning of the line. With figures, the units stand on the left.

The Egyptians also wrote from right to left in the hieratic and the demotic or enchorial styles. The Pelasgians did the same (*j*, Fig. 3613), and were followed by the Etruscans. In the demotic character, Dr. Brugsch remarks that, though the general direction of the writing was usually from right to left, yet the individual letters were formed from left to right, as is evident from the unfinished ends of horizontal letters when the ink failed in the pen.

In writing numbers in the hieratic and enchorial the units were placed to the left. The Arabs write from right to left, but received their numerals from India, whence they call them "Hindee," and there the arrangement of their numerals is like our own, units to the right.

The Ethiopic and cuneiform characters (*c e*, Fig. 3611) are written from left to right like our own, and this is true of most of the Indo-European languages, while those of Semitic origin are written from right to left. The Phœnician alphabet, the reputed parent of this family, is so written, and the branches include the Chaldaic, Hebrew, Syriac, Carthaginian, Samaritan, Arabic, and Persian characters.

The Pelasgic tribes spoke a language of the Aryan family, allied to the Sanscrit, but obtained their letters from the Phœnicians, and long wrote them from right to left (*j*, Fig. 3613) as in the land from whence they were adopted. The Greek was afterward written *boustrophedon* (as oxen plow), right to left and left to right alternately (*k*, Fig. 3613); in allusion to the usual mode of plowing, before mold-boards and plowing in lands were invented, when the oxen returned close alongside the last furrow made. The laws of Solon were written *boustrophedon*. The later Greek, long before the Christian era, came to be written from left to right like the Sanscrit and the other languages to which it — not its characters — was allied.

The number of letters in the following alphabets is thus given in Ballhorn's "Grammatography," Trubner & Co., 1861 : —

Hebrew	22	Ethiopic	202
Chaldaic	22	Chinese	214
Syriac	22	Japanese	73
Samaritan	22	Dutch	26
Phœnician	22	Spanish	27
Armenian	38	Irish	18
Arabic	28	Anglo-Saxon	25
Persian	32	Danish	28
Turkish	33	Gothic	25
Georgian	38	French	28
Coptic	32	German	26
Greek	24	Welch	40
Latin	25	Russian	35
Sanscrit	328		

The letter "J" was introduced into the alphabets by Giles Beye, a printer of Paris, 1660.

Short-hand writing was known to the Greeks and Romans. Its invention was ascribed to Xenophon. It was introduced into Rome by Cicero. Pliny employed a short-hand amanuensis

The Chinese dictionary shows 43,496 words : of these 13,000 are irrelevant, and consist of signs which are ill-formed and obsolete. For ordinary use 4,000 signs suffice. Kung-fu-tze can be read with a knowledge of 2,500. There are 214 root-signs, so to speak, which indicate the pronunciation, and form *keys* or *radicals*, called by the Chinese *tribunals*. Each character is a word, and the actual number is vastly increased by tones which give quite a different value and meaning.

Quills for pens are assorted into qualities determined by the character of the barrel. They are plunged into heated sand to make the exterior skin peel off and the interior membrane shrivel up. This may be performed, however, by alternate soaking in water and drying before a charcoal fire. They are hardened by soaking in a hot solution of alum. The yellow color so much admired is conferred upon the quill by a dip into nitric acid.

Iron pens are mentioned by Chamberlayne in 1685.

The first metallic pens regularly introduced for sale were by Wise, about 1803. They were made in *barrel* form, being adapted to slip on a stick, and under the name of *perpetual pen* were industriously distributed throughout the stationers' shops of London. The prejudice was strong against them, and up to 1835 or thereabouts quills maintained their full sway, and much later among people of a conservative cast of mind and in the circumlocution offices here and abroad.

The writer recollects the tedious waiting for the patient usher who passed from desk to desk with his pen-knife, mending pens and paying very little attention to anything else ; also the wonder felt and expressed at the first sight of steel nibs, and how they dug into the paper.

Bramah patented *quill-nibs;* made by splitting quills and cutting the semicylinders into sections which were shaped into pens and adapted to be placed in a holder. These were, perhaps, the first *nibs*, the progenitors of a host of steel, gold, and other pens. See PEN-MAKER

Hawkins and Mordan, in 1823, made nibs of *horn* and *tortoise-shell*, instead of quill. The tortoise-shell being softened, *points* of *ruby* and *diamond* were imbedded. Metallic points were also cemented to the shell nibs.

Doughty, about 1825, made *gold pens* with *ruby points*. See GOLD PEN.

Gold pens with *rhodium points* were introduced soon afterward.

Gillott devoted much pains to the improvement of the material and manufacture. One of his patents was in 1831. See STEEL PEN.

Perry exercised considerable ingenuity in the application of new forms and in developing the elasticity. His patents were in 1830 and 1832.

Mordan's *oblique pen*, English patent, 1831, was designed to present the nibs in the right direction while preserving what most people appear to think the most convenient position of the pen and the hand.

Scheffer's *fountain-pen* was introduced about 1835 by Mordan. The pressure of the thumb on a stud in the holder caused a continuous supply of ink to flow from the reservoir to the pen. See FOUNTAIN PEN.

Parker's *hydraulic pen* (English) has a piston which works up and down in a tube by means of a screw stem and a revolving nut on the end of the holder.

Fig. 3616 shows several forms of pens.

a is a pen with a broad flat nib made for marking packages, for writing placards and show-bills. Ink is retained between the several superposed plates, and the breadth of the nib determines the width of the stroke, unless the pen is turned edgewise.

b is a reservoir pen having fluted sides to lead the ink from the reservoir to the nib

c is the iridium-tipped gold-nib pen, mounted with gutta-percha or hard rubber.

d has wings to hold a globule of ink.

e has a flexible strap around the nibs for the same purpose.

f has a peculiarly bent body to give elasticity and also form a holder for ink.

g has wire below the nib, to hold ink.

h has bent-over wings for the same purpose.

i has a wire likewise.

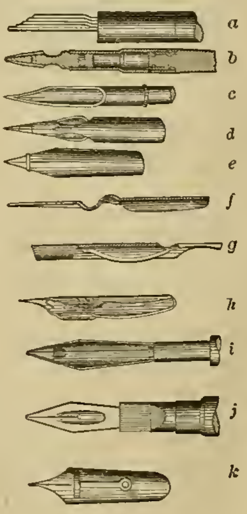
j, a depression in the body of the pen.

k, a cruciform piece riveted to the under side of the pen.

2. An ink-leg of a compass.

A draftsman's instrument for drawing lines of even thickness, or dotting lines. See DRAWING-PEN.

Fig. 3616.



Pens.

See Gold Pen; Steel Pen; Fountain-pen; Drawing-pen; Ruling-pen; Music-pen; Dotting-pen, etc.

3. An inclosure of limited size for cattle or hogs.

Pen'chute. A trough conducting the water from the race to the water-wheel.

Pen'cil. 1. A cylinder or slip of marking material, usually graphite, but may be of colored crayon or French chalk. It is usually inclosed in a sheath of cedar, but is sometimes a cylinder or prism of sufficient size to be grasped by the fingers or by a porte-crayon.

The kind of pencils known as lead-pencils is made from *graphite*, otherwise known as *plumbago* or *black-lead*. The latter two names are misnomers, as no portion of lead enters into its composition. See Graphite.

Graphite is a soft variety of carbon, sometimes containing a small proportion of iron. It is found in many parts of the world, but few localities yield it of sufficient purity for making pencils. For many years the best obtainable was from the mine of Borrowdale, Cumberland, England, discovered in 1564. It was locally known as *wad*. This mine gave England the monopoly of the finest quality of pencils, and the amount taken from the mines yearly was strictly limited in order to keep up the price. The annual product was valued at £ 40,000. This source of supply eventually failed, but the loss was scarcely felt, as a number of other mines had been discovered in various parts of the world.

The ancients drew lines and letters with leaden styles, and afterward an alloy of lead and tin was used. Pliny refers to the use of lead for ruling lines on papyrus. La Moine cites a document of 1387 ruled with graphite. Slips of graphite in wooden sticks (pencils) are mentioned by Gesner, Zurich, in 1565; he credits England with the production. They were doubtless the product of the Borrowdale mine, then lately discovered. In the early part of the seventeenth century, *black-lead* pencils are distinctly described by several writers. They are noticed by Ambrosinus, 1648; spoken of by Pettus, in 1683, as inclosed in fir or cedar.

Red and black chalk pencils were used in Germany in 1450; in fact, fragments of chalk, charcoal, and shaped sticks of colored minerals had been in use since times previous to all historic mention.

Painting of the body, face, and limbs is an accomplishment in all countries where clothing is scanty, and some tribes have ingeniously contrived to make it permanent by tattooing. This art is both ancient and modern, and has its professors in many countries. The name is Polynesian, and among these singular peoples the practice has been, perhaps, perfected. Vagabonds on the fringe of civilization emulate the rites of their ancestors, and naturally recur to the habit of tattooing; hence ships, hearts, true-lovers' knots, and mottoes pricked into the arms and breasts; and hence means of identification equal to the famous "strawberry-mark on the left arm" of the long-lost brother, or, equally famous now, the absence of the tattooed mark on the arm of the spurious Tichborne.

Hans Holbein drew portraits in crayon in 1540. Sir Thomas Lawrence excelled in crayon-drawing during the early part of the present century. Crayons and pencils are used by painters in designing and sketching-in on canvas. The imitation of the chalk-drawing has given rise to one style of plate-engraving, known as the *stipple* or *chalk* engraving.

When Cortez landed in Mexico in 1520, he found the Aztecs using graphite crayons, which were probably made from the mineral found in Sonora.

As has been said, the mounting of the small graphite bars in wood originated in England. The block of graphite was sawed into prisms of the required shape, and of such length as the lump admitted. Each slip of graphite was laid in a groove made in a slip of cedar, a little glue causing it to adhere; another slip of cedar was laid over it, and the pencil was shaped by a round-soled plane. Several lengths of graphite filling were required for the length of a pencil, as the lumps were usually small in size and the pieces very frangible.

To utilize the waste, Mr. Brockedon attempted to compress it into blocks in powerful hydraulic presses, but without much success. The plan of grinding up into a pigment, which was hardened into a block by baking, was afterward introduced with better result.

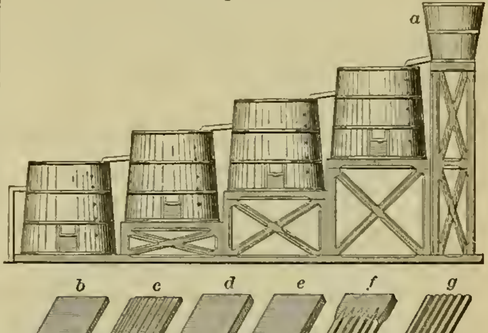
When the Borrowdale mine was giving out, Conté of Paris invented the method of producing the *leads* by making a mixture of graphite and clay, pressing it into the required shape from a mass like dough, and baking it to the requisite hardness for use. All the pencils now made in any part of the world are made by Conté's process.

The following is the method employed by Mr. Cleveland, of the Dixon Company, at Jersey City, in the production of "Dixon's American Graphite Pencils": —

The graphite is purified by various means, according to the nature of the foreign matter it may contain. Ticonderoga graphite ground fine in water is treated with sulphuric and nitric acids, and, after washing clean, heated to a bright red. See Graphite.

It is then mixed with water until thin enough to run very freely, and the mixture turned slowly into the hopper (see *a*, Fig. 3617). The coarser or heavier particles will settle at the bottom of the first tub, the next heavier in the next tub, and so on, till the water will run almost clear from the overflow of the last tub, as shown in the cut.

Fig. 3617.



Pencil-Making.

For the finest pencils the deposit in the last tub is used, but for the commoner sorts the deposit in the tub next to the last will answer very well, and for ordinary pencils the deposit in the one still before that is used. The stream should run into the first tub very slowly and gently, so that the contents of each tub will be but slightly disturbed.

When the operation has been going on for some time the inlet is stopped, and after leaving the tubs for half a day to settle, the clear water above the deposit is decanted by withdrawing a small pine plug, several of which are inserted in holes bored in the sides of the tubs, at convenient distances from the top, and by drawing out these one at a time as the water gets lower, all the water is decanted without disturbing the deposited graphite, which is very light and will rise with the least agitation, especially that which is deposited in the last tub.

The gates near the bottom of the tubs, shown in the cut, are then raised and the contents removed and dried.

The graphite is now ready for the *clay*.

The clay this company employs is known in market as *pipe-clay*, of a bluish-gray color, has great strength, and is very unctuous and fatty when wet. It comes to this country from Rotterdam for the manufacture of crucibles. The clay is separated in water and floated through a series of tubs in the same manner as the graphite, only the finest part being fit for pencils.

Like the graphite, it is dried before mixing, in order that the mixture may be exact and reliable for the production of the different grades of *leads*. The larger the proportion of clay the harder the grade, and a less proportion of clay and more graphite produces a softer grade. For a medium grade the proper proportion is, 7 parts of clay to 10 parts of graphite, by weight.

Water is added to the clay and graphite, and the mass fairly mixed by the hands to the consistency of thick cream. In this state the mass is fed into the mills for final grinding. The mills are of stone, 24 inches in diameter, only the top stone running, and that at considerable speed. This operation is much like grinding paint, and the mass is passed through these mills many times; for the fine pencils it is ground over as many as twenty-four times before it is considered ready for use. It is now a pasty mass, and this is inclosed in a canvas bag and placed in a powerful steam-press, where the water is pressed out, much the same as oil is pressed out of ground linseed. This pressing is carried to that point that leaves the mixture a stiff dough, ready for the forming-press.

The forming-press is composed of a cast-iron well, 8 inches deep and 4 inches in diameter, inside measure, having a follower or plunger, like an old-fashioned sausage-stuffer. The material is molded into the shape of the inside of the well, by working it with the hands as the potter works his clay, placed in the well and driven snug down with a hammer and wooden plug; the iron follower then comes down slowly, driven by a powerful screw.

In the lower end of the well, which is upright, is an opening of the exact size and shape, square or round, desired for the leads; and as the follower presses upon the material, a thread spins out below and coils itself upon a board placed underneath to catch it. A sufficient quantity being spun out for convenient handling, the board is removed and another put in its place. From this coil the *lead* is drawn off and straightened out upon boards of suitable length for three pencils, the back edge of the board having a raised straight-edge against which the first length is placed, the next length laid snug against the first, and so on till the board is full, when it is placed carefully away for the leads to dry. When dry they are very brittle, and are cut into lengths for pencils, placed upright in crucibles of graphite, made for this use, with straight sides and fitted with covers.

When the crucible is full the leads are covered over with fine graphite to exclude the air, and as a farther precaution the cover of the crucible is well luted on. The crucibles are then heated to a red heat, taken out of the oven and cooled, and the leads removed ready for use.

The next step is the preparation of the wood. Only a soft, close-grained wood will answer, and the best is the Florida cedar.

The wood is sawed into pieces *b* of the right length for a pencil, of a width suitable for six, and of half the thickness for pencils.

These blocks run through a machine that planes and grooves them (*c*), the grooves being the depth of half the size of the leads The leads are then laid into the grooves of one piece while the other piece of cedar exactly like it is coated with glue and laid on the first (*d*). These double pieces, or blocks, are then placed in a press, many of them together, till dry enough to proceed. Leaving the press they are solid blocks containing six leads equidistant from each other, ready to be shaped into six pencils, and these blocks (*e*, Fig 3617) go through the first machine, that brings them to size, and then through the next machine, similar to a molding-cutter, coming out six pencils from each block. The cut *f* shows the block before it is quite through the machine; *g* shows six perfect pencils.

The machine which converts the block into pencils is of the nature of a planing-machine with a series of circular cutters above and below, like the molding-machines for wood-working. The effect of the upper and lower rows of cutters is, respectively, to cut a series of six beads, the joint effect being to make six cylinders from the block, the parts and positions of the cutters being so accurately gaged as to leave the *leads* in the exact center of each cylinder (or hexagon, as the case may be), and leave no fin or mark upon the edges of the pencils where the action of the upper and under series of cutters meets at the middle of each pencil, as shown in the cut.

The knives in these shaping-machines, in order to do the work well, should revolve at the rate of 4,500 revolutions per minute, and must run absolutely true, as any weakness or tremor will destroy the finish on the surface of the wood, and make it necessary to adopt the old process of sand-papering each pencil, as still practiced by other manufacturers. The finish obtained by the machine is such that sand-paper would roughen them. The round and hexagon or other shapes are produced in the same way. The pencils are now ready to receive the color and finish, according to taste, and are then stamped and packed for market. Great care must be taken to have the wood dry, and it is better air-dried than kiln-dried.

The machine for shaping turns out the pencils from the blocks at the rate of 72 per minute, or over 43,000 per day. The varnishing and coloring of the surface is done by a machine at the rate of 120 per minute, or 72,000 per day, and they are polished by a machine at the rate of 106 per minute, or over 63,000 per day. All of these machines are attended by girls about twelve years of age, one to each, no skilled labor being required.

The granular formation of graphite is more easily prepared than the foliated. The Dixon Company has extensive mines at Ticonderoga and a large mill at the outlet of Lake George into Lake Champlain, where the pure foliated graphite is manipulated very cheaply.

Colored pencils are made in the same way as black, except that the little bars cannot be baked like the black *leads*. Heating destroys the color.

In making them, coloring-matter of the kind desired is used with the clay, instead of graphite, and they are boiled in wax before being placed in the wood.

The Florida cedar is used by all of the principal pencil-makers in the world, on account of its fine grain, softness, and strength combined.

Dixon's American graphite pencils are in different styles, as *black*, *maroon*, *cedar-finish*, the latter being in the natural color of the cedar of which they are all made; *satin-finish*, a new style, is made of the same cedar, but finished to resemble French walnut in color, showing the grain of the wood. There are ten distinct grades of hardness in the leads, shown by the grade stamps, as follows: VVS, *very, very soft*, for the deepest heavy shading. VS, *very soft*, for very deep shading. S, *soft*, for rapid shading in sketching, the softest grade for office use. SM, *soft medium*, for general sketching, the popular grade for office or pocket. MB, *medium black*, for drawing or general use. M, *medium*, for office and stenographic, professional, or desk use. MH, *medium hard*, for finer desk use or fine lines in drawing. H, *hard*, for bank use, or finer lines in drawing. VH, *very hard*, for architects, engineers, draftsmen, etc. VVH, *very, very hard*, for the finest lines.

The S, SM, M, H, and VH are the five regular office grades. The whole ten grades are for artists. The SM and M only are made in the round black pencils with the gold stamp, and in the maroon finish both round and hexagon shapes. But the five regular office grades of leads are all made in round and hexagon shapes, in both the *cedar finish* and the new *satin finish*, and the whole ten distinct grades of lead are made of the hexagon shape only, both of these styles of finish, for artists and technical uses.

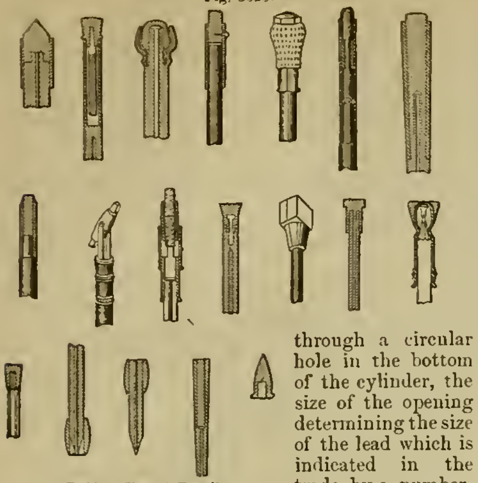
The old method of sawing them out of solid blocks of graphite produced leads of rectangular shape, and they have been continued in that shape to the present day; but the Dixon Company has introduced round leads in round wood, making a decided improvement. The round leads are more easily sharpened, are stronger than the flat shape, and more in harmony with the exterior of the finished pencils.

Fig. 3618 shows a number of modes of attaching rubber to lead-pencils.

Various convenient additions to pencils have been made, such as attaching calendars thereto, sheaths to cover the leads, thimbles and sockets to attach the pencil to the lappel of the coat or vest. Two pencils in a pair of sheaths jointed together make a convenient pair of compasses for many purposes.

The *pencil-leads* as sold by stationers and jewelers for pencil-cases and ever-point pencils are little cylinders made of graphite and clay kneaded with water until it assumes the consistency of putty. This is placed in a cylinder and forced by heavy pressure

Fig. 3618.



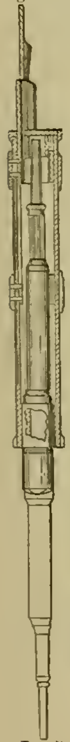
Rubber-Tipped Pencils.

through a circular hole in the bottom of the cylinder, the size of the opening determining the size of the lead which is indicated in the trade by a number. The material issues in long flexible threads, which are received on sheets of metal and placed in an oven. The length of time occupied in the baking determines the hardness. The threads are then broken up into short pieces and boxed according to their sizes, Nos. 1 to 9.

2. A small brush or *tool* employed by painters. Pencils are made of camel, badger, squirrel, fitch, or sable hairs.

3. To draw a line of white paint along a mortar-joint in a brick wall, to render the joint more conspicuous and contrast with the color of the bricks. This is termed *penciling*.

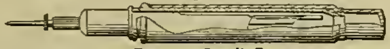
Fig. 3619.



Pencil-Case.

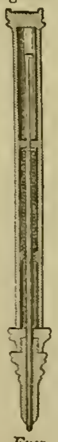
Pen′cil-case. A holder for a pencil, usually with a slide by which the pencil is retracted into its sheath to reduce the length of the instrument and preserve the lead from breakage when carried in the pocket. The usual form has a hollow holder from which the tube holding the pencil-lead is projected by twisting or by simply sliding out.

Fig. 3620.



Pen and Pencil Case.

Fig. 3621.



Ever-point Pencil.

In Fig. 3620, the case consists of a single tube with a screw cap, and a reversible pen-holder and pencil-point. The tube has also a section extensible telescopically.

In Fig. 3619, the pen is on a sliding piece at one end, while the pencil-holder is socketed in the other end, either projecting for use or inclosed for compactness in carrying.

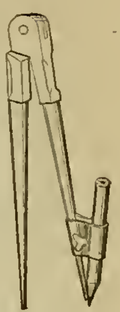
The ever-point pencil was patented in England in 1823 by Hawkins and Mordan.

The small cylinder of black-lead is pushed forward by a driver, so as to project through the end of the nozzle. On the outside of the driver is a screw, and on the end of the nozzle-cylinder is a nut, so that when the nozzle is held in one hand while the case is turned by the other, the driver is worked in or out for the reception of another lead or for the driving out of the contained lead, respectively.

Pen′cil-clasp. A device to hold a pencil to the lappel or breast of the coat. Used by import clerks and others.

Pen′cil-com′pass. One having a pencil-end at one leg; or a compass to which an ordinary pencil may be attached, as in the example.

Fig. 3622.

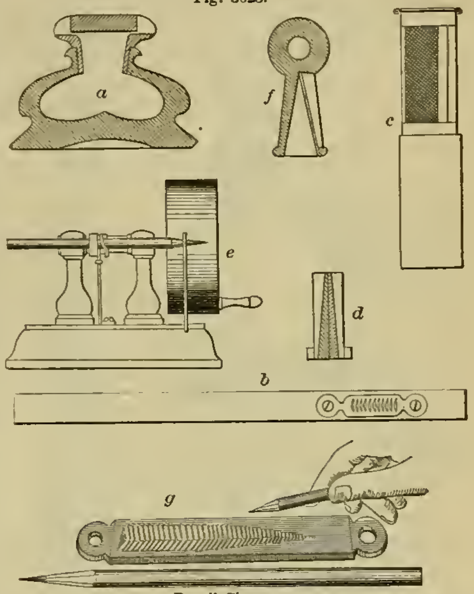


Pencil-Compass.

Pen′cil-sharp′en-er. A device against which a lead or a slate pencil is drawn or rotated in order to sharpen the point.

For slate-pencils it may consist of a file on a stake, in a cup *a* or on the edge of a slate-frame *b*. The same may answer for lead-pencils if the wood be previously cut away. *c* is a pocket-file which slips into a sheath. *d* is a serrated socket in which the pencil-point is rotated. *e* is a form in which the pencil is held against a rotating wheel. *f* has a blade which will cut wood and lead impartially. *g* is of hardened steel, the groove being serrated.

Fig. 3623.



Pencil-Sharpeners.

Pen′dant. 1. (*Nautical.*) *a.* A strap or short rope depending from a mast-head, and having thimbles for bearing the blocks, which transmit the effects of tackles to distant points. Their names indicate their specific duty; as, *fish*-pendant, *brace*-pendant, *stay-tackle* pendant, etc. Used especially in setting up masts and rigging.

b. (Or *Pennant.*) A long, narrow strip of bunting worn at the mast-head of vessels of war. Playfully called a *coach-whip*, in contradistinction to a *broad pennant*. See PENNANT.

2. (*Architecture.*) *a.* An ornament suspended from the roof of a Gothic or Tudor building; the hanging ornament from the crown of a vaulted ceiling.

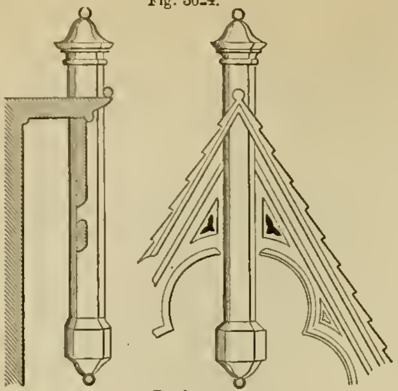
b. A hanging keystone, the lower face projecting beyond the intrados of the arch.

3. An ear-ring or bob.

4. The part of a watch by which it is suspended. Usually consisting of a guard-ring and pusher-pin.

5. A suspended chandelier.

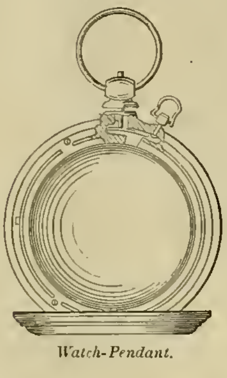
Fig. 3624.



Pendants.

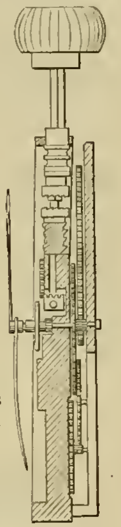
Pen′dant-wind′ing Watch. (*Horology.*) One whose spring is wound up by the rotation of the pendant brought into gear with wheels connecting to the spring-arbor. In the example, the spring is wound and the hands set through the stem of the pendant; a single inflexible rod operates each mechanism. For setting, the stem is partially retracted, and the watch is wound by rotating the stem at its normal projection. See also STEM-WINDING WATCH.

Fig. 3625.



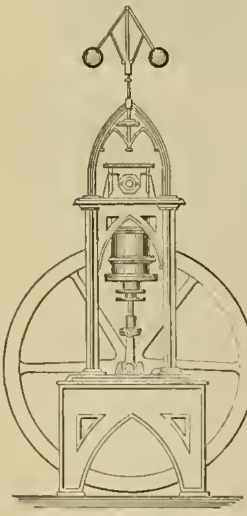
Watch-Pendant.

Fig. 3626.



Pendant-Winding Watch.

Fig. 3627.



Pendulous-Cylinder Steam-Engine.

Pen-dent′ive. (*Architecture.*) *a.* The filling in of the spandrels between the arches of a vault.

b. Also between the arches under a dome.

c. The portion of a groined ceiling supported and bounded by the apex of the longitudinal and transverse vaults. In Gothic ceilings of this kind the ribs of the vaults descend from the apex to the impost of each pendentive, where they become united.

Pen′du-lous-cyl′in-der Steam-en′gine. A form of oscillating-cylinder steam-engine in which the cylinder is suspended so as to oscillate below its trunnions, as seen in the illustration. The valve may be a disk-valve in the trunnion or a slide-valve on the side.

Pen′du-lum. *a.* A heavy body so suspended as to vibrate about a fixed point by the action of gravity.

Pendulums in chronometry are known by structure or function; as, —

Compensation pendulum, having isochronous means within itself for adjustment, compensating the effects of heat and cold.

Conical pendulum, having a circular path, the rod of suspension describing a cone.

Cycloidal pendulum, vibrating in the arc of a cycloid instead of a circular arc.

Gridiron pendulum, having parallel bars of brass and steel, whose diverse expansion under heat is made to preserve uniformity of the center of oscillation of the bob.

The *mercurial* pendulum, having for a bob a vessel of mercury, whose upward expansion by heat so compensates the lengthening of the rod that the center of oscillation remains the same.

The *seconds* pendulum, vibrating 3,600 times in an hour.

b. A wheel oscillating on an axis, known as a *verge*, and determining by its isochronal pulsations the movement of the train.

c. Besides these are devices not chronometric, as the *hygrometric pendulum*, *ballistic pendulum*, etc.

Previous to the application of the pendulum, a fly-wheel was used, the vanes meeting the resistance of the air, forming a limit to the speed, as in the musical boxes of the present day.

Such was probably the regulator in the clocks of the Saracens, which were moved by weights as early as the eleventh century; the clock which struck the hours, referred to by Dante (1265–1321); the clock in the old Palace Yard, London, put up about 1288 and remaining till the time of Elizabeth; the clock made by William of Wallingford in the reign of Richard II. (1377–85).

Ebn Junis, of the University of Cordova, invented the time-measuring pendulum, and his friend and fellow-philosopher, Gerbert, invented the escapement, as it is believed. Gerbert became, successively, schoolmaster at Rheims (where he had a clock), Archbishop of Ravenna, and Pope Sylvester II. He died by poison in 1002. So did his patron, Otho III., about the same time.

An oscillating arm was substituted for the fly, probably in the fourteenth century.

The clock of Henry de Wyck, erected in 1364, for Charles V. of France, was regulated by an alternating balance (*a*, Fig 3628) which was formed by suspending two heavy weights from a horizontal bar fixed at right angles to an upright arbor, and the movement was accelerated or retarded by diminishing or increasing the distance of the weights from the arbor.

The clocks erected at Strasburg, 1370, Courtray, 1370, and Spire, 1395, were probably of this character, as were also the astronomical clocks of Tycho Brahe and other less celebrated astronomers of his period.

b shows the Harris pendulum as contrived by him in the clock put up in the turret of the Church of St. Paul, Covent Garden, London, in 1641. It will be seen that it may have occurred as a modification of the De Wyck vibrating arm, one of the weights being taken off and the arm hung vertically.

Galileo, about 1581, observed the swinging of a suspended lamp and the regularity of the vibrations recommended a pendulous weight as a time-measurer. He applied it as such successfully, at first employing persons to count the oscillations, but soon effected it by machinery.

Dr. Thomas Young in his lectures on Natural Philosophy and the Mechanic Arts, 1807, Vol. I. p. 19, ascribes the first combination of the pendulum with wheel-work to Sanctorius, in 1612.

The *conical* or *spherical* pendulum is one which moves in a circle under the influence of gravitation, it and its suspending cord describing a cone, of which the point of suspension is the apex. The theory of such a pendulum is of a complicated nature, and the instrument, not being used in practical horology, possesses little interest to the non-scientific reader. It is, however, employed in controlling the rotating mechanism of the equatorial telescope. The theory of the ordinary pendulum, which vibrates in a vertical plane, was first clearly elucidated by Huyghens.

The simple pendulum is theoretically an imaginary gravitating point attached by a rigid rod devoid of weight to its point of suspension. As these conditions are impossible in practice, the actual pendulum is a compound pendulum, the weight and shape of the bob and rod serving as elements for determining a point, called the *center of oscillation*, within the pendulum, whose vibrations are performed in the same time as those of the whole mass would be were it concentrated at that point. This being done, the mathematical investigation of the vibrations of this point, oscillating freely under the influence of gravity, is identical with that of the imaginary simple pendulum.

The result of the investigation develops the following laws: 1. At equal distances from the earth's center the times of oscillation of two pendulums are directly proportional to the square roots of their lengths.

2. At different distances from the earth's center the times of vibration are inversely proportional to the square roots of the distances, i. e. to the force of gravitation.

3. The length of a pendulum vibrating seconds is directly proportional to the force of gravity at the place.

From the latter law the force of gravity, that is, the velocity with which a falling body is drawn toward the earth's center at any particular place, is readily deduced. Thus the length of the seconds pendulum at London being, according to Captain Kater's experiments, 3.2616 feet, a body will fall 16.1 nearly, at that place, during the first second of time.

The length of a pendulum beating seconds at the level of the sea in the latitude of London is 39.1393 inches.

Huyghens first observed the difference in the beats of the pendulum at different hights; and extended experiments to ascertain the density of the earth have been made with the pendulum by Professor Airy in the years 1826 – 28, in deep mines in Cornwall, and later in other places at great depths and hights.

From the first of the foregoing laws it follows that as the length of the pendulum varies in consequence of changes of temperature, the number of its oscillations in a given period, as the sidereal day, will also vary.

Various contrivances have been devised to remedy this defect by keeping the center of suspension and that of oscillation at a uniform distance apart. Such are known as *compensation* pendulums.

Huyghens, about 1656, designed mechanism whereby the small isochronous vibrations of a moving body could be *sustained* and *measured*. He may therefore be considered the inventor of the complete contrivance. This invention is regarded as the most important ever made in reference to practical astronomy. He soon found that the oscillations in circular arcs of different amplitudes are not equal, the wider requiring a rather longer time than the narrower, and that when oscillating in a cycloidal curve the pendulum was free from this defect. As a means of compelling the pendulum into this path, he placed cycloidal checks (*c*, Fig. 3628), whose effect upon the elastic pendulum-rod was such as to cause the center of oscillation of the *bob* to describe the arc of a cycloid, and to make oscillations in equal times whatever might be the extent of the arc described. Mechanical difficulties prevented this beautiful contrivance from being practically useful. See Huyghens's "Horologium Oscillatorium" and other works on horology.

It has been found that pendulums vibrating in very small arcs do not, however, sensibly vary their times of oscillation in consequence of a small proportional increase or decrease in the extent of that arc, and, accordingly, where extreme accuracy is required, the *amplitude* or extent of the oscillation on either side of a vertical line passing through the point of suspension is restricted within narrow limits, and provision is made for preventing, as far as possible, any change in the amplitude.

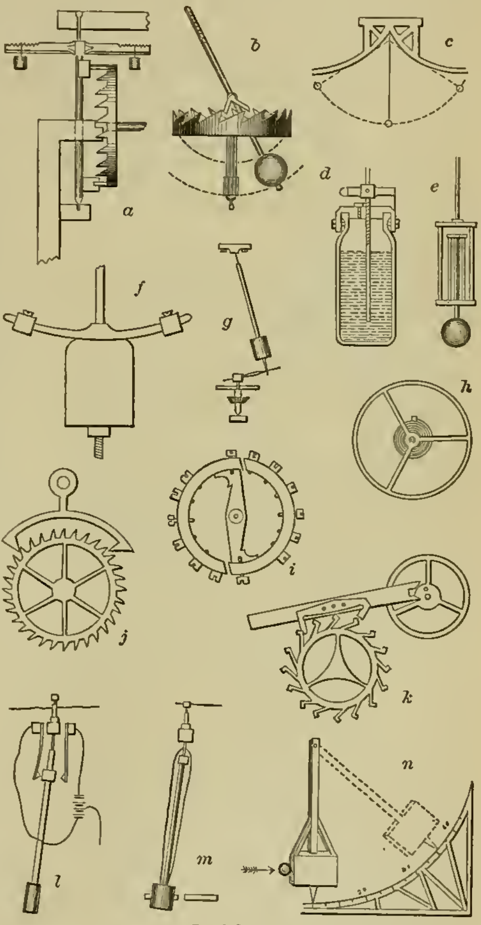
The thin, flat spring by which a clock pendulum is suspended assists in maintaining the uniformity of its oscillations.

The forms of the clock-escapements before Clement of London (1676) invented the *anchor*-escapement are not perfectly known, but were probably on the verge principle, two pallets on the axis of oscillation of the pendulum alternately escaping from the teeth of a crown-wheel propelled by the train.

Clement also devised, about the same time, the mode of suspending the pendulum from a stud by a small piece of watch-spring.

Graham, of London, invented the mercurial compensation pendulum (*d*) about 1700. In it a jar of mercury is used for the *bob* or weight. As the pendulum-rod is expanded longitudinally by increased temperature, the expansion of the mercury in the jar carries it to a greater hight therein, and so raises its center of gravity relatively to the rod as to compensate for downward expansion of the latter.

Fig. 3628.



Pendulums.

Contraction of the rod by cold has the reverse effect, and thus the center of gravity is always kept at the same distance from the point of suspension, the effective length of the pendulum remaining the same, and the beats isochronous.

The gridiron pendulum (*c*) was invented by Harrison, and takes its name from its form, which consisted of a frame of parallel bars of steel and of brass or zinc, while the center bar of steel is fixed at top to the cross-bar connecting the middle brass bars, sliding freely through the lower bars, and bearing the pendulum-bob. The remaining bars are fastened to the cross-piece at both ends, and the uppermost cross-piece is attached to the axis of suspension. It is easy, therefore, to see that the expansion of the steel bars tends to lengthen the pendulum, while that of the brass ones tends to shorten it; and, consequently, if the two expansions exactly counteract each other, the length of the pendulum will remain unchanged. The relative lengths of the brass and steel bars are determined by the expansions of the two metals, which are found by experiments to be generally nearly as 100 to 61.

A compensation pendulum (*f*) has been contrived, in which, by means of a compound bar of metal, a certain portion of the weight of the bob is lifted when heat extends the pendulum-rod. The bent bar is a compound of brass and steel, brazed together brass downward. As brass expands more than steel with a given increment of heat, it carries the weights up with it, raising the center of gravity of the aggregate weight to compensate for the extension of the rod.

The conical pendulum (*g*) is hung by a piece of small round wire. The lower end is connected with and driven in a circle by an arm attached to a vertical, rotating spindle. The pendulum-rod describes a cone in its revolution.

A *rolling pendulum*, consisting of a cylinder oscillating in small spaces on a horizontal plane, has been suggested, but has not evinced any qualities superior to the suspended pendulum describing an arc.

In Reid's *compensation pendulum* (1818) the bob rests in a hollow cylinder of zinc, through which the rounded end of the steel pendulum is passed, the zinc itself being supported by the nut at the end of the rod. As the rod lengthens by heat, carrying the bob downward, the upward expansion of the zinc lengthens the rod and raises the bob to an equal degree.

The pendulum of the watch is an oscillating wheel termed the balance (*h*); this is impelled by the main-spring and train in one direction, and is returned by the force of the hair-spring on the arbor of the balance. It is probably the invention of Dr. Hooke. Jewels were added by Facio of Geneva about 1700. The compensation balance (*i*) was made by Harrison. (See CHRONOMETER.) The circumference is divided into two sections, the ends of which are free. The outer rim, or tire, is of brass, and the inner rim and cross-bar of steel, — these being soldered together so that one expansion counteracts the other. Cold, contracting the inner steel rim, would reduce the circumference; but, as it contracts the outer brass rim still more, an opposite effect is produced, the circumference being enlarged. The effect of expansion is checked in a similar way.

j is Dr. Hooke's anchor-escapement. *k* is the escapement known as the "lever," or "detached lever." The bar to which the pallets are attached turns upon a center-pin, so that the ends of the lever move backward and forward through small arcs, as the pallets are alternately released from the scape-wheel. One end of the lever has a little nick in it, which, as it passes backward and forward, catches a pin upon the balance, and throws it right and left. As the lever, for example, moves to the left, one of the pallets catches a tooth of the scape-wheel, and stops the train; at the same time the balance is thrown round, so that the pin passes out of the nick, and the balance swings free to the extent of the impulse, that is, it is *detached* from the lever. As it swings back under pressure of the hair-spring, the pin catches in the nick again, and, moving the lever back, unlocks the pallet, when instantly the other pallet is caught by another tooth, and the lever throws the balance the other way. The balance is therefore the pendulum of the watch, determining by its isochronal swing the rate of movement of the train.

In electric clocks the pendulum completes a circuit at each vibration. See ELECTRIC CLOCK.

Fig. 3628. *l* represents the controlling pendulum in a series of two or more clocks designed to beat isochronously. It alternately comes into contact with one of two weak springs connected with the poles of a battery having one of its middle plates connected with the earth. The bob of the controlled pendulum (*m*) is a hollow cylinder of soft iron encircled by a coil whose ends are connected through two suspending springs with a wire and the earth respectively, so that during the passage of a current the bob becomes an electro-magnet. Two magnets having their poles turned opposite ways are so fixed that the hollow bob of the pendulum always surrounds one or both of them. Thus the controlled pendulum is either checked or accelerated according as it tends to go faster or slower than the other.

2. The *ballistic pendulum* (*n*) is used for measuring the velocity of projectiles by impact. It was invented by Robins. It consists of a large mass of wood banded with iron, or of a box filled with sand-bags, and suspended by iron bars from an axis. The cannon-ball whose velocity is to be determined is fired against the solid block of this pendulum, and the hight to which it is made to oscillate by the blow is shown by an index on a wooden arc, and determines the velocity with which the mass first began to move, when its quantity of motion was equal to that with which the ball struck it.

The velocity at starting is proportional to the square root of the vertical hight ascended, whatever may be the curve; when that curve is circular, as in this instance, the velocities are as the *chords* of the arcs described; so that, if the arc be so graduated that the numbers are proportional to their distances in a straight line from 0, they will correctly express the relative velocities at starting from 0.

3. Foucault's pendulum renders visible the diurnal rotation of the earth. An account of it was presented by M. Foucault to the Academy of Sciences in Paris, September, 1852, and the apparatus was thus arranged: —

> At the center of the dome of the Pantheon, a fine wire is attached from which a sphere of metal, 5 inches in diameter, is suspended so as to hang near the floor of the building. The apparatus is put in motion after the manner of a pendulum. Under and concentrical with it is placed a circular table some 20 feet in diameter, the circumference of which is divided into degrees, minutes, etc., and the divisions numbered. Now, supposing the earth to have the diurnal motion imparted to it, which explains the phenomena of day and night, the plane in which this pendulum vibrates will not be affected by this motion, but the table over which the pendulum is suspended will continually change its position by virtue of the diurnal motion, so as to make a complete revolution around its center in 24 hours. Since, then, the table thus revolves, and the pendulum which vibrates over it does not revolve, the consequence is that a line traced upon the table by a point projecting from the bottom of the ball will change its direction relatively to the table from minute to minute and from hour to hour, describing

a system of lines radiating from the center of the table. A practiced eye will actually observe that the point on the bottom of the ball does not return to the same point on the table after two successive vibrations. Thus is rendered visible the motion which the table has in common with the earth.

Foucault's experiment was soon afterward tried in the rotunda of the Capitol at Washington, which, though the dome had not then attained its present magnificent proportions, was yet sufficiently high (96 feet in the interior) to insure ample success and afford the many spectators who witnessed the slow apparent change in the plane of vibration of the pendulum relative to the fixed lines described on the pavement, convincing proof of a fact which few perhaps had previously so fully realized.

The experiment has since been repeated at many other places where there were apartments of sufficient hight to exhibit it to advantage.

Foucault afterward made an application of Bohnenberger's gyroscope, which demonstrated the same laws of motion. See GYROSCOPE.

Without tracing the demonstration all through, the result may be stated: over either pole, disturbing causes removed, such as friction, rigidity, or from the air, the pendulum would make a complete (apparent) revolution in 24 hours The time required would increase as the plane of experiment approached the equator, varying with the sine of the latitude; at the equator no revolution would occur.

The motion is in the direction of the hands of a watch in the northern hemisphere, and in the other direction south of the equator.

4. (*Nautical.*) An instrument for measuring the *heel* or inclination of a ship, so as to assist in the laying of her guns.

5. The *hydrometric* pendulum is a *current-gage.*

Pen′du-lum-hausse. (*Ordnance.*) A species of breech-sight, having a brass bulb at the lower end which keeps it in a vertical position when the carriage is on uneven ground.

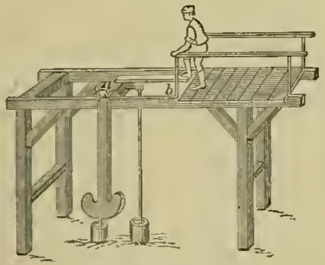
It is made of sheet-brass, and has a slit down its center in which works a slider. It is graduated to degrees and quarters, and for giving the desired elevation a notch in the slider is brought into line with the top of the front sight by lowering or raising the breech of the gun. The hausse has two side branches or trunnions, which rest in the hausse-seat. The seat is made of steel, and is permanently attached to the piece by means of screws.

Pen′du-lum-lev′el. One determining the horizontality of a surface by the verticality of a plumb bob. A mason's or bricklayer's level. See LEVEL.

The plumb or pendulum level, as a geodetic instrument, which shows the horizontal line by means of a line cutting the plummet-line perpendicularly. It consists of two legs, joined together at right angles, with a telescopic sight, and other apparatus; the whole is fixed on a stand by means of a ball and socket. Invented by Picard.

Pen′du-lum-pump. A pump in which a pendulum is employed to govern the reciprocating motion of the piston. In that illustrated, the pendulum is attached to the axis of a beam *a* connected by a transverse bar to the ends of the two piston-rods, and caused to oscillate by depressing a treadle *b*.

Fig 3629.



Pendulum-Pump.

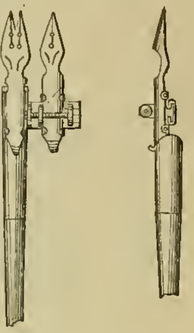
Pen′du-lum-wheel. The balance-wheel of a watch which governs the rate of the motion. See BALANCE.

Pen′du-lum-wire. (*Horology.*) Flattened wire, by which the bob of a clock is suspended.

Pen-hold′er. A staff for a writing nib. It is usually a stick with a tubular piece having a pair of bent-in ears which form a socket into which the butt of the nib is slipped.

A more pretentious article, carried in the pocket, has a slipping piece for the pen which may be thus retracted into the handle on occasion.

Fig. 3630.



Holland's Double Pen.

The stems of pen-holders are of wood, gutta-percha, cork, vulcanite; coiled ribbons of metal or of vulcanite make holders having the pliability of the quill. Sometimes they are of a more costly material around a core of metal or wood. Some varieties may be cited.

A pen-holder having an attachment to the shaft, to make a seat for the fingers and thumb, giving a better grip than the simple round barrel.

Toof (1868) has an attachment to secure oblique presentation of the pen.

Holland (1868) has a pair of pens stocked together for ruling parallel lines.

A pen-holder formed of a sheath, to place like a thimble on the end of the finger. A brush may be substituted for the pen.

A tubular sheath to prevent ink from running back on the hand when the holder is inverted.

A pen-holder having marks on which it may be poised, and with the ends so graduated in weight as to form a weighing-balance for letters of different grades of weight.

Holtzapffel's pen-holder for enfeebled hands (English, 1846) has a vertical post which is grasped by the hand and rests on the paper. The pen is held by an arm jointed to the post at an angle of 45°, and is pressed upon the paper by a feeble spring. See also PEN and PENCIL-CASE.

Pen-i-cil′lus. (*Surgical.*) A tent. *Peniculus.*

Pe′nis-syr′inge. (*Surgical.*) A small syringe from 1 to 4 ounces capacity, with a short nozzle, for introduction into the meatus urinarius. Used for injecting the urethra in venereal diseases. It is made of tin, silver, ivory, or hard rubber.

Pen′knife. A pocket-knife with a small blade or blades; so called from its former use in making quill-pens.

The blade is forged from the end of a rod of cast-steel with a light hammer upon a small anvil, and is then cut off. The joint is then finished and a temporary tang drawn out, to be driven into a handle for grinding. The nick called the *nail-hole*, in which the thumb-nail is inserted to open the blade, is stamped by a chisel while the blade is hot.

In hardening, the blades are heated in a coke or charcoal fire, and dipped in the water obliquely; pure water at 40° Fah. The blades are tempered, twelve or more at a time, on a plate of iron or copper. They are arranged close together on their backs, and lean at an angle against each other. As they come down to the temper, they are picked out with small pliers and thrown into the water, if necessary Other blades are then thrust forward from the cooler parts of the plate to take their places. They are then finished on the glazer and polishing-wheel.

Pen-mak′er. A tool formed like a pair of pinchers for making quill-pens.

The jaws of the tool are convex and concave to receive the point of a quill which has one half cut away; and, by closing, a set of small dies form the outline of the pen, while a little blade in the middle makes the slit.

A machine on this principle was invented by Bramah, and by it six double-pointed pens were made from each quill. A very large number of pens were made in this way before the introduction of steel-pens.

Pen'nant. 1. A rope to which a purchase is hooked. See PENDANT.

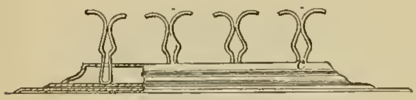
2. A long, narrow streamer borne at the mast-head by vessels of war. A *penon.*

The head is 6.24 inches to a length of 70 feet; 5.76 to 55 feet; 5.24 inches to 40 feet; 4.8 inches to 30 feet; 4.2 inches to 25 feet.

Pen'nis-tone. (*Fabric.*) A coarse woolen frieze.

Pen-rack. A piece of desk-furniture to hold an idle pen. It may consist of a row of hooks on branches rising from the base of the inkstand, or, as in the example, spring clips which embrace the pen-holder with sufficient strength to retain it and yet yield it to the writer.

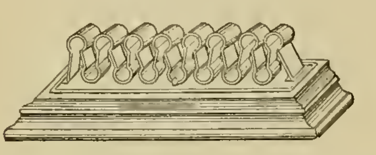
Fig. 3631.



Pen-Rack.

A coil of wire slightly extended answers the same purpose.

Fig. 3632.



Spring Pen-Rack.

Pen-stock. 1. A conduit for water, usually of boards, and notably a trough of planks, which conducts the water to a water-wheel. It begins at the end of the *race*, of which it forms a continuation, and ends at the *gate*, which is lifted to discharge the water on to the wheel. A *shuttle* or *pen-trough.*

2. A sluice or flood gate restraining the waters of a mill pond or race.

3. A flood-gate used in inundating certain parts of fortified works.

Pen'ta-graph. See PANTOGRAPH.

Pent'house. 1. (*Carpentry.*) A projection over a door, entrance, window, or a flight of steps, etc., for protection from weather.

2. (*Ordnance.*) A small house, made of boards united by hooks and staples, for protecting a gun and its carriages mounted *en barbette* from the weather.

Pent-roof. (*Carpentry.*) A roof with *two* equal sloping sides. A compass-roof. A shed or lean-to roof.

Pep'per-box. A small box or caster for dredging pepper on to meat or other food.

Black-pepper is a vine with a knotty stem, which unpruned will reach the hight of 30 feet, but on Singapore Island, and probably elsewhere, is trained on poles of about 12 feet high, which are grasped by the tendrils of the vine. The branches are brittle; the leaves deep green, heart-shaped, and abundant; the blossom a cluster of small, white, almost odorless flowers. The fruit hangs in clusters of 40 or 50 grains in a bunch. At full size it is green, red at maturity, black after being picked, and then shriveled by drying on mats in the sun.

White-pepper is macerated in water until the black cuticle can be rubbed off and the grains again dried in the sun.

Pliny says that pepper was brought from India; "and what was he, gladly would I know, that ventured first to bite of pepper and use it in his meats? Who might he be that, to provoke his appetite and find himself a good stomach, could not make a shift with fasting and hunger only?"

Capsicum (red-pepper) appears to have been unknown to the ancients. It is probably a West India production.

Per-am'bu-la'tor. 1. A machine for measuring a distance traveled. It usually consists of a wheel of known circumference, say 99 inches or half a rod, with a register to record the number of revolutions.

It may be driven by hand or attached to the wheel of a carriage, as in those described by Vitruvius and those among the effects of the deceased Emperor Commodus. The latter not only measured the distance traveled, but also pointed out the hours. A *pedometer, odometer,* or *surveying-wheel.* See ODOMETER.

In one form of this instrument, the wheel, 8¼ feet in circumference, is journaled in the end of a stock, so that it may be lifted out of contact with the ground; on the axis of the wheel is a pinion which works another pinion on the end of a rod having at its upper part an endless screw which moves a train of gearing that gives motion to two hands on an index registering the distance to miles, furlongs, rods, and yards. The instrument is furnished with a stop, so that after measuring a certain distance it may be carried on without altering the position of the hands.

2. A child's carriage propelled from behind.

Per'bend. (*Masonry.*) A *header*-stone which passes through the whole thickness of a wall.

Per-cale'. (*Fabric.*) A cotton goods, printed or plain, and with a linen finish.

Per-ca-line'. (*Fabric.*) Fine French printed cotton goods.

Perch. 1. (*Vehicle.*) *a.* A pole connecting the fore and hind gears of a spring carriage. It has lateral strengthening-bars, called *hind-hounds,* in a wagon.

It is strengthened on the under side by the *perch-plate.*

The *strap* passes from the perch to the foot of the *kingbolt.*

b. An elevated seat for the driver.

2. A console. A bracket.

Per'co-la-tor. A filter. The term is specifically applied to the filter of the pharmacist; and to the French coffee-pot, in which the boiling water is filtered through the ground coffee.

The coffee-percolator was invented by Benjamin Thompson, Count Rumford It consists of an upper cylindrical vessel with a perforated bottom, in which the ground coffee is placed and covered with a perforated disk having a stem by which it may be pressed down so as to compact the coffee and allow boiling water poured thereon to percolate the mass and pass into the coffee-pot below.

In Jones's percolator the lower vessel is heated by a spirit-lamp, and the generated steam forces the water up through a pipe at the side and filters through the coffee placed in a vessel with a perforated bottom above. See COFFEE-POT.

Per-cus'sion-cap. A small cylinder of copper adapted to fit on the nipple of a gun and having a flake of fulminating powder inside, which is exploded by the fall of the hammer upon the nipple, communicating fire through the latter to the charge in the gun.

Detonating powder or pellets were used in 1807, having been patented in England by Rev. Mr. Forsyth for use with artillery; but the charging of caps therewith was a later invention. The percussion principle had a hard struggle with the old flint-lock in the armies of Europe and America until long after it was universally adopted for sporting purposes.

It was not introduced into the United States service until 1842. Caps were invented in England in 1814 by Joshua Shaw. He came to the United States for the purpose of procuring a patent, but was refused as an alien. In 1822, he patented a percussion-lock; in 1828, the percussion-wafer primer. He subsequently received $17,000 from the United States government for his improvements, and died in 1860. Caps for small-arms are made of thin sheet copper, those for sporting-guns, etc., usually having longitudinal striations.

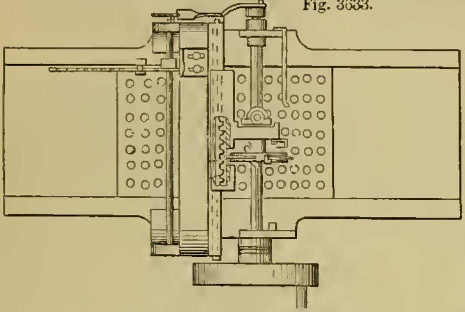
The composition used in the United States service is fulminate of mercury mixed with half its weight of niter. This renders the fulminate less explosive, and gives body to its flame; it is protected by a drop of copal varnish, which soon dries in a thin film, preventing access of decomposing agents. Tin-foil is also employed for the same purpose.

In the British service, a composition of 6 parts fulminate of mercury, 6 chlorate of potash, and 4 antimony, is used. The machines for making caps display great ingenuity. In Boughton's they are stamped from strips of copper previously cut to proper widths, and then charged with the composition. Wright's machine cuts the blanks from the sheet, forms, and charges them with fulminate at one continuous operation. The varnish is applied by a very simple device to a whole row of caps arranged in holes in a board. Percussion-caps of paper, fitting on the hammer, were formerly used for cannon, but have been superseded by quill-tubes and friction-primers.

Separate caps for military purpose are now mostly disused, having been superseded by the modern capped metallic cartridge, in which the fulminate is applied inside the base of the shell, forming a ring in rim-fire cartridges or a cap in the center of central-fire cartridges. With many of the latter class detachable caps are used, which are inserted from the outside in a depression in the base of the shell. See CARTRIDGE.

Per-cus′sion-cap Fill′ing-ma-chine′. The metallic bodies of percussion-caps are placed in perforations in a plate, open end upward. A plate with corresponding but smaller perforations is placed on a flat table, and damp fulminate brushed lightly across it till the perforations are filled. This plate is then placed over the empty caps and the powder shaken down into them. The charged caps are then passed to a machine similar to Fig. 3633, in which the punch moves on a stationary guide across the plate, and, entering each hole, lines the caps in succession with the tin-foil, the plate being moved as each row is completed. A second punch may be used to apply a drop of varnish after the lining is in place.

Fig. 3633.

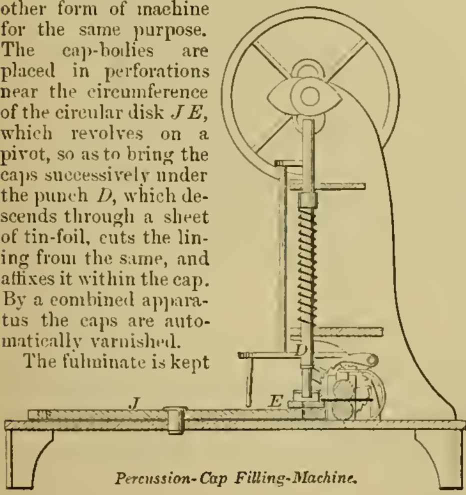


Percussion-Cap Filling-Machine.

Fig. 3634 shows another form of machine for the same purpose. The cap-bodies are placed in perforations near the circumference of the circular disk *J E*, which revolves on a pivot, so as to bring the caps successively under the punch *D*, which descends through a sheet of tin-foil, cuts the lining from the same, and affixes it within the cap. By a combined apparatus the caps are automatically varnished.

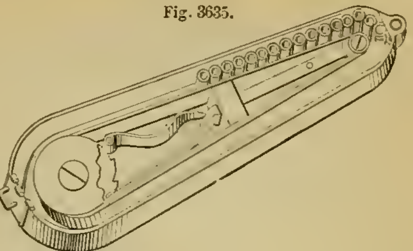
The fulminate is kept wet during the operations of filling, and not more than twelve ounces of the composition is allowed in an establishment at one time.

Fig 3634.



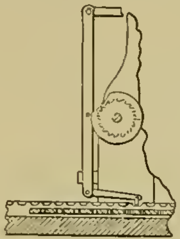
Percussion-Cap Filling-Machine.

Fig. 3635.



Percussion-Cap Holder.

Metallic cartridge-shells are primed with fulminate and varnished in the inside in the same way as caps, but the tin-foil is generally dispensed with. The separate caps for Parker's and Maynard's, and some other central-fire cartridges are made in the same manner as gun-caps, but the shells are shallower. They are inserted in depressions in the head of the cartridge, the head of the cap on a line with the surrounding shell and forming part of the head of the cartridge.

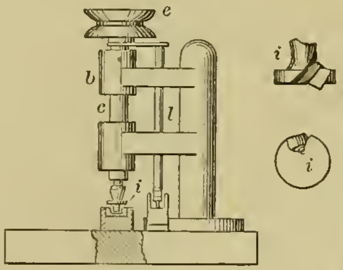


Per-cus′sion-cap Hold′er. A sportsman's device for holding caps in such way as to be readily attached to the nipple of the piece. The caps are arranged in a groove and fed toward the opening by a spring. One is always presented at the point of discharge in convenient position to be slipped over the nipple, and then withdrawn from the case by a pull. The next in series immediately assumes the place at the opening.

Per-cus′sion-cap Trim′ming-ma-chine′. For trimming the edges of cap-bodies after they have been formed by the dies.

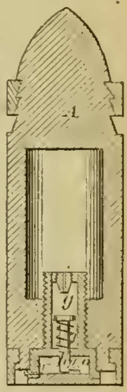
The caps are placed in perforations in a plate and passed beneath a rotating cutter-disk to trim the edge. Fig 3636 shows a machine of this character, in which *b* is a bearing for shaft *c*, which carries the cutter *i*. *e* is a pulley round which the driving-belt passes, and *l* is a gage or lever to raise and depress the cutter-shaft, so that it may operate on the caps as they are brought beneath the cutter.

Fig. 3636.



Percussion-Cap Trimmer.

Fig. 3637.



Percussion-Fuse.

Per-cus′sion-fuse. (*Ordnance.*) A fuse in a projectile set in action by concussion when the projectile strikes the object.

In the example, *A* represents a shell. A plunger *h* held by a spring *i* and detent o, which engages in a notch at its rear end, is released by withdrawal of the detent occasioned by the shock of impact, and strikes a nipple *g* on which is a percussion-cap.

Per-cus′sion-grind′er. A machine for crushing quartz or other hard material by a combined rubbing and pounding process.

Per-cus′sion-lock. (*Fire-arm.*) One in which the *cock* or hammer strikes a fulminate to explode the charge.

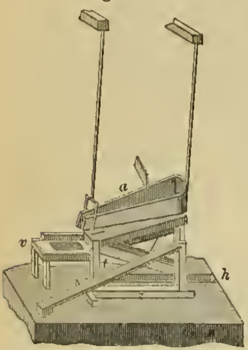
The percussion principle was first applied to fire-arms by the Rev. Mr. Forsyth of Belhelvie, England, in 1803.

The interior mechanism may be the same as that formerly used in the flint-lock, the shape of the hammer being altered to allow it a greater sweep, and the *battery* and *pan* replaced by a *nipple* or *cone*.

Per-cus′sion-pow′der. An explosive ignited by percussion. See FULMINATE.

Per-cus′sion-sieve. (*Metallurgy.*) An apparatus (*crible à secousses*) for sorting ores, principally those of lead, but closely allied to the tin and copper apparatus.

Fig. 3638.



Percussion-Sieve.

It consists of two inclined sieves, the upper one of which discharges on to the second and lower one The upper sieve *a* is fed by the shovelful, and receives a vertical agitation by means of a lifting lever operated by a wiper-wheel on the machine-shaft. Water is also conveyed into the sieve, and the larger refuse or chunks of ore which are too large to fall through the grating are received upon the table *v*, while the other matters fall on to the second inclined and finer sieve *t*, which is similarly agitated and provided with a water-sluice. The fragments which do not pass through the meshes are collected in the box *h*, while the smallest portions fall into the cistern *z*.

This sorting is not like the operations on tin, such as *jigging*, *framing*, *racking*, *tying*, *trunking*, *buddling*, *tossing*, etc., in all of which the attempt is made to sort the comminuted ore by *gravity*. In the *percussion-sieve* the sorting is entirely by *size*. See the above processes for gravity arrangement. See also CONCENTRATOR; ROCKER.

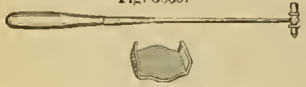
Many of the miners' operations in collecting gold are by gravity. See GOLD-MINING.

Per-cus′sion-stop. (*Music.*) A piano-forte stop to the organ, which renders the touch like the former.

Per-cus′sion-ta′ble. (*Metallurgy.*) A form of ore-separating apparatus consisting of a slightly sloping table on which stamped ore or metalliferous sand is placed to be sorted by gravity. A stream of water is directed over the ore, and the table is subjected to the concussion at intervals.

The French apparatus (*table à secousses*) is like the rack used in the tin-works of Cornwall. The comminuted ore is brought upon the swinging table by a thin sheet of water, and, being spread in a state of mechanical suspension in the liquid, is caused to arrange itself to some extent by gravity, as the heavier grades will sink the sooner while the lighter pass to a greater distance down the inclined table. The latter is suspended in such manner as to receive a double motion, horizontally and vertically, the latter being accompanied by a jar, as the table drops upon two wooden stops.

Fig. 3639.



Percussor and Pleximeter.

Per-cus′sor. A hammer employed in auscultation, in connection with a plate placed on the chest and called a *pleximeter*. For other auscultation instruments see STETHOSCOPE; SPIROMETER, etc.

Pe′rer. (*Ordnance.*) An old form of ship's gun, for throwing stone-shot.

Per′fect-ing. (*Printing.*) Printing the second side of a sheet.

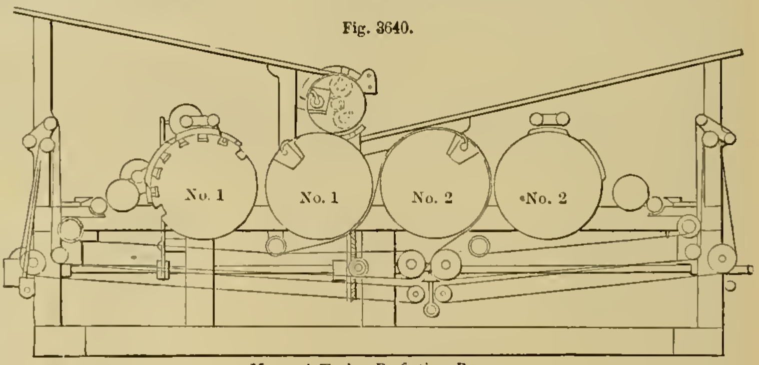
Per′fect-ing-press. (*Printing.*) One in which the paper is printed on both sides during one passage through the machine. In Hoe's rotary-cylinder perfecting-press, two impression-cylinders and two form-cylinders are placed side by side in a horizontal frame, the impression-cylinders occupying the center, with the form-cylinders at each end. The two forms are attached to their cylinders, and inked as in the usual type-revolving press, the fountains and distributing cylinders being placed at the ends of the press. The sheets are supplied by feeders in the usual manner; they are delivered by a feeding-cylinder to the first impression-cylinder, whence they go to the second impression-cylinder, and are thence conducted right and left alternately to a sheet-flier at each end. See also PRINTING-PRESS; WEB-PRESS.

In the flat-bed perfecting-press the bed has a reciprocating motion, the paper being transferred automatically from the first impression-cylinder to the second, and then conducted by tapes to the self-acting sheet-flier. The second cylinder is provided with reels holding a large roll of facing blanket, which, as it becomes soiled by the set-off from the first side of the sheet, is rolled up and a fresh portion brought into use.

The machine may be arranged to have an additional feed-board, from which a set-off sheet may be fed to the second impression-cylinder, the two sheets being thrown out together on the fly-board and separated by hand; or, a sheet-flier may be added for the set-off sheet, which is then separated automatically from the printed sheet and flown on a separate board.

In the press shown in Fig. 3640, the sheets, as they come from the printing mechanism, are directed alternately on opposite sides, so as to be delivered in two piles, either by two separate fly-frames or a double-acting fly-frame. The plates are clamped directly to the surface of the type-cylinder, so as to dispense with the use of blocks and iron frames commonly used.

Fig. 3640.



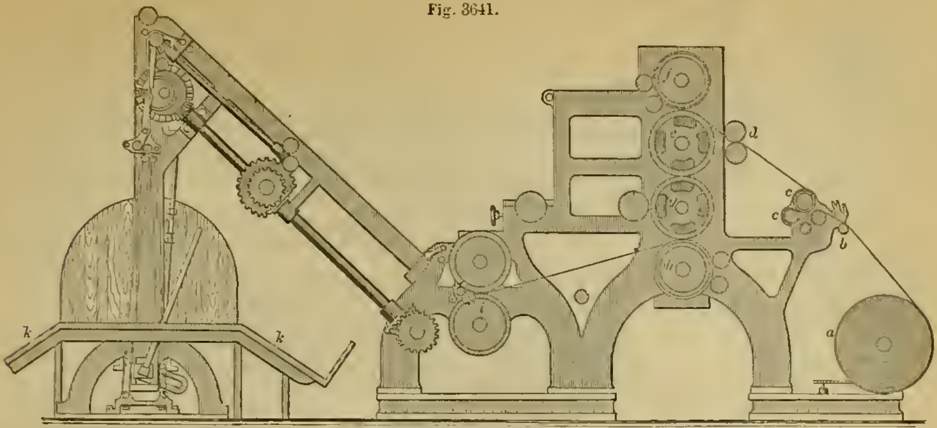
Hoe and Tucker Perfecting-Press.

A late style of perfecting-press uses a double form which engages with a cylinder both in its forward and backward movement, the cylinder performing only a partial revolution and returning with the form. An inking-apparatus on each side of the cylinder inks the form as it passes, and a reversing apparatus on one side takes the sheet after the first printing, reverses it, and returns it to the grippers The back stroke of the press completes the printing, and the sheet is then cut in two

The Walter's English press, which prints the London and the New York "Times," is shown in Fig. 3641. A roll of paper *a*, three miles long, reels off over the pulley *b*, which serves to keep it taut, and is damped in passing the cylinders *c c*. The web then passes over the cylinder *d* to the first type-cylinder *e*, between which and the blanket-cylinder *f* it receives its first impression. Following the direction of the type-cylinder it passes between two blotting-cylinders, and is then delivered to the second printing-cylinder *g*, receiving the impression at *h*. It is then cut by a knife on the cylinder *i* The sheets are finally piled on the paper-boards *k k*. The speed of the Walter press is said to be 11,000 printed sheets, or 22,000 impressions, per hour.

The Bullock press, so named from the inventor, the late William Bullock of Philadelphia, carries the forms upon two

Fig. 3641.



Walter Press (*London "Times"*).

cylinders, requires no attendants to feed it, and delivers the sheets printed on both sides.

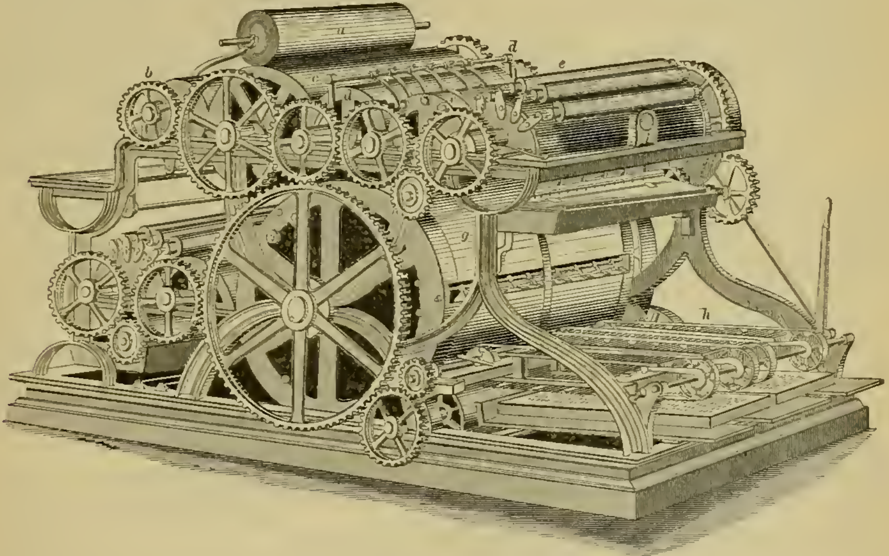
The paper in the form of an endless roll is moistened by passing through a shower of fine spray. A single roll will contain enough for several thousand sheets, and the printing operation, including the cutting of the paper into proper lengths, proceeds uninterruptedly until the roll is exhausted.

The roll of paper having been mounted in its place, the machinery is started, unwinds the paper, cuts off the required size, prints it on both sides at one operation, counts the number of sheets, and deposits them on the delivery-board at the rate of eight thousand to fourteen thousand per hour; or, counting both sides, at the rate of sixteen thousand to twenty-eight thousand impressions. The labor is only that of placing the rolls on the press and removing the printed paper.

The press is shown in perspective in Fig. 3642. The roll of paper *a* on top is cut into sheets by a knife on roller *b* acting against the cylinder *c*. The sheets are seized by grippers, carried between the impression-cylinder *g* and the *form e*, receiving the first impression. The printed sheet then follows the large cylinder *g* to the second *form*, receiving its second impression from this *form* acting against the large drum *g*. From the large cylinder the sheets are automatically delivered to the receiving-board. *i* is a counting device or arithmometer. The inking-rollers are shown above the inking-cylinders, beneath which are the ink-troughs. The starting-lever is shown on the right.

Fig. 3643 shows parts of the Bullock press detached, for a better understanding of their operation. *A* is a section midwise of the principal working parts. *a* is the roll of paper which is cut off in sheets by the knife on cylinder *b*, which strikes through the web of paper into slots in the cylinder *c*. As soon as the sheet is cut off it is grasped by grippers on *c*, passed to impression-cylinder *d*, and around that, between it and type-cylinder *e*, where the first side is printed. It is then seized by grippers on the large cylinder *g*, and carried between that and the second type-cylinder *f* to print the other side. The sheets are taken from the large cylinder by endless belts which pass over pulleys, and are piled by the action of the flier *h*.

Fig 3642.



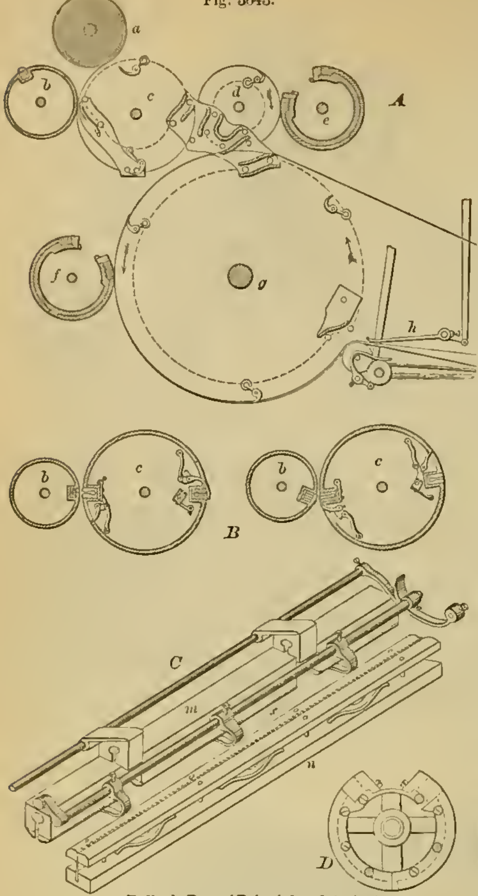
Bullock's Self-Feeding and Perfecting Press.

The large cylinder *g* is covered with a blotting-pad to prevent offset when the face of the freshly printed sheet is carried on to it from cylinder *d*. The inking-rollers, not shown in this view, are kept constantly in contact with the type or plates on cylinders *e f*. The grippers are so arranged that the delivery of a sheet from one set to another is certain and uniform.

B shows the cutting and receiving cylinders, with the grippers on the latter in their positions before and after the sheet is cut from the web. *C* shows the knife *x* and carrier *n*, and the slotted block *m*, into which the cut is made. The carrier *n* is a segment of cylinder *b*, and *m* is a similar portion of *c*.

D is an end view of the printing-cylinders *e f*. The plates from which the printing is done are of extraordinary thickness, and are cast to fit the cylinders in circular molds. The molds are made in plastic material spread on a steel plate which is pressed flat, but which assumes a circular shape when released,

Fig. 3643.



Bullock Press (Principle of Action).

curving the mold with it Kellberg's arrangement of the Bullock press cuts the sheets after printing.

The Victory press, shown under PRINTING-PRESS, is also a *web-press*, and damps, prints, cuts, folds, and pastes at the back a 24-page paper like the "Christian Union" of New York, at the rate of 7,000 per hour.

Per′fo-rat′ed File. A file invented by Hiram Powers, having openings through which the abraded material is allowed to escape. It is especially intended for sculptors' use.

Per′fo-rat′ed Saw. One having a series of apertures behind each gum of the teeth, as originally made. These serve to prevent fractures at the bases of the teeth, and lessen the amount of filing required, becoming themselves the gums after each refiling. See SAW.

Per′fo-rat′ing-ma-chine′. 1. (*Mining.*) The rock-drilling machine used in tunneling. See TUNNEL; DIAMOND-DRILL, etc.

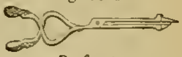
The machine used at the Mt. Cenis Tunnel was worked by air compressed by water-power. The air is compressed to 90 pounds per square inch, and conveyed in flexible pipes to the workings. The machines are on tramways, and upon them are mounted jumpers, which are reciprocated by the action of compressed air. The force of the blow is estimated at 180 pounds, and the rate is three strokes per second. The depth in the average rock is about 0.6 inches per minute. The drill is rotated one eighth of a revolution at each retraction. A jet of water clears the débris from the hole.

2. (*Paper.*) The machine which makes the rows of perforations on sheets of postage-stamps has a couple of cylinders revolving together. The upper one is provided with punches, and the lower one has counterpart holes. As the sheet is passed between them, the holes are made and the little disks of paper fall into the hollow lower roller. The machine will perforate 250 sheets per hour, and the punches and holes are adjustable for stamps of different sizes.

3. (*Telegraphy.*) A machine for making holes in paper for messages to be sent by the automatic method.

Per′fo-ra′tor, Ob-stet′ric. (*Surgical.*) An instrument for perforating the skull of the fetus in utero, as a means of prehension to draw it past the pelvic cavity. The operation is known as *cephalotomia.*

Fig. 3644.



Perforator.

Per′fume. From the Middle Ages up to the last century musk, civet, ambergris, and lavender sum up the best-known and most popular perfumes. Six flowers form the base of most European flower-scents: orange-flower, rose, jasmine, violet, acacia, and tuberose; heliotrope is imitated by vanilla dashed with almonds. To these are added geranium, lavender, rosemary, thyme, and other aromatic herbs; also the peel of bitter oranges, of which the fruit goes to make curaçoa; the peel of citrons and bergamots, musk, sandal-wood, ambergris, and gum benjamin; the leaves of the patchouli (*Pogostemon patchouli*, one of the Labiatæ), from India; wintergreen (*Gualtheria procumbens*), from the United States; various of the Andropagons, from Ceylon; ihlang-ihlang (*Unona odoratissima*, one of the Anonaceæ), from the Philippine Islands; vanda (*Aerides suaveolens*, an orchid), chiefly from Java, but from other places too in the Indian Archipelago; frangipanni (*Plumeria alba*, one of the Apocyanaceæ), from both the East and West Indies. The French are the greatest producers of perfumes; there are two notable exceptions, *attar gul*, or attar of roses, and eau-de-cologne.

See Morfit's "Perfumery," Philadelphia, 1853.

Per′get-ing. See PARGETING.

Per′i-a′gua. A canoe formed by hollowing out a single log or by joining two logs correspondingly hollowed out. A *dug-out.*

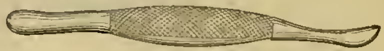
Per′i-er. (*Founding.*) A metal-founder's iron rod for holding back the scum in the ladle.

Pe′ri-od. The full stop (.) which marks the end of a sentence in punctuating, or indicates an abbreviation, as Mr., Jan., B. C., etc.

Pe-ri-od′o-scope. (*Surgical.*) An instrument for determining the date of menstruation, labor, etc., and for other calculations.

Per′i-os′te-um-el′e-va-tor. (*Surgical.*) A device for loosening and raising the periosteum out of the way of an instrument in making exsections, etc.

Fig. 3645.



Periosteum-Elevator.

Per′i-scop′ic Lens. (*Optics.*) Dr. Wollaston's *periscopic* lens for microscopes had two plano-convex lenses ground to the same radius, and between their plane surfaces a thin plate of metal with a circular aperture. The aperture had a diameter equal to one fifth the focal length.

It was proposed to fill up the central aperture with a cement of the same refractive power as the lens.

Another mode, proposed by Coddington, was to make a deep equatorial groove around a sphere of glass in the plane of a great circle perpendicular to the axis of vision; the groove to be filled with opaque matter.

The *periscopic* lens for spectacles is concavo-convex, the ratio of the radii of the respective surfaces constituting it a magnifying or diminishing lens, as the case may require.

The object is to give the lens a curved surface approximating that of the cornea, for the purpose of increasing the distinctness of objects when viewed obliquely.

Per′i-style. (*Architecture.*) A row of columns surrounding the interior of a place.

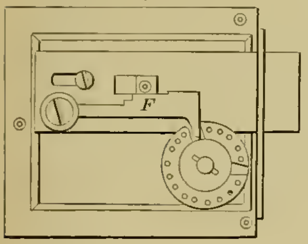
Per′ma-nent Way. (*Railway Engineering.*) The finished road-bed and track, including bridges, viaducts, crossings, and switches. The term is used in contradistinction to a temporary way, such as is made in construction, in removing the soil of *cuttings* and in making *fillings*.

Per-mu-ta′tion-lock. (*Locksmithing.*) A lock in which the moving parts are capable of transposition, so that, being arranged in any concerted order, it becomes necessary before shooting the bolt to arrange the tumblers. The LETTER-LOCK (which see) appears to have been the earliest of this class; and locks on the same principle, but of more complicated mechanism, still form a favorite subject of invention.

The permutation principle was introduced into tumbler-locks by Dr. Andrews of New Jersey, about 1841. The tumblers are capable of variable adjustment, and the key has a series of small shiftable steel rings of such radii as to suit the variable tumblers.

To this succeeded the Hobbs lock, invented by Newell of New York, which is provided with a series of secondary tumblers separated from the main tumblers by a wall; the secondary tumblers have notches corresponding to teeth on a series of intermediate tumblers, which teeth correspond to the hights of the main tumblers; in shooting or retracting the bolt the intermediate tumblers are engaged with both the primary and secondary tumblers, lifting the latter to the hight determined by the variable arrangement of the movable key-bits, but when the bolt is shot they become detached, and the former, on withdrawal of the key, fall, so that their acting surfaces are all on the same level, affording no indication of the hight to which they must be lifted in order to withdraw the bolt; the wall prevents all access to the secondary tumblers for this purpose.

Fig. 3646.

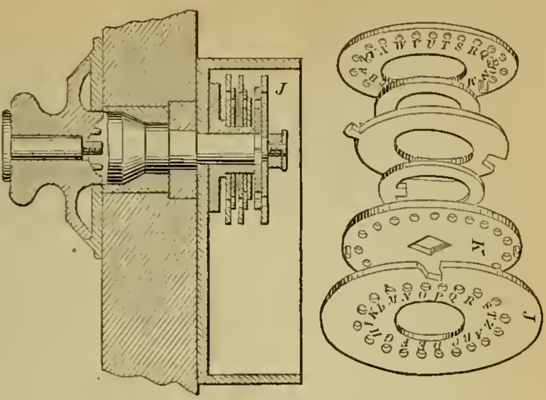


Permutation-Lock.

In Fig 3646, the movement of the bolt is effected by the direct action of a series of rotating tumblers. A bar *F* pivoted at one end to the bolt carries at the other end a projecting tooth, which, when the tumblers are arranged in a certain position, falls into the notch or gate. By turning the spindle, the toothed bar is drawn upon by the tumblers, and the bolt will thus be projected outward, and by turning still farther, the tooth will ride up out of the gate and rest with its point upon the periphery of the series, in doing which a notch on the upper surface of the toothed bar will embrace a permanent stub projecting from the lock-plate, and thus render the bolt immovable until the tumblers shall have been so arranged as to permit the tooth to again fall into the gate.

In Fig. 3647, a dog connected with the bolt engages notches in the tumblers *J*; between these are secondary wheels *K* communicating motion from one tumbler to another, and adjustable thereon, so that the tumblers may be set to any desired combination.

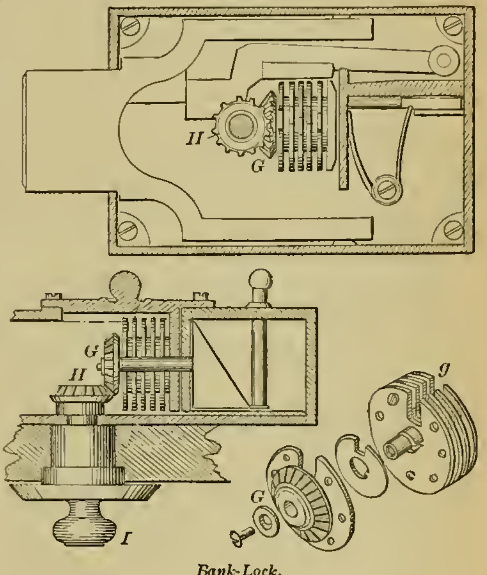
Fig. 3647.



Permutation-Lock.

In Fig. 3648, the arbor of the tumblers is at right angles with the knob-spindle *I*, and the latter carries a miter-wheel *H* engaging a similar wheel on the outer tumbler-wheel. The combination is discovered by the introduction of a pin into the back-plate of the lock when the door is open. The pin impinges upon the inclined head of a pintle, and forces it through the slots *g* of the tumbler-wheels *G* as they are brought into line by turning the knob. The combination is shown by the position of the index-finger when the pin enters each slot.

Fig. 3648.



Bank-Lock.

In one patented lock of this class a vibrating dog is pushed away once in each rotation of the spindle and frees the fence; if then the notches of the tumblers be in line, the fence falls into them and the bolt may be thrown by the spindle. In another, the backward movement of the bolt on shutting the door throws the tumblers out of adjustment by means of a spring-arm.

In a third, a dog pivoted to the case holds the bolt unless the tumblers are in such adjustment as to let the fence fall into corresponding notches in the tumblers, when the head of the dog gravitates and falls from opposing contact with the bolt.

A fourth has a dog on the armature of a magnet held out of contact with a series of permutation-wheels until the spindle which moves the bolt is rotated a certain distance; the armature is then freed and attracted toward the magnet, causing the dog to enter notches in the wheels.

In a modification of the above, the magnet is pivoted and oscillates between an upper and a lower position.

Permutation-locks are constructed with or without keyholes; in the former case the tumblers are set by the key-bits; in the latter, they are brought into adjustment by rotating the knob-spindle back and forth, according to a preconcerted series.

Table of Permutations whereby any Questions of Permutation from 1 *may be solved by Inspection, the Number of Terms not exceeding* 20.

1	1	11	39916800
2	2	12	479001600
3	6	13	6227020800
4	24	14	87178291200
5	120	15	1307674368000
6	720	16	20922789888000
7	5040	17	355687428096000
8	40320	18	6402373705728000
9	362880	19	121645100408832000
10	3628800	20	2432902008176640000

See LOCK; LETTER-LOCK; WHEEL-LOCK. See list under LOCK.

Per-pend′er. (*Masonry.*) A stone going through from side to side of a wall and acting as a binder, called also perpend-stone, through-stone, through-binder. A course of such is called a perpend-course, and a wall in which all the stones run through from side to side a perpend-wall.

Per′pen-dic′u-lar Lift. See CANAL-LIFT.

Per′pent. A bond-stone; a large stone reaching through a wall so that it appears on both sides of it.

Per-pet′u-al Mo′tion. An *ignis fatuus* which has led astray some persons of limited scientific knowledge in all ages and regions. As the knowledge of scientific truth advances, we arrive at some axioms, and we now know that motion involves an expenditure of force, and that even a balance-beam poised by steel edges on agate plates and started pulsating, meets with the resistance of the air and generates some friction between the contacting surfaces, and must come to a stop. The modern demonstration of the convertibility of the various dynamic forces has made the matter more clear and explainable.

It is impossible to make a machine which shall move without a motor, or which shall maintain the motion originally imparted to it unimpaired for an indefinite length of time, without receiving an accession of power.

Perpetual motion induced by natural fluctuations, such as the rise and fall of the tides, of the waves, the flow of a river, the pressure of wind, variations in the weight of the atmosphere, expansion and contraction by heat and cold, do not come within the conditions of the problem of the perpetual motion, the mechanical problem which has annoyed so many. These are subject to recurrent fluctuations and changes which may give a more or less constant motion to objects, and have been made use of in all ages. For an interesting and comprehensive dissertation on this subject, see "Perpetuum Mobile," Dircks, London, 1861.

The Marquis of Worcester, in his "Century of Inventions," refers to a number of contrivances which appear through the fog of the descriptions to be attempts at perpetual motion. The old cavalier was rather curious than profound. He was a genuine gentleman, and true to a false master in victory and in defeat.

The "Siddhânta Çiromani," a Sanscrit text-book on astronomy, gives an account of a wheel having on its outer edge a number of holes of equal size and at equal distances from one another, but upon a zigzag line; these holes are filled half full of mercury, and stopped at the orifice; and it was claimed that the wheel will then, if supported by an axis upon a couple of props, *revolve of itself.*

Bishop Wilkins (b. 1614, d. 1672), in his "Mathematical Magic," tells of perpetual motion produced by "chymical attractions" caused by grinding mercury and some other substances together; in distilling and redistilling the mass until small atoms are produced, which, being placed in a glass globe, serve to keep it perpetually moving. The worthy bishop does not, however, repose implicit confidence in the efficacy of this means to produce the desired result.

According to Thomas Tymme, a certain Cornelius Dreble devised a machine representing the revolutions of the sun and moon, exhibited before King James I., which was actuated by a fiery spirit contained within the axle of the wheel. These things were certainly quite as adequate to cause movement without power as any of the mechanical contrivances afterward devised for the purpose. Among the first of these which we meet is one depending on magnetic attraction. A ball rolled down an inclined magnet, dropped through a hole at its lower end, was then to be attracted by the other pole so as to ascend along a curved surface, pass through another hole in the upper part of the magnet, again roll down, and so on *ad infinitum* Just one half the result was verified; the ball rolled down in strict accordance with the programme, but refused to ascend without coercion.

Next appears the time-honored wheel rotated by plummets or pivoted weight-levers so arranged that those on the descending side shall always preponderate. This form of perpetual motion frequently recurs at the present day.

Nearly allied to this is the wheel having grooved or hollow spokes, along which a series of balls move alternately inwardly and outwardly between the axis and the circumference, so that the greater weight shall always be on the side which is descending. Though it has been mathematically demonstrated hundreds of times, so as to appear almost in the light of a self-evident proposition, that even were there no friction between the acting surfaces, the resultants obtained by multiplying the weights by their distances from a vertical plane passing through the axis of the wheel must always be equal, and that the two sides must, therefore, be in equilibrio, persons are found who are willing to spend time and money in the attempt to construct motors, maintainers, or increasers of power.

In another old form (1685 A. D.), the arms or spokes of the wheel are tubular and carry bellows containing quicksilver at each end; the idea being that when the wheel was set in motion the quicksilver would flow from each bellows as it rose above the horizontal line passing through the axis of the wheel, pass through the tube to the bellows opposite, and accelerate its downward movement.

The apparatus of Dr. Conradus Schiviers, D. D., 1790, consisted of a wheel with compartments similar to those of a water-wheel, and an endless chain passing over pulleys; a number of balls were placed in a trough at the upper part of the wheel, whence they ran down an inclined plane one by one into each compartment of the wheel, causing that side to descend; as each ball arrived at the lowest point of the wheel, it was to be discharged, scooped up by one of the buckets on the endless chain, which it was supposed would raise it to the upper trough to go through the same round. Thus the wheel would move the chain, and the chain would reciprocally move the wheel. The principle is the same as that of a man lifting himself over a fence by taking hold of the straps of his boots.

In the same year, John Haywood invented a perpetual-motion machine strongly suggestive of some "mechanical movements" which have appeared within the past few years. It embraced a wheel with a cranked axle, to the end of which several rods were connected, passing from side to side of the main wheel, and having at their ends small wheels which rotated around the inner rim of the larger wheel; by this arrangement, the preponderance, according to Haywood, would always be on that side toward which the wheel was turning, the points at which the rods were supported by the crank arm continually shifting so as to constitute levers whose longer arms would always be on that side in every position of the main wheel. This, like the preceding, involves the absurdity of two parts reciprocally maintaining the motion of each other, without the aid of extraneous force.

Count de Thiville proposed to use a tube closed at one end, which, being suddenly immersed in water at its open end, the fluctuations produced thereby were to be utilized as a perpetual motor.

Hydraulic devices of this kind are numerous. Prominent among these is the application of a water-wheel to turn an Archimedean screw, which in turn raises the water to supply the wheel. This, also, is a chronic and persistent fallacy which, under various forms, continually reappears.

Several attempted applications of the pump in combination with a water-wheel are also found. These are all based upon the assumption that the force of the water descending in the buckets of the wheel may be made to reciprocate the pump piston, raising the water by which the wheel is turned.

In one, a siphon in an upper reservoir supplied by the pump carries the water to a series of wheels, one above the other; the water escaping from the buckets of the upper wheel falls into those of the one beneath, and so on; a supposed gain of power being effected by this means, while the siphon provides for a continuous flow.

In another device of this kind, power is supposed to be gained by a pulley on the axis of the wheel driving a smaller pulley which actuates the pump machinery, reducing the friction in the proportion of their acting surfaces. This is based upon the theory of the man who purchased two stoves which were claimed to consume but half the usual amount of fuel, that if one saved half two would save it all.

One inventor proposes to use mercury inclosed in an air-tight vessel; the mercury is partly drawn off into a reservoir below, through an aperture producing a vacuum above that which remains; this causes the mercury from the reservoir below to rise in an exhausted tube, passing upward into the vessel from which it was originally derived, and this movement is to be continuous.

Another employs water under pressure, which straightens flexible tubes affixed to the periphery of a wheel, causing its rotation; on passing a certain point, these tubes are caused to discharge, resuming their flexible condition and allowing them to freely turn with the wheel until each arrives at the proper point to exert a propelling action.

Multiplying levers have also been employed for increasing the rotary movement originally imparted to a wheel, the short arm of one being applied to the longer arm of the next, and so on. This arrangement, if it worked in practice, would render the boast of Archimedes, that had he a place for his lever he could move the world, a mere bagatelle. A power of one pound applied in this way at one end of the series might, if the theory of perpetual-motion inventors be correct, be developed into thousands of tons at the other; and, as this would increase at each revolution of the wheel, the consequences might be fearful, so that we may consider it fortunate that in this class of machines some little obstacle which the inventor can usually account for, but never succeeds in entirely overcoming, prevents their working at all.

Many others might be enumerated besides those already mentioned, but we must be content with a few more, probably the most absurd of which is the perpetual-motion railroad-car. In this ingenious device, the load is on a platform suspended below the center of gravity, the car is cylindrical with conical ends, which rest upon the rails at either side. The track forms a series of inclined planes, the car rolling down one by gravity and up the next by the momentum acquired, and so on. Practically, however, this is quite as feasible as the others, among which we may mention: The wheel provided with 25 weights, 15 of which are constantly descending on its outer rim, while 10 are being raised in a straight line on an endless band, each ball being, in its turn, transferred from one to the other; spiral troughs or tubes, down which balls run and are received into similar and opposite spirals, whence they are returned to the first, causing rotation in opposite directions; and rocking devices, in which a ball is allowed to run down an inclined vibrating plane whose motion is automatically reversed each time the ball reaches either end.

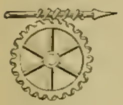
Pneumatic devices are a prominent subject. Among these is the occasionally recurring hollow cylinder, in which a weight or pressure of some kind is applied on one side of a chamber, fixed on an arm or spoke, while the air is exhausted from the other side. We believe it is the correct thing to inclose concerns of this kind in a water-chamber; at all events, this was done by Richard Varley, according to the specification of his English patent (1790), because "water has no spring."

A drum journaled in a cylinder axially divided by a vertical air and water tight partition, one side containing liquid and the other air, has also been claimed as a perpetual motor; the periphery of the wheel is provided with reservoirs containing a substance lighter than the liquid; these necessarily rise therethrough, but being heavier than air have a downward tendency on reaching that part of the cylinder which contains it. The construction of this device would appear to present some mechanical difficulties, to say the least.

The object in citing antiquated instances is to show late inventors in this line, not merely that their contrivances are fallacies, — which they are not likely to believe, — but that such are not even new, and hence, perhaps, not worth pursuing with the expectation of exclusive right, public reward, and enduring fame.

Per-pet′u-al Screw. A screw without longitudinal motion acting upon a wheel whose cogs have a pitch coincident with that of the worm.

Fig. 3649.



Perpetual Screw.

It is often used as a MICROMETER-SCREW (which see). See also WORM-WHEEL.

Per-ro-tine′. (*Textile Manufacture.*) A kind of French calico-printing machine, named after the inventor.

Three wooden blocks, 3½ to 5 feet long and 2 to 5 inches broad, faced with pear-tree wood engraved in relief, are mounted in a cast-iron frame with their planes at right angles to each other, so that each of them may in succession be brought to bear upon the face, back, and top of a square prism of iron covered with cloth and fitted to revolve on an axis between the said blocks. The calico passes between the prism and the engraved blocks, and receives successive impressions from them as it is drawn through by a winding cylinder. The blocks are pressed against the calico through the agency of springs which imitate the elastic pressure of the workman's hand. Each block receives a coat of colored paste from a woolen surface smeared after every contact with a mechanical brush. It executes about thirty pieces a day in three colors, requiring one man and three children for attendance. — URE.

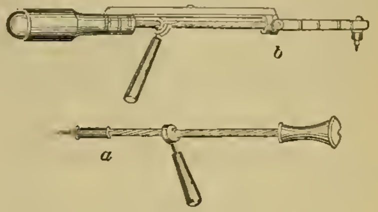
Per′sian. (*Architecture.*) A male figure draped after the ancient Persian manner, and serving to support an entablature, after the manner of a column or pilaster. *Atlantes* have a similar duty.

Per′sian Car′pet. One made in the same manner as the Turkey: usually the whole piece is set up; that is, the carpet warp is the whole width of the piece, instead of being made in breadths or strips to be joined. The web of the carpet has a warp and weft of linen or hemp, and the tufts of colored wool are inserted by twisting them around the warp all along the row. A line of tufts being inserted, a shoot of the weft is made, and then beaten up to close the fabric. See TURKEY-CARPET.

Per′sian Drill. A hand-drill (*a*) which is sometimes known as the Persian drill has a shank with a *quick* thread and a back-center in the head or handle. The nut is moved back and forth on the screw-shank, which is thus rotated, the action of the drill being rotary reciprocal.

It is frequently used for fine work and in dentistry, the shank being made of *pinion wire* twisted, and the spiral grooves inside the nut being made conformable to the screw-threads of the shank.

Fig. 3650.



Persian Drills.

The *screw-stock drill* (*b*) is a modification of the preceding, in which the motion of the screw-stem is communicated by a pair of bevel-pinions to the drill, whose axis is at right angles to that of the driving-screw.

Per′sian Wheel. This name is given to two forms of water-raising wheels: —

1. A wheel with pots or buckets on or near its rim, dipping water at the lower part of their revolution and discharging it when they reach their extreme elevation. See BUCKET-WHEEL; CHAIN-WHEEL.

The wheel is sometimes driven by the current acting upon vanes.

2. A wheel with chambers formed by radial or curved partitions, dipping water as their edges are submerged, raising it, and discharging it near the axis.

These are both common in Oriental countries. Travelers mention them as running in Persia, Arabia, Syria, Palestine, Egypt, Spain, Tyrol. The first is here treated under NORIA (which see); the second under TYMPANUM (which see).

Per-spec′tive-glass. (From *prospective*, i. e. *prospect-glass.*) The terrestrial or land telescope, which has two more lenses than the astronomical telescope, so as to show objects in the right position.

"After dinner I to the parish church, and there did entertain myself with my perspective-glass up and down the church, by which I have the great pleasure of seeing and gazing at a great many very fine women; and what with that, and sleeping, I passed away the time till sermon was done." — PEPYS'S *Diary*, 1667.

Per-spec′tive-in′stru-ment. A mechanical contrivance to assist persons in drawing in perspective.

A *camera-lucida* or *camera-obscura* will enable a perspective delineation. See CAMERA-LUCIDA; CAMERA-OBSCURA.

Bevis's perspective-instrument, described by Ferguson, consists of a rectangular board with a hinged movable frame of an arched shape, and having two adjustable strings, which may be made to intersect each other and assume any direction. The eye steadily beholding an object, say the pediment of a building, the strings are brought into coincidence with the required lines of the object; the frame is then laid down on the board, the point or lines marked on the paper, and, the frame being raised, another point or line is observed and similarly transferred to the paper. The observations are taken through an eye-piece, which may be approached to or receded from the frame, according to the scale of the drawing required.

Ronalds's perspective-machine, patented in England, has an eye-piece and an arrangement by which a bead traversing in the plane of delineations is made to confer a corresponding motion upon a pencil.

A perspective-instrument for drawing the outlines of any object in perspective was invented by Dr. Christopher Wren, about 1669, and is described in the "Abridgment of Phil. Trans.," Vol. I p 325

Per-spec'to-graph. An instrument for the mechanical drawing of objects in perspective. The object is placed in front of the eye, which is applied to a small hole. A movable hinged bar is so adjusted as to bring a point between the eye and a certain part of the object. The bar is then folded down and the mark transferred to the paper. A series of such marks afford data for the drawing of the object.

Pes'sa-ry. (From the Greek *pessos,* a round stone used in playing at checkers.) An instrument in the form of a staff, ring, or ball, made of elastic or rigid materials, and introduced into the vagina to prevent or remedy the prolapse of the uterus.

The variety of these is very great, — ring, oval, globular, horseshoe shaped. Made of gold, silver, hard and soft rubber, ivory, boxwood, etc.; solid, hollow, inflatable.

They may be classed as, —

A rigid body pushed into position, and of a nearly solid or of a skeleton form. The pessary of Hippocrates was a pomegranate pierced through the core.

A ring or frame which is supported by resting against the os pubis.

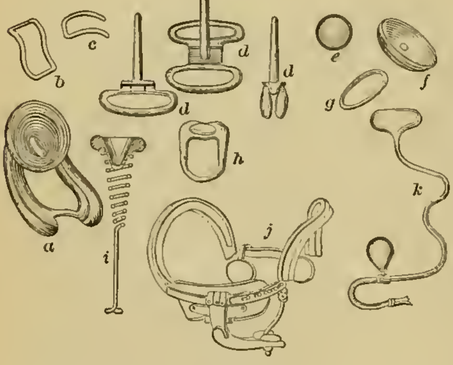
A staff or finger which is supported by an external brace or truss, and enters the vagina so as to form a seat for the uterus.

An inflatable ball or annulus, which is expanded after reaching its sphere of action.

Several kinds are shown in Fig. 3651

a is Fraser's pessary of hard rubber, having a cup for the cervix and a supporting bow which passes down the posterior walls of the vagina, the lower portion resting upon and being supported by the levator ani muscle near its attachment to the os pubis. The entire posterior or convex portion of the bow resists the action of the downward tendency of the uterus in the cup, while the bladder pushes the anterior wall of the vagina into the concavity of the bow, which in turn is so constructed that it clasps the parts, and is thereby aided in keeping its position. Room is provided for the urethra in the notch at the base of the instrument.

Fig. 3651.



Pessaries.

b is Hodge's double-S or closed lever.

c is Hodge's horseshoe pessary.

d is Conant's two-winged pessary of hard rubber.

e is a globular pessary of silver or glass.

f, a concave or cup-shaped, of any material.

g, a ring-shaped, made of watch-spring covered with gutta-percha.

h, the concave, perforated disk forms a support for the parts affected, while the lower loop affords a means for its introduction and withdrawal, as also a support for it while in place.

i, the india-rubber pessary is cup-shaped, with a heavy curved lip, and is supported by a spiral spring with a rod and ring for external attachment.

j is Banning's uterine supporter attached to an abdominal supporter, a curved finger extending up the uterus, whose cervix rests in the cup at the extremity.

k is an inflatable rubber globe.

Pes'tle. 1. An implement used in braying substances in a mortar.

Its use is more ancient than that of the mill. In the Bible, and in the remains of Egypt, Nineveh, and the later civilizations of Greece and Rome, it, in connection with the mortar, was a favorite mode of grinding grain for bread, as well as preparing other articles of food and medicine. See BREAD.

Being smaller and more fragile than the mortars, not so many of them have been recovered from the débris of ancient civilizations. See MORTAR.

2. The vertically moving bar in a *stamping-mill.* A *stamp.* See STAMPING-MILL.

3. The pounder in a fulling-mill.

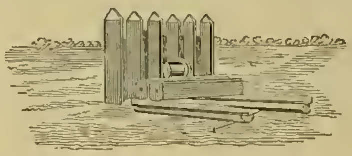
Pe-tard'. A box or bag filled with powder, used for blowing open gates, doors, etc. It is provided with a slow-burning fuse, and to produce any considerable effect should be charged with at least twenty pounds of powder. The effect is increased by loading the petard with sand-bags or other weights. A shell of large caliber may be used for the same purpose.

The effect of petards is nearly proportional to the square of the charge of powder they contain.

Disks of gun-cotton, designed to be simply attached to a stock, drawbridge, gate, or barricade, have lately been used with great effect upon experimental structures.

Powder or gun-cotton petards are placed in position for firing in the manner shown in Fig. 3652, in which the petard is laid against the stockade which it is desired to breach, resting upon timbers to give the petard greater resistance. A simple way of holding the bursting-charge to its work is by a diagonal brace with its upper end holding a powder-bag against the barrier, and the other resting in a slight depression in the ground

Fig. 3652.



Petard.

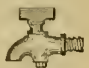
The invention is ascribed to the Huguenots in 1579. Those first used were of metal, in the shape of a hat, and were employed to blow up gates or other barriers, and also in countermines to break through the enemy's galleries. The petard was formerly fixed to a plank called a *madrier.* Cahors was taken by Henry IV., by means of petards, in 1580.

Pet-cock. 1. (*Steam-engine.*) A little faucet at the end of a steam-cylinder, to allow the escape of water of condensation. It is kept open until the engine is fairly under way, and is then shut.

2. A *test*-cock.

3. A valve or tap on a pump.

Fig 3653.



Pet-Cock.

Pe'ter-sham. (*Fabric.*) A heavy and fine woolen goods for men's overcoats, the face being rolled so as to present the appearance of little tufts.

Pe'tong. (*Alloy.*) Chinese white copper; an alloy of copper and nickel. *Packfong.*

Pe-tro'le-um. A liquid, inflammable, bituminous substance, composed of hydrogen and carbon.

Among the distillates of petroleum are, —

Carbon oil, 59° B and downward.
Benzine, 59° to 64°.
Naphtha, 64° to 70°.
Gasoline, 70° and upward.
Paraffine is also one of the products of petroleum.

Petroleum in various forms was known in most remote antiquity. The Egyptians used it in embalming their dead. The Jews employed it as a cementing material for their edifices, and the inhabitants of ancient Memphis covered the lower parts of their dwellings on the outside with asphaltum in order to preserve them from the dampness of the surrounding soil. The present petroleum well of Zasyuthus, one of the Ionian Islands, was known to Herodotus, more than 2,000 years ago.

Pliny says: A bituminous oil is found on a spring at Agrigentina in Sicily, the waters of which were tainted by it. The inhabitants of the spot collect it on the panicles of reeds, to which it very readily adheres, and make use of it for burning in lamps as a substitute for oil; as also for the cure of itch-scab on beasts of burden.

He remarks that the inflammable material found at Samosata was used by the inhabitants to defend themselves against the army of Lucullus; that it would burn on water, and is only extinguished by earth.

In Crawford's "Embassy to Ava," published about 1826, appears the following: "Petroleum wells supply the whole Burman Empire with oil for lamps and also for smearing wood, to protect it against insects and particularly against the white ant. Its consumption for burning is said to be universal, until its price reaches that of the Sesamun oil, the only other kind used for lamps. The wells, which occupy a space of 16 square miles, vary in depth from 200 to 250 feet; the shaft is square, not more than 4 feet on each side, and is formed by sinking wooden frames. The oil, on coming up, has a temperature of 90° Fah. It is thrown into a large cistern, in the bottom of which are small apertures for the aqueous parts to drain off, when the oil is left for some time to thicken. It is then put into large earthen jars, placed in rude carts drawn by oxen, and carried to the banks of the river, from whence it is sent by water to all parts of the empire."

He estimates the amount transported by the number of boats engaged in the traffic, their usual load, and the time occupied in an average trip. He puts it at 46,556,400 pounds per annum.

James Young, of Glasgow, undertook the refining of a mineral oil found in a coal-mine in Derbyshire in 1847. Having exhausted his supply, he turned his attention to the distillation of a sort of bituminous shale, known as boghead cannel, from which he extracted an oil which was an excellent lubricant and quite well adapted to illuminating purposes. His sales in England amounted to £100,000 in 1854, and in the same year a refinery, operating under his patent, was established in New York for the distillation of Nova Scotia cannel-coal. A number of coal-oil factories were soon after started in various parts of the United States.

The usual process of coal-oil distillation was by placing cannel-coal in retorts similar to those of gas-works and distilling at a moderate temperature.

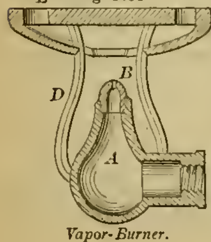
Natural petroleum had been known to exist in Pennsylvania since a date prior to the war of the Revolution, and in Ohio and West Virginia it was well known, but was considered worthless or a nuisance. The use of Young's coal-oil led to the belief that the natural oil might have a value, and about 1857 efforts were made to bring what was then known to a market, and to discover other supplies. As soon as it was found that artesian wells in the oil-regions would furnish crude petroleum, thousands of wells were sunk, and the supply is now considered inexhaustible, although the annual production fluctuates considerably. See OIL-WELL

The annual production of crude petroleum in the United States now reaches at least $20,000,000, and in its refined state it has a value four times as great. The export of petroleum and its products in 1872 was over thirty million dollars.

Pe-tro′le-um-burn′er. A burner contrived to vaporize and consume liquid petroleum fed to it from a reservoir.

In Fig. 3654, the oil from an upper tank is admitted to the chamber *A*, where it is vaporized, and, issuing from the nozzle *B*, is inflamed, heating the plate *E*; this is supported upon two arms *D*, which conduct the heat downward and maintain the chamber *A* at a temperature sufficiently high to vaporize the oil Apertures in the plate *E* conduct the flame to the base of a vessel placed above it

Fig. 3654.

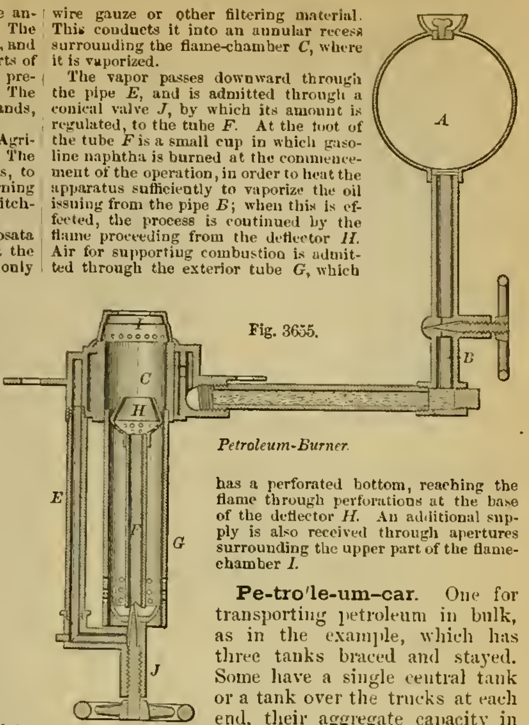


Vapor-Burner.

In the burner, Fig. 3655, the petroleum from a reservoir *A* is permitted to flow through the pipe *B*, which is provided with a conical regulating valve, and has a horizontal branch containing wire gauze or other filtering material. This conducts it into an annular recess surrounding the flame-chamber *C*, where it is vaporized.

The vapor passes downward through the pipe *E*, and is admitted through a conical valve *J*, by which its amount is regulated, to the tube *F*. At the foot of the tube *F* is a small cup in which gasoline naphtha is burned at the commencement of the operation, in order to heat the apparatus sufficiently to vaporize the oil issuing from the pipe *B*; when this is effected, the process is continued by the flame proceeding from the deflector *H*. Air for supporting combustion is admitted through the exterior tube *G*, which has a perforated bottom, reaching the flame through perforations at the base of the deflector *H*. An additional supply is also received through apertures surrounding the upper part of the flame-chamber *I*.

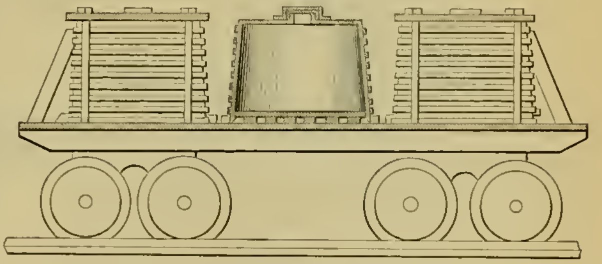
Fig. 3655.



Petroleum-Burner.

Pe-tro′le-um-car. One for transporting petroleum in bulk, as in the example, which has three tanks braced and stayed. Some have a single central tank or a tank over the trucks at each end, their aggregate capacity in either case being the same. See also OIL-CAR; OIL-TANK.

Fig. 3656.



Petroleum-Car.

Pe-tro′le-um-fil′ter. One for removing dirt and foreign matter from petroleum.

They are of several kinds.

The tank with filtering material in a false bottom, which acts as a strainer.

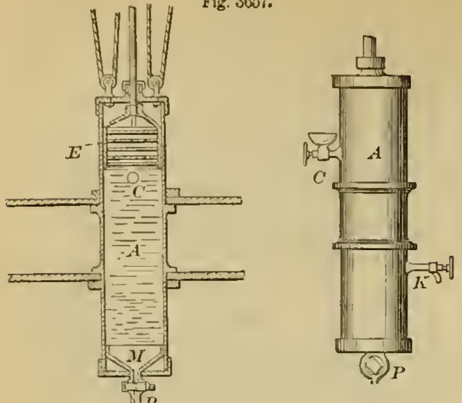
The centrifugal filter, which acts on a similar principle to the sugar-filter shown at Figs. 1213, 1214, page 514.

The piston-filter, wherein the piston forces before it the foul matter, the oil escaping through the foraminous folds of the piston.

Fig. 3657 is a piston-filter. The oil is admitted to the vessel *A* through the pipe *C*, and the filtering piston *E* is caused to descend; the impurities are forced downward by the piston and collect in the funnel-shaped false bottom *M*, while the pure oil passes through the piston, and, collecting above it, is drawn off by the cock *K*. The impurities below the piston are removed through the cock *P*.

Fig. 3658 is a centrifugal filter. The oil is placed in a wire-gauze vessel *C*, lined with two thicknesses of fabric between which layers of filtering-paper are interposed. Rapid rotation is imparted by means of the axial shaft *A* and gears *H I*, causing the purified oil to be thrown off in the form of spray and

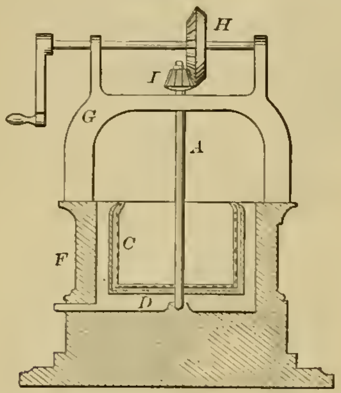
Fig. 3657.



Oil-Filter.

received in the cylinder *F*, while the impurities are retained by the filtering material. See also page 1550.

Fig. 3658.



Centrifugal Filter.

Pe-tro'le-um-fur'nace. A steam-boiler furnace constructed for burning jets of petroleum, or a spray of petroleum mixed with a proportioned stream of air, sometimes accompanied by a steam-jet.

In some cases the steam under pressure is made to lead in the petroleum and atmospheric air in the manner of the *Giffard injector* One in use in Paris has an oil-distributing device consisting of a pipe with branches, and of a grooved grate along which the oil flows after dropping from these tubes. A wrought-iron cistern contains the supply of petroleum, and is connected to the distributor by an india-rubber tube. The grate is placed vertically; the air, passing between its bars, supplies the oxygen for the combustion of the petroleum vaporized by the heat of the fire. The petroleum is supplied to the grate a little in excess of the requirements of the furnace, and the surplus drops into a receiver, and is volatilized by the heat of the furnace and the vapor consumed.

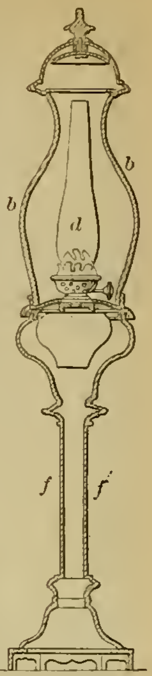
Pe-tro'le-um-lamp. A lamp for burning coal-oil. See list under LAMP for varieties.

The lamp (Fig. 3659) is particularly designed for use where, as in hot climates, a strong artificial current of air is produced by fans or punkahs. The reservoir with its chimney *d* is supported on a hollow pillar *f f*, and is surrounded by a shade *b b* covered by a cap, so that access of external air is prevented, except through perforations at the base of the pillar, which admit sufficient to support combustion. Suitable orifices in the cap permit the escape of the hot air. The burners, two or more in number, have flat wicks, but may each form a segment of an ellipse or circle.

Pe-tro'le-um-still. A still for separating the hydrocarbon products from crude petroleum, etc., in the order of their volatility.

In Kelley and Tait's continuous distillation apparatus (*H*, Fig. 3660), oil from the tank *a* passes through the pipe *b* to the upper retort *c* of a series arranged within the furnace *d* and connected by overflow-pipes *e*, through which it successively flows from one to the other. Steam introduced into the furnace through a pipe *f* entering near its top passes downward, and, becoming superheated, enters the retorts through the pipes *g g*, by which they are connected with the upcast branch of the pipe *f*, causing the vaporization of the oil. The vapors pass through the pipes *h h* into the chamber *i*, in which water from the tank *k* is admitted through rose nozzles in the form of spray The lighter vapors pass off through the chimney *l*, in which a shower of water from a rose nozzle serves to condense those which are less volatile. Water accumulating at the bottom of the condenser *i* passes off through the overflow-pipe *m*, the supernatant hydrocarbon liquid being withdrawn through the pipe *n*. A glass gage *o* at the side of the chamber indicates the hight of the oil and water contained therein. If it be desired to rectify the oil without the use of steam, the cocks of the pipes *h* are closed, with the exception of the uppermost, so that the vapors pass upward through the series of overflow-pipes e' to the top retort of the series before being discharged into the condenser. The lowermost retort or retorts are provided with discharge-cocks *p*.

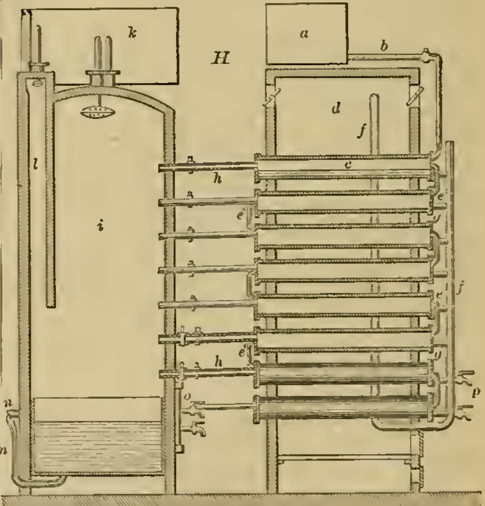
Fig. 3659.



Lamp with Protected Burner.

Lockhart and Gracie's still (Fig. 3661), in which *A* is a vertical and *B C* horizontal sections, has the still *a* surrounded with a hot-air space *b*; it is heated by a plurality of fire-chambers *c c c c*, divided by walls *e e e e*, from which the products of combustion pass over bridge-walls *d d d d* before entering the chimney *e*; this is provided with a damper *f*. The interior of the still is provided with a stirrer, shown in detail at *C*; this consists of a ring *h* carrying arms *i i*, to the lower part of which scrapers *k k* are attached, which remove the tarry sediment or residuum from the bottom of the still, discharging it into a pipe by which it is withdrawn into a reservoir. The arms are rotated by a set of gears *l m n*, the last of which meshes with the toothed ring *h*.

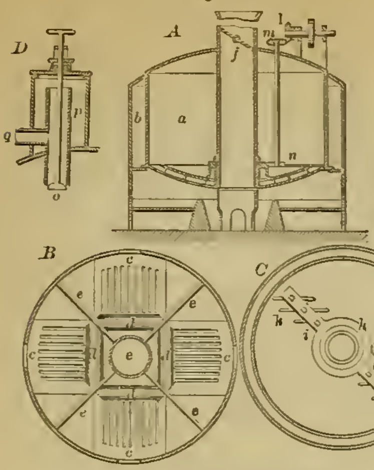
Fig. 3660.



Kelley and Tait's Petroleum-Still.

D is a pipe at top of the still into which the lighter vapors of distillation, naphtha and benzine, pass directly when the valve *o* is closed, at the beginning of the operation, flowing down the pipe *p* and out through *q* to the condenser; when the flow of the lighter products has sensibly diminished, the valve *o* is

Fig. 3661.



Lockhart and Gracie's Petroleum-Still.

opened and the heavier products rise through the lower end of the pipe p and pass to the condenser.

Rogers's still (Fig. 3662) is designed to perform the series of fractional distillations required to separate the various products evolved from hydrocarbon oils by a continuous operation. a is the retort, which is filled with liquid through the charging-pipe b, and heated in any suitable manner. From the retort the vapors pass to the column c, having a series of compartments c^1 c^2, etc., one above the other, filled to a certain hight with the liquid to be distilled by means of a pipe d, having valves so that any number of the compartments may be filled; it may also be used for drawing off the liquid when required. e is the worm; it is surrounded by a tank containing water, and is connected at one end to the pipe f and at the other to the pipe g by valved openings. The lower bends of the worm are connected by pipes to the lower cooling worms h h'; these pipes have valves by which the fluids condensed in the upper worm may be diverted into the pipe i.

Heat being applied to the retort a, the vapors evolve, pass through the pipe a' into the column c, and ascend successively through the various compartments, the heavier portions and impurities being condensed in the liquid contained therein, while the lighter portions pass on to the worm e, where the less volatile vapors are condensed and the liquid is drawn off into the auxiliary or cooling worms h h'; or, if it is desired to run the liquid or any portion of it back into the column or the retort, one or more of the valves of the worm-connecting pipes are closed, and the liquid flows into the pipes j j. The worms h h' are so arranged that the liquid supplied them may be of different grades, as, for instance, h receiving that from the three first coils of the worm, which are of lower grade than those condensed in the next three coils, and which are received in the worm h', and so on. When it is desired to run only the highest grade of liquid, all that is condensed in the worm e may be run back into the column or retort and again distilled, that vapor only which is uncondensed by the worm e passing over through the pipe g to be condensed in a worm contained in the tank k: or only the vapors which are not condensed by the right-hand turns of the worm may be passed over, the remainder being returned to the retort.

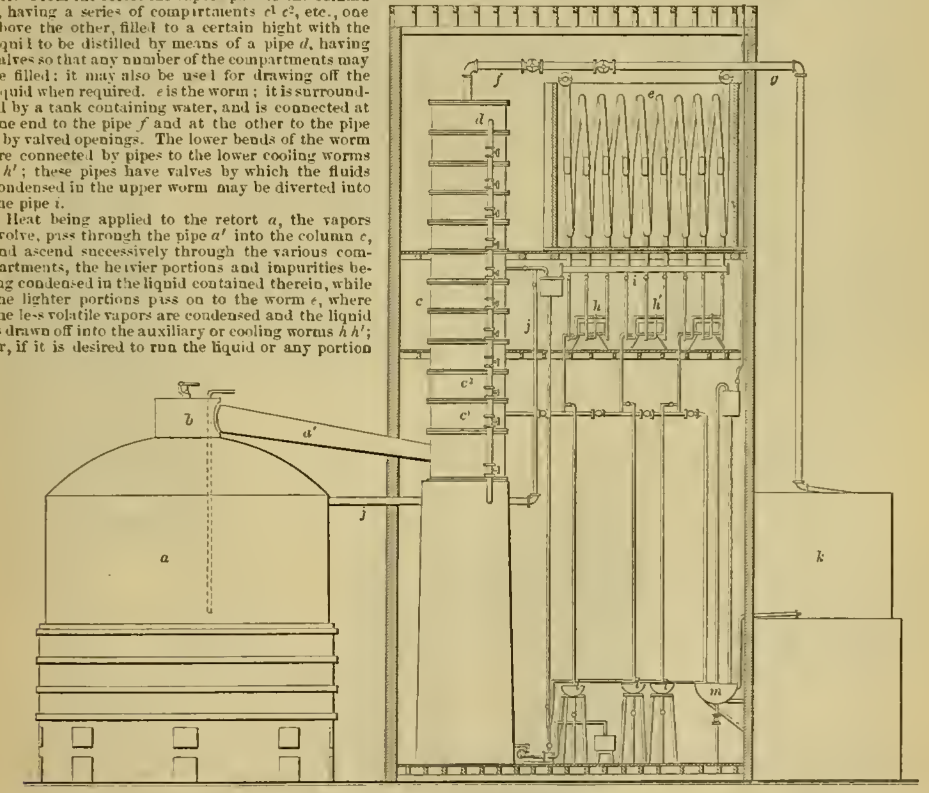
The most volatile vapors may require pressure or cold artificially produced, in order to condense them; for this purpose the coil in the tank k may be surrounded by ice or other cooling mixture, and pressure applied by an air-pump arranged to work either as a vacuum or pressure pump: any remaining uncondensible vapors are carried off into the air or burned.

The liquid from the pipe i passes into a water-trap which is provided with a pipe for drawing off the water. l l l are running pans for receiving the liquids from h h', etc., and m the main running pan.

Carpenter's apparatus (Fig. 3663) is designed for generating a permanent illuminating gas from petroleum. The oil from a tank C is admitted through a valved pipe D to the boiler A, where it is volatilized and conducted through the pipe h to the retorts F F F, by which the gas is superheated and rendered non-condensible.

The amount of vapor generated in the boiler is indicated by a gage a, and if this is in excess of the capacity of the retorts F the surplus is conducted into the tank E, where it is condensed and reconducted to the boiler A. The gas from the retorts F is then passed through a cooler I into a purifier J, provided with a series of foraminous diaphragms containing lime or other substance for absorbing impurities, and is finally received in the gasometer K, where it is retained until required for use. B G are grates for heating the boiler and retorts.

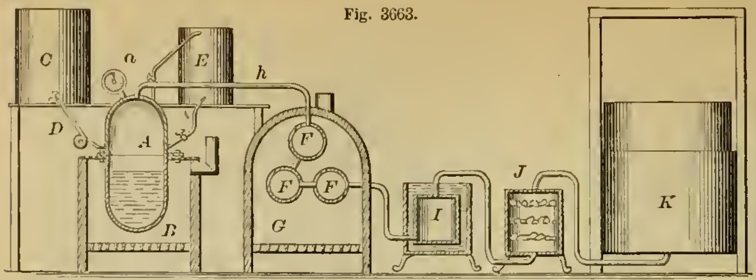
Fig. 3662.



Rogers's Petroleum-Still.

In the invention of Olney, 1874, and St. John, 1874, the petroleum is vaporized by steam coils in the still or the jacket around it, so as to leave no residuum. This vapor is then mixed with ordinary coal-gas of low illuminating power, and passed slowly through a highly heated retort to make permanent gas.

Fig. 3663.

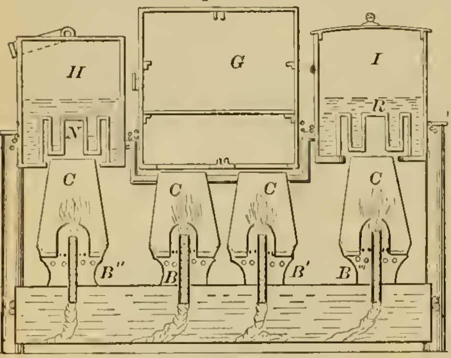


Still for generating a Permanent Gas from Petroleum.

Pe-tro′le-um-stove. One in which the heat is derived from the burning of coal-oil, usually in lamps, but sometimes in pans.

In Fig. 3664, the burners *B B′ B″ B‴* have sheet-metal chimneys and mica doors, so that their combustion may be watched and regulated. The bottoms of the boilers *H I* have peculiarly shaped chambers *N R*, to expose a large surface to the heat. The oven *G* has removable vertical partitions dividing it into compartments, each of which may be heated independently in case it is not desirable to have more than one burner lighted.

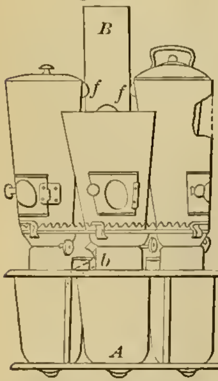
Fig. 3664.



Lamp-Stove.

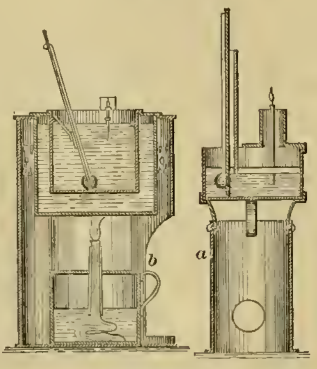
In Fig. 3665, a series of oil-reservoirs are arranged between two horizontal plates, and may be turned around on rollers so as to present either in front. The vapors formed over the surface of the oil in each reservoir are conducted by pipes *b* into the lower part of the chimney *B*, beneath a wire-gauze diaphragm, to prevent danger of explosion. The burners of the reservoirs are within sheet-iron vessels of inverted conical form, adapted to receive cooking-vessels, and provided with mica doors; the products of combustion are conducted by pipes *f f* into the central chimney *B*. See also Fig. 1359, page 581.

Fig. 3665.



Coal-Oil Cooking-Stove.

Fig 3666.



Petroleum-Tester.

Pe-tro′le-um-tank. See Oil-tank.

Pe-tro′le-um-test′er. An instrument for determining the inflammability of illuminating oils, or of inflammable matter in compound liquids, by means of a thermometer and a flame, the thermometer being applied to the liquid while the heat is imparted to the latter, and the vapor generated by the heat being directed to the flame, so as to take fire when the heat rises to the point at which the liquid gives off explosive vapors. The illustration shows Smith and Jones's (*a*) and Tagliabue's (*b*) devices for this purpose. See also Millochan, September 5, 1865; Tagliabue, October 28, 1862; Hartshorn, June 29, 1869.

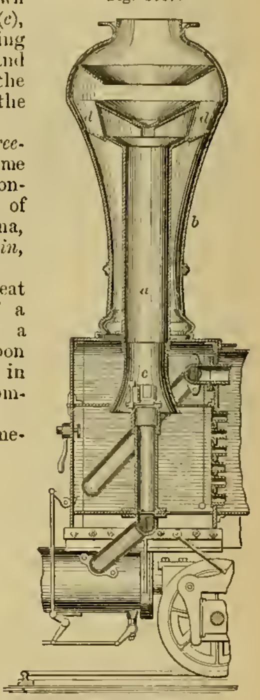
Pet′ro-nel. A grade of cannon in some services, 6-inch bore and 24-pound ball.

Pet′ti-coat-pipe. (*Steam-engine.*) A pipe (*a*) in the chimney (*b*) of a locomotive, which comes down over the exhaust-nozzle (*c*), and conducts the escaping steam and the smoke and sparks which follow the induced current into the arrester *d*.

Pe-tunt′ze. (*Porcelain.*) The Chinese name of a feldspathic rock containing an admixture of quartz, and used in China, when mixed with *kaolin*, for making *porcelain*.

Pew-chair. A seat affixed to the end of a pew so as to occupy a part of the aisle upon occasion when seats in excess of the pew accommodation are required. *Camp*-chairs are sometimes used, but the *pew*-chair is a specific folding-seat attached to the pew.

Fig. 3667.



Petticoat-Pipe.

Pew′ter. 1. An alloy of tin and lead, to which other metals are sometimes added. The lead is sometimes entirely replaced by other metals.

Its most common use is for cheap table-ware, tankards, beer-mugs, etc., though it is also employed, when containing a little copper, in making toy musical instruments; from it are also made polishing-laps for jewelers and other articles. The plates from which cheap music is printed are frequently made of pewter, the notes being stamped instead of cut, as is done in copperplate engraving. When a large proportion of lead is used it constitutes tinman's solder.

The usual proportion of lead in pewter of good quality is from 16 to 20 per cent. Any excess over this tends to impart a dull, bluish appearance. Hardness and sonorousness are imparted by the addition of a little copper; by substituting antimony for the copper, hardness and a silvery luster are produced. If, during the process of melting, the contents of the pot are stirred with a strip composed of equal parts of zinc and tin, or a lump of zinc is allowed to float on the surface, the formation of dross is prevented; hence it is said to "cleanse" the mass.

The following are some of the formulas given.

Common: tin, 4; lead, 1.
Better: tin, 112; lead, 16; copper, 6; zinc, 2.
Hard pewter: tin, 192; antimony, 16; copper, 4.
Best pewter: tin, 100; antimony, 17.
Aiken's: tin, 100; antimony, 8; copper, 4; bismuth, 1.

Manufacturers consider that a better article is produced by melting up old pewter with new ingredients; when this is done analysis alone can determine the proportions of each metal in the alloy. See ALLOY.

The English pewterers have three varieties, *plate*, *trifle*, and *ley* pewter.

The *plate*-pewter has, tin, 100; antimony, 8; bismuth, 2; copper, 2.

The *trifle*-pewter has, tin, 83; antimony, 17; with a good deal of lead occasionally.

The *ley*-pewter consists of, tin, 4; lead, 1.

Some inferior varieties contain nearly 50 per cent of lead. To remedy this debasement and establish a uniform standard, the English Pewterers Company attempted in 1772 to regulate the quality by comparison of its weight with that of a given bulk of tin; for this purpose a button of pure tin weighing 182 grains was employed; a similar button of *plate*-pewter would weigh 183½ grains; of *trifle*, 185½ grains; and of *ley*, 198½ grains; equal parts of tin and lead weighing 232 grains. Their rule, however, was not much regarded.

The finest pewter, frequently called *tin* and *temper*, is produced by adding *temper*, composed of 2 parts tin and 1 copper, in the proportion of from ½ to 7 pounds to each pig of tin weighing from 360 to 390 pounds.

Owing to the liability of lead to corrosion when exposed to vinegar, sour fruits, etc., the French government appointed a commission to determine what amount of lead is admissible in *pewter*. They determined that 82 parts of tin might safely be alloyed with 18 lead. A standard was then adopted, of tin, 83.5, lead, 16.5, with a tolerance of 1.5 per cent to allow for unintentional errors.

The density of the legal standard is 7.764.

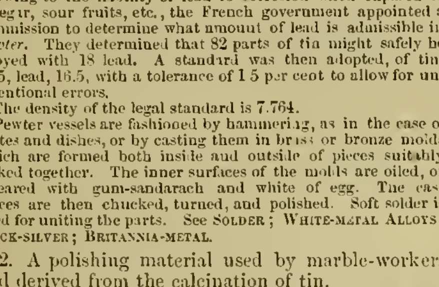
Pewter vessels are fashioned by hammering, as in the case of plates and dishes, or by casting them in brass or bronze molds which are formed both inside and outside of pieces suitably locked together. The inner surfaces of the molds are oiled, or smeared with gum-sandarach and white of egg. The cast pieces are then chucked, turned, and polished. Soft solder is used for uniting the parts. See SOLDER; WHITE-METAL ALLOYS; MOCK-SILVER; BRITANNIA-METAL.

2. A polishing material used by marble-workers and derived from the calcination of tin.

Pew'ter-er's Sol'der. It is of three grades, termed *hard pale*, *soft pale*, and *middling pale*. The first contains 2 parts tin and 1 lead; the second, 2 lead, 1 tin, and 1 bismuth; the third a middle grade.

Pew'ter-er's Tem'per. An alloy of 2 parts tin and 1 copper; from ½ pound to 7 pounds of this are added to a block of tin weighing from 360 to 390 pounds to produce the finest kind of pewter, frequently called *tin and temper*.

Fig. 3668.



Phaeton.

Pha'co-cys'tec-tome. An instrument adapted for Rognetta's operation for cataract, by cutting out a portion of the capsule of the crystalline lens.

Pha'co-pis. (*Surgical.*) A lenticular-shaped scalpel.

Pha'e-ton. (*Carriage.*) An open four-wheeled carriage, usually drawn by two horses.

Phan-tas'ma-go'ri-a. An optical effect produced by a machine similar to a magic-lantern, except that instead of the figures being painted on transparent glass, the glass is painted black on all parts except that occupied by the figures, which are painted in transparent colors, and all the light transmitted is through the figures. The image is thrown upon a screen of thin silk placed between the spectators and the lantern. By moving the instrument towards or from the screen, the figures are made to diminish or increase in size.

Dissolving views are produced by the employment of two lanterns of equal size and power, so arranged that the circle of light transmitted from each shall fall upon the same part of the screen. A perforated plate with a crescent-shaped opening is adjusted so that as light is admitted to the slider of one lantern it is shut off from the other, the first picture disappearing as the second becomes illuminated. See DISSOLVING VIEW.

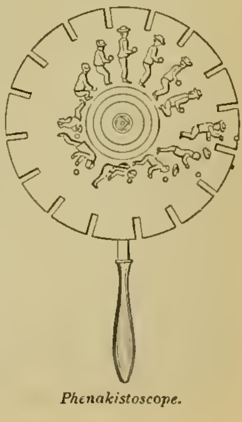
Phan'ta-scope. An instrument invented by Dr. John Locke of Cincinnati, to illustrate some phenomena of binocular vision. It consists of a flat board with an upright rod at one end, with two adjustable thimbles, like those of a retort-stand. The upper one supports a card with a slit 3 inches long and ¼ inch wide, so as to admit both eyes to look through it. The other thimble supports a second card with a slit, and an index marked across its middle. By an adjustment of the second card, a pair of objects on the base-board is viewed through the perforations of both cards, and by viewing the index the optical axes of the eyes are converged and the objects are reduplicated, and eventually a merged image appears in the central position. *Phantasmoscope.*

Pha'ros. A LIGHTHOUSE (which see).

Pha-ryn'go-tome. (*Surgical.*) An instrument to scarify inflamed tonsils and open abscesses in the parietes of the pharynx. It has a long, narrow blade with a lancet point, inclosed in a slightly curved silver sheath, in which it is carried to the part to be cut, and from which it is made to protrude by pressing a button at the end. The blade is retracted by a spring.

Phe'na-kis'to-scope. Invented by Dr. Roget. Improved by Plateau and Faraday. This instrument, which, like the *thaumatrope* and *zeotrope*, depends upon the persistence of visual impressions, consists of a circular disk on which a row of figures are painted in a series of attitudes such as would be consecutively attained in the progress of an action; for example, leaping, walking, swimming, etc. The effect is to produce the appearance of actual motion. The disk is placed on a handle and rotated by the finger on a nut. It is held in

Fig. 3669.



Phenakistoscope.

front of the observer, the face of the toy toward a looking-glass, and the figures are viewed through the slits.

Phi′al. A small bottle used chiefly for medicine.

Pho-nau′to-graph. Or *phonograph.* An instrument, invented by Leon Scott, which automatically records phonetic sounds by diagrams in a manner analogous to that in which the indicator-diagram of a steam-engine records the pressure of the steam.

It proceeds upon the premises, that articulate sounds are accompanied by the expulsion of air from the mouth; that the impulses vary in pressure and duration and in the suddenness with which they commence and terminate; that different syllables vary in volume, force, continuity, and abruptness.

Professor Barlow uses a speaking-trumpet about 4 inches long, having an ordinary mouth-piece connected to a tube, which has an end expansion of 2½ inches diameter, which is covered with a membrane of gold-beater's skin or gutta-percha. A spring rests gently against the membrane, and carries a light arm of aluminium, which holds a small sable brush, forming a marker which touches a traveling strip of paper, registering the vibrations of the diaphragm which agree with the characteristic force, persistence, and celerity of the enunciated syllables. See "Popular Science Review," London, July, 1874. Also Silliman's Journal, August, 1874, pp. 130, 131.

Charles A. Morey, Massachusetts Institute Technology, suggests as a mode of increasing the excursion of the *marker* to have the shorter end of a lever in contact with the membrane, the larger one to carry the style or marker. The effect is to magnify the motion.

The future of this instrument, which is at present little more than an acoustic toy and apparatus for the lecture-room, is undetermined. It would be possible to so connect the style with electrical devices that its excursions, both as to distance and continuity, might be exactly repeated at any distance by the telegraphic circuit; or the diagram might become a record capable of transmission by the autographic or automatic plans; or the instrument might be made to operate a type-writer, and so the spoken words might become a record printed in ordinary letters on paper.

Pho′no-graph. An instrument in which the tracer is moved by the vibration of a circular stretched membrane, which is itself excited by sonorous waves proceeding from any sounding body, as a bell, a diapason, a musical instrument, or the human voice. In order to intensify the impulses upon the membrane, this is fixed in the focal point of a large hollow paraboloid, truncated at the apex. The sounding body is placed in front of the paraboloid, and the receiving cylinder is brought into a convenient position at the opposite extremity to receive the trace. Also known as a *phonautograph.*

Pho′no-scope. An apparatus for testing the quality of musical strings, invented by M. Koenig, and shown at the International Exhibition, in 1862.

Phos′phor Bronze. An alloy of copper, tin, and phosphorus capable of being made tough and malleable, or hard, according to the proportion of the several ingredients. It is rendered so liquid in the molten state by the addition of the phosphorus, that it forms very clean castings. At the London International Exhibition it was shown in the form of bearings of machinery, cog-wheels, guns, cartridge-cases, wire, and tuyeres for blast-furnaces, hammers, knives, scissors, hinges, locks, keys, bells, netting, sieves, wire for pit-ropes, and plates for the sheathing of sea-going ships.

Messrs. Levi and Kunzel, of the Val Benvit Nickel-Works, near Liege, Belgium, have, for a number of years past, been engaged in making experiments for the purpose of improving bronzes of this kind. The results of their experiments are thus summed up by M. Dumas: —

"The color, when the proportion of phosphorus exceeds one half per cent, becomes warmer and like that of gold largely mixed with copper. The grain and fracture approximate to those of steel. The elasticity is considerably increased, the absolute resistance under a fixed strain becomes more than doubled; the density is equally increased, and to such a degree that some alloys are with difficulty touched by the file. The metal, when cast, has great fluidity, and fills the mold perfectly to the smallest details. By varying the dose of phosphorus, the particular characteristic of the alloy which is most desired can be varied at will."

In a series of experiments at the Royal Academy of Industry at Berlin, a bar of phosphor bronze (proportions of components not stated), tried under a constant strain of 10 tons per square inch, resisted 408,230 pulls of that amount, while a bar of ordinary bronze broke before the strain of 10 tons to the square inch had been attained. A bar of phosphor bronze, under a strain of 10 tons, resisted 862,980 bends, while the best gun-metal broke after 102,650 bends. Another bar, tested under a strain of 9 tons, has resisted 1,260,000 bends without breaking. In Austria the following comparative results have been obtained: —

Absolute Resistance.

Phosphor bronze . . .	81,798	pounds per square inch.
Krupp cast-steel . . .	72,258	" " " "
Ordnance bronze . . .	31,792	" " " "

The best English copper sheets lost, during six months' immersion in sea-water, 3.058 per cent; phosphor-bronze sheets but 1.158 per cent.

The composition of several alloys of this class is given in the following table: —

	Copper.	Phosphorus.	Tungsten.	Zinc.	Nickel.	Tin.	Lead.	Bismuth.	Arsenic.	Antimony.	Brass.	Manganese.	Mercury.
Parke's Eng. Pat. (12,325 of 1848) for sheathing boilers, etc.													
No. 1...........	95	3-5											
2...........	95	1 2	3-5										
3...........	60	2-5		38									
4...........	60	5		40	20								
For casting in molds.													
No. 1...........	5	5				60	20	5					
2...........	2	5				25	25			5			
3...........	2	3		45		50							
4...........	2	3				10	50		5				
Parke's Eng. Pat.	240	1		160									
(2,996 of 1857)	400											1-1.5	
for sheathing *	400												1 5
											400		1
Parke's Eng. Pat. (5 of 1858) for wire or tubes..	100	.5											
Lavroff, U. S. Pat. (Aug. 22, 1871)	80	1				19							
Levi & Kunzel†	89.9	1.6				7							
(May 23, 1871)	92 5	.5				7							

* Phosphorus added in the stick to the melted copper.

† Phosphorus added in the form of phosphuret of copper or tin, and while the alloy is covered with a reducing layer of carbon cast in chilled molds smeared with petroleum.

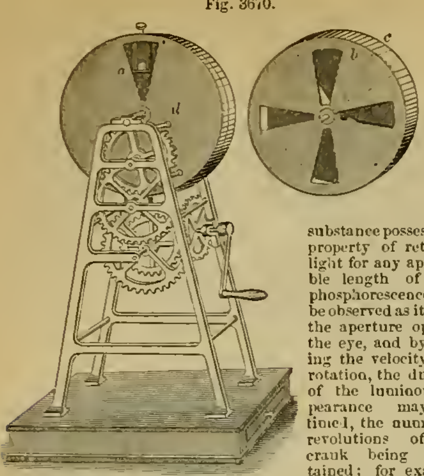
Phos-phor′o-scope. 1. A philosophical toy, the "trap to catch a sunbeam," consisting of glass tubes arranged in a box and containing phosphorescent substances, as the sulphides of lime, strontium, barium, etc. When this is exposed to the sun's rays or to the light emitted by a gas-burner or burning magnesium, and then removed to a dark place, each tube appears to glow with light of a different color, as red, blue, green, etc.

Another mode of displaying this property in certain substances is by spreading them in thin layers on a dark surface; these may be formed into any desired fanciful figures or representations of natural objects whose images may often be presented in their natural colors by a judicious selection of the phosphorescent materials.

2. An instrument devised by Becquerel for measuring the duration of phosphorescence in different substances.

A crystal of fluor spar or other substance to be examined is placed in a cage *a* between the two perforated screens *b c*, which are rotated within the casing *d* by a hand-crank and gearing. The casing has two apertures on opposite sides, so arranged that the rays from an electric light behind it shall not pass through, but are admitted to the crystal once during each revolution. The interior screens may be rotated at a high velocity, when, if the

Fig. 3670.



Becquerel's Phosphoroscope.

substance possesses the property of retaining light for any appreciable length of time, phosphorescence will be observed as it passes the aperture opposite the eye, and by slowing the velocity of its rotation, the duration of the luminous appearance may be timed, the number of revolutions of the crank being ascertained: for example, if this be turned once in a second, and a train of three multiplying wheels and pinions with teeth in the proportion 100×100×100 to 10×10×10 be employed between it and the screens, the latter will be rotated at the rate of 1,000 times per second.

In this way it has been found that many substances previously thought non-phosphorescent are capable of retaining light for very short periods.

Phos'pho-rus-paste. A poison for rats, mice, roaches, etc.

Take 8 ounces of common starch and pour over it 1 pint of water; stir and then pass through a No 60 sieve into an enameled dish capable of holding a gallon, and add 1½ pints of water and 24 ounces of flour. Mix thoroughly, introduce 24 fluid ounces glycerine, and heat on a sand-bath, stirring constantly. When a plasma begins to form, take it from the fire, but continue stirring. After a few minutes reapply heat, stir, and set aside to cool. Mix 6 ounces of the plasma gradually with 8 ounces water in a porcelain measure, and set in nearly boiling water. When hot enough, drop in 2 drams of phosphorus. When this has fused, agitate the whole thoroughly and introduce as much more phosphorus, repeating the operation until 2 ounces of phosphorus have been added After this, thicken the phosphoric emulsion with more of the reserved plasma, and finally incorporate it thoroughly with the remainder Preserve in small, wide-mouthed bottles, protected from the air.

Pho'tics. That department of science which treats of light. The term originated in the United States Patent Office, and is there applied to that class of mechanical inventions embracing lamps, gas-light arrangements, and illuminating apparatus generally.

Pho'to-e-lec'tric Lamp. A name for the electric lamp.

Fig. 3671 illustrates the electro-magnetic safety-lamp invented by MM. Dumas and Benoit for miners' use. The generating cell and helix are inclosed in a case provided with a strap, by which it may be slung over the miner's shoulders. The helix wires pass through insulating tubes to an illuminating coil within the glass lamp cylinder, which prevents access of fire-damp to the lamp. See SAFETY-LAMP.

Fig. 3671.

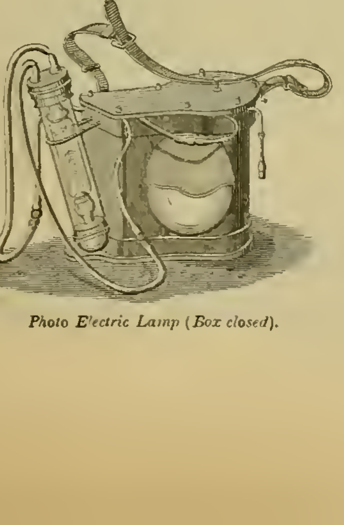


Photo Electric Lamp (Box closed).

Pho'to-e-lec'tro-type. (*Photography.*) A process in which a photographic picture is produced in relief so as to afford, by electro-deposition, a matrix for a cast, from which impressions in ink may be obtained. See PHOTO-GALVANOGRAPH, etc.

Pho'to-en-grav'ing. 1. A name applied to each of many processes, in which the action of light on a sensitized surface is made to change the nature or condition of the substance of the plate or its coating, so that it may by processes be made to afford a printing surface corresponding to the original from which the photographic image was derived. The processes are divisible into PHOTO-INTAGLIO, PHOTO-RELIEF, and WOODBURYTYPE.

2. The photographic process is also used for obtaining a picture upon a plate or block for subsequent engraving. The value of the process consists in the quickness and the fidelity of the picture. In some cases it is a substitute for an offset or tracing process, in other cases it affords a means of obtaining a picture from nature or from a model.

In this relation occurred one of the most remarkable patents on record for what it failed to do: that of James Palmer, England, No. 13,736, of August 23, 1851 The object was to use gelatine as a vehicle for receiving delineations of objects. 1. The sheet of gelatine was placed in a frame, in the manner of a pane of glass, between the eye and the object, and the outline of the object was traced upon it "Various methods of reducing, enlarging, multiplying, and transferring are thus obtained." 2. The sheet was treated with chemicals, especially alum, to render it insoluble in water, in order that *wet* paper might be employed in taking from it impressions to act as transfers. 3. The design might be deeply scratched upon it in manner of an etching, and the gelatine used as a copper-plate, the lines to hold ink which furnished an impression in a press. 4. This impression was to be transferred to stone or zinc for printing by the lithographic process; or to copper or wood for engraving by the usual tools. 5. It might be colored yellow by bichromate of potash. 6. It was to be placed in a camera obscura in order that an image might be thrown upon it. 7. The engraved gelatine was to be used as a matrix for casting or electrotyping.

Without any apparent intention here were suggestions of a *photogelatine process*, *gelatine lithographic-transfer*, *photolithography*, and a host of *photo-relief* and *photo-intaglio processes*. He needed but to have exposed the sheet of bichromated gelatine to the action of light, and then applied ink and water, to have anticipated all the above inventions and reached a result which would have very much surprised him.

In the Chandler process as an aid to engraving: —

The surface of a polished plate of copper is blackened by a sulphuret of potassium and coated with a ground of resin, wax, and sulphate of lead The surface is sensitized and an image thrown on and fixed. The lines are followed by an etching-point or graver down to the black copper surface. The plate is treated with graphite and then a film of copper deposited on it in a bath. This is backed for printing. See RELIEF-LINE PROCESS

The following process is adopted for photographing on wood for engraving purposes: —

The box-wood block is first dampened with water, then whitened with enamel from visiting-cards. The dry whitened surface is flowed with a solution of albumen, made with the white of one egg and 16 ounces of water. When this is dry coat it with a filtered solution of the white of one egg; water, 4 ounces; chloride of ammonia, 40 grains. Dry this by a gentle heat.

Prepare a solution of ether, 1 ounce; alcohol, 1 ounce; guncotton, 8 grains; nitrate of silver, 30 grains dissolved in as small a quantity of water as possible. Mix and allow to settle for a few days, protected from the light. Flow the block as previously prepared in the dark room, and dry by gentle heat. Expose under the negative in a printing-frame. After printing, the last composition is removed from the surface of the block by dissolving in ether and alcohol, assisted by rubbing gently with a soft sponge. The picture can now be toned and fixed in the ordinary way, or fixed and toned at one operation, by the hypo. and gold bath. After being allowed to dry, it is ready for the engraver.

Pho'to-gal-van'o-graph. (*Photography.*) A process for producing printing-plates in relief by the consecutive actions of light and electro-deposition.

As invented and practiced by Pretsch in 1854: Take a positive photographic print on paper or glass; cover a sheet of glass with bichromated gelatine; when dry, lay the positive upon it and expose to light. Develop by immersing in water; where the light has not acted the gelatine swells and the parts where the light has acted do not absorb water, and are sunken relatively. Take a mold in gutta-percha, which gives an intaglio. Take a plate by treating the surface with graphite followed by electro-deposition, which gives a matrix like the gelatine. Take a cameo electroplate from the matrix, which gives a plate to be printed from by the ordinary printing-press.

For metallic ornamentation. It has been suggested that the surface of a metallic object being polished or frosted, a film of iodide of silver be formed on it, and an image from a negative thrown upon the object in a camera. Being placed in an electro-bath, a deposit of copper takes place on the parts exposed to light, while the unexposed parts, protected by the shadows of the negative, receive no deposit of copper. The object is now dried, etched with a solution of sulphuric acid, saturated with nitrate of potash. This attacks the silver and not the copper. When the silver is corroded the required depth, the copper is removed by aqua regia, which does not affect the silver. The surface previously protected by copper is in relief, and corresponds to the lights of the negative, the dark lines of the print, for instance, from which the negative was obtained.

Pho′to-gel′a-tine Pro′cess. One in which gelatine, prepared chemically, usually by the bichromate of potash, is made to receive a photographic image, which may become a printing-surface or be transferred to a stone or zinc to form a printing-surface thereon.

The term may be used to distinguish those processes employing gelatine, from those in which starch, gum, asphaltum, etc., are used.

The processes are various. For early items on this subject, see GELATINE PROCESS. See also ALBERTYPE; HELIOTYPE.

Gelatine Processes. *a.* The drawing or print being in lines or dots, a negative on glass is obtained. From this a print on a film of bichromated gelatine is obtained, and this, after suitable treatment, is transferred to stone and rolled up for printing. Osborne's process. See PHOTOLITHOGRAPHY.

b. A photographic positive on glass is placed over a sheet of talc bearing a film of bichromatized gelatine. This being exposed to the light, through the talc, the gelatine is hardened, according to the intensity of the transmitted light, leaving unaltered the parts in perfect shadow. The film being washed in hot water, the unaltered gelatine is dissolved away, leaving an intaglio plate in gelatine, in which the depressions correspond to the light portions of the picture. A cast forming a cameo in metal is obtained by electro-deposition or by a press, giving a printing-surface in relief. A peculiar ink is used, consisting of gelatine holding coloring matter, the degree of depression determining the quantity of ink and consequent depth of tone. The WOODBURY PROCESS (which see).

Pho-to-gen′ic Draw′ing. A picture on paper by the agency of light on a sensitized surface. See PHOTOGRAPHY.

Pho-to-glyph′ic En-grav′ing. See PHOTOGLYPTIC-ENGRAVING.

Pho-to-glyp′tic En-grav′ing. A process invented by Mr. Fox Talbot, October 29, 1852, in which a design was so produced on metallic plates as to form a printing-surface.

A solution of gelatine, 1 part, water, 40 parts, is mixed with 4 parts of a saturated solution of bichromate of potash The mixture is floated over a plate, giving an exceedingly thin film, and allowed to dry in the dark. Being exposed in connection with a print in a frame to sunlight, its surface is strewed with finely powdered copal, which is melted by the aid of heat. The plate is then etched by a solution of perchloride of platinum or perchloride of iron, which attacks only the parts unacted on by the light. When a sufficient depth is attained, the etching liquid and the ground are washed off, and the plate, after cleaning, is employed for printing. In place of the surface of copal he used, before exposure, fabric to cut up the flat tints by intercepting the light and enable them to hold the ink. The ingenuity of the process depends a good deal upon the selection of the solvent which dissolves the metal without effervescence, penetrating the unaltered gelatine and preventing its disturbance by the evolution of gas.

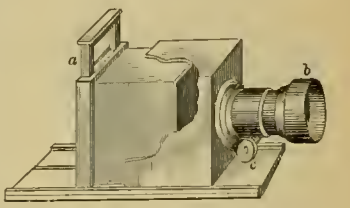
Pho′to-graph-e-nam′el. A process of transforming photographic plates into colored enamels. Two methods are employed. In the first, introduced by De Camarsac of Paris, colored vitrifiable powders are applied with the pencil to the different parts of the proof on glass, and the whole is raised to the necessary heat in a muffle. In the second, that of Tessié du Motay and Maréchal of Metz, the photographic proof, taken in the ordinary way, but made as forcible as possible, is immersed in solutions of other metals by which the silver is displaced. If this be done successively in several baths, with exposure of different parts of the device in each, the subsequent process of enameling will furnish corresponding varieties of tint.

Pho-to-graph′ic Cam′e-ra. (*Photography.*) A chamber in which a sensitized surface, usually a glass with a film of sensitized collodion, is exposed to the actinic action of light. See PHOTOGRAPHY.

In photographic operations different forms of cameras are used, named according to the construction, purpose, or the conditions under which the picture is being taken; such are *box*, *bellows*, and *stereoscopic*, *field* and *studio*, *copying*, *enlarging*, and *solar* cameras, etc.

Fig. 3672 is a *box*-camera, an early and yet very useful form. One portion slides telescopically in the other, to regulate the size of the image, which bears a certain proportion to the relative distances of the plate and the object from the lens. *a* is the plate-holder; *b*, the lens-holder; *c*, a rack adjustment for focus.

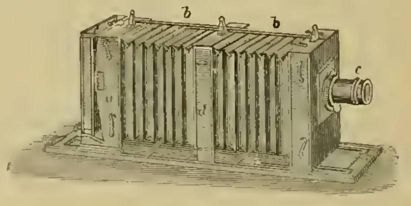
Fig. 3672.



Box-Camera.

Fig. 3673 is a *bellows*-camera, in which the portion of the chamber holding the lens *c* and that containing the plate-holder *a* are united with a central rigid portion *d*, by expansible portions *b b*, which are like the bellows of an accordeon, and thereby permit the adjustment of the distance of the plate from the lens.

Fig. 3673.

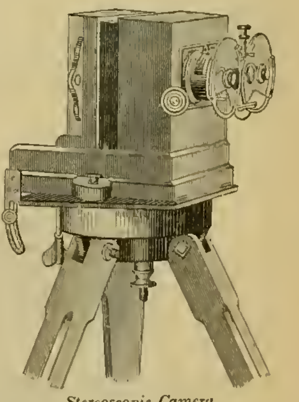


Bellows-Camera.

The plate-holder portion has also a rocking adjustment, so as to allow the face of the plate to be brought parallel with the general plane of the object being copied. The great advantage of the bellows is the compactness of the device for transportation when collapsed The bed portion is hinged so as to be doubled up.

Fig. 3674 is a stereoscopic camera used for field work especially, having an arrangement for instantaneous exposure of the two lenses, which admit pencils of beams to the plates in the binary chamber. Shutters are placed in front of each tube, so arranged that, by the touching of a spring, they are simultaneously rotated, bringing for an instant of time a hole in each shutter in correspondence with the tube, admitting rays of light from the object to the sensitized surfaces in the interior.

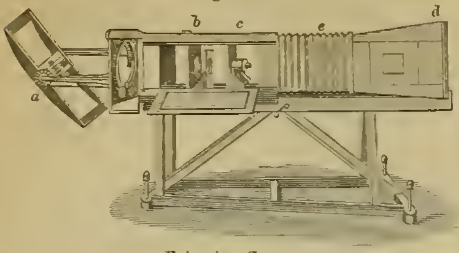
Fig 3674.



Stereoscopic Camera.

Fig. 3675 is a form of copying and enlarging camera having a reflector *a* for directing the rays into the interior, which is shown exposed by letting down the door forming a portion of the side. *b* is the position of the negative; *c*, of the lens; *d*, of the sensitized paper on which the positive enlarged print is obtained. The negative and lens are adjustable by sliding in the chamber: the paper-holder by the bellows *e*.

Fig. 3675.



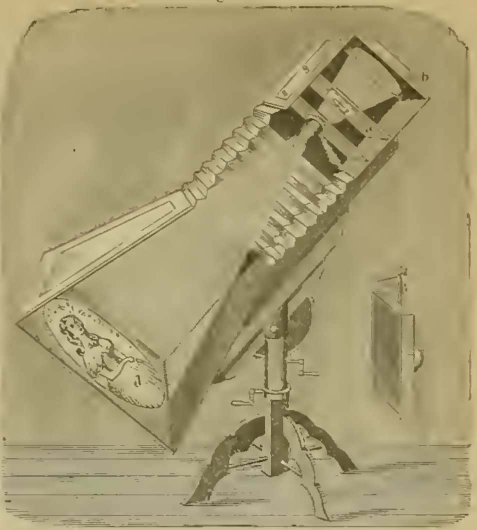
Enlarging-Camera.

Fig. 3676 is a view of a solar camera for enlarging by sunlight *a* is the adjustable partition having a central aperture at which the negative is exposed to the rays entering at the window *b*. *c* is the lens; *d*, the board for the paper enlargement.

J. W. Osborne's copying-camera and table is unique in the respect that it combines the camera and its support by a rigid and permanent connection with the *plan-board*, upon which the object to be copied is exposed The whole apparatus is portable, and in use is adjustable on casters for horizontal direction, and by a rapid screw for inclination, so as to give the required presentation of the plan-board in order that it may take the light from the sky, and not from secondary, and usually vertical, reflecting surfaces.

Fig. 3677 shows the instrument as seen obliquely from the back of the plan-board, in its tilted position. The table *a* consists of a truss-frame, hinged upon the ridge of a truck *b*, to which the casters are attached. In use, the casters are lifted from the floor, throwing the weight of the truck upon rubber blocks *d d*, 10 or 12 inches high, the object of which is to cut off vibration. This is done by moving a handle *c* and ratchet, which by means of an endless chain act upon all the casters at once, either in raising or lowering. The truck also carries the step of the double-threaded screw, used for tilting the table. The screw passes through an oscillating nut in the table.

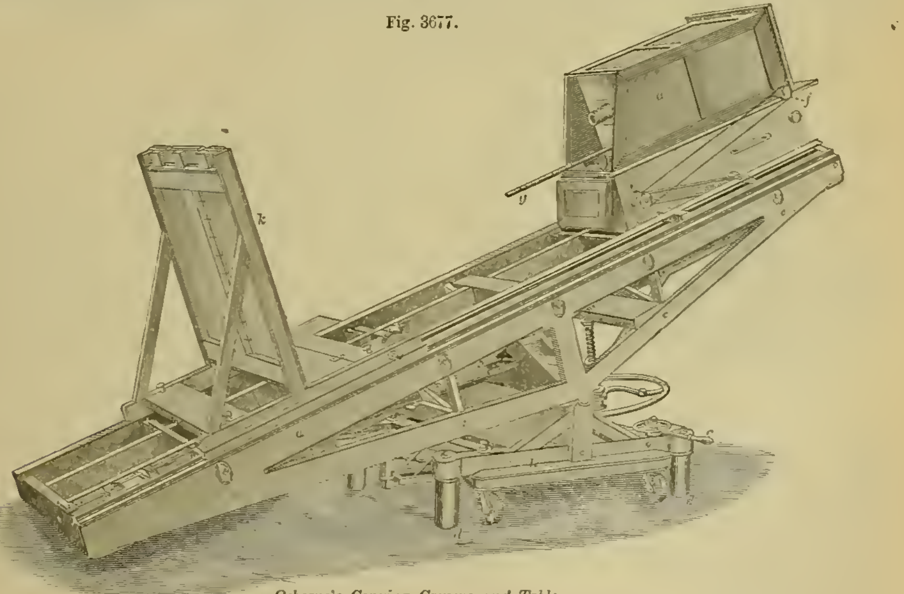
Fig. 3676.



Solar Camera.

The camera *e* rests upon a hollow block, which raises its axis to a convenient hight as regards the plan-board. Unlike ordinary cameras, it consists of a single trunk permanently attached to its place at the end of the table. The back part of this *camera-box* has a rabbet to receive the *focusing-screen*, and afterward the *dark-slide*, or *plate-holder*. The other end is cut to a bevel, and has a double-flap door hinged to its lower edge, for the purpose of shutting off the light until all is ready for the exposure of the sensitized plate. The bevel at the end stands nearly perpendicular when the camera is tilted. Inside the camera-box is a sliding *lens-holder*, moving on V's for adjustment. The joint is made *light tight*, without occasioning friction, by a broad strip of soft fur. let into a shallow rabbet around the lens-holder. The fur extends against the sides of the camera-box and perfectly excludes the light, leaving sufficient clearance The motion is effected by an endless steel belt passing over small metallic pulleys at either end of the trunk, and controlled by outside milled heads *f* on a shaft passing through the pulley and across the box, conveniently presented to the operator. This original method of focusing by thin metallic belts has the advantage of affording a means for rapid and positive movement, being free from back-lash and yet having great delicacy. It affords a means for rapid adjustment on either side of the problematical focus, enabling the eye to use its

Fig. 3677.



Osborne's Copying-Camera and Table.

power of comparison under the most favorable circumstances. The measuring-rod *g* is attached temporarily to the lens-holder and slides through a notched disk also removable; its object is to indicate the position of the lens-holder or restore it to an old position. The rod and disk are removed while the negative is being made. The pulley *i* and belt afford a means of adjusting the position of the lens while watching the graduated rod

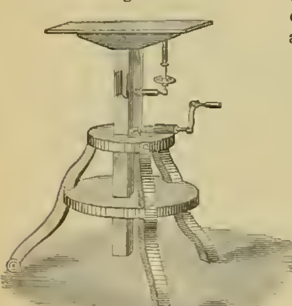
The plan-board *k* stands at right angles to the plane of the table, is adjustable longitudinally on the same, and can be firmly clamped in any position. The adjustment is by a steel belt passing over pulleys at both extremities of the table; the pulley at the camera end being provided with a horizontal capstan arrangement and lever, so that the position of the plan-board is under the control of the operator while inspecting the focusing on the ground-glass screen. The position of the plan-board on the table is indicated by a pointer traveling along a graduated scale. The plan-board consists of a number of narrow slats fitting into rabbets on the inner edge of its frame, each slat being held in its position by a single screw in its center passing into the middle back-bar of the frame; any warp occurring is therefore in detail, and does not affect the general plane.

The table is always brought to a horizontal position in focusing, the end of the camera-box being covered by a hood under which the operator stands. So placed, he controls both the positions of the plan-board and the lens, and has the ground glass always at a constant distance from him. In copying at or near full scale, the position of the lens affects the size of the picture, making little change in the sharpness of the focus, which latter operation is then done with the plan-board. When a large reduction is required, the position of the plan-board affects the size, and the focusing is done with the lens. It will be observed, that the lens is placed far back in the box, never advancing to its end save for enlargements; it follows, therefore, that for the great mass of work required, the accidental rays, which might otherwise fall upon the lens, are excluded. This object is farther accomplished by a rectangular diaphragm, falling into the bevel end of the box behind the door when the latter is closed.

The construction of an instrument of this kind must be very exact, so as to maintain the parallelism of the plan-board, the lens-board, and the ground-glass screen in all positions of the table. The first instrument of the kind was constructed by Mr. Osborne in 1866, for the American Photolithographic Company, at their works in Brooklyn, N. Y. The length of the table is 14 feet; width, 4 feet; plan-board, 4 × 5 feet.

Pho-to-graph'ic Cam'e-ra-stand. (*Photography.*) A table to support a camera, having adjustments for hight and inclination, and obtaining its lateral adjustments by moving about with facility upon casters.

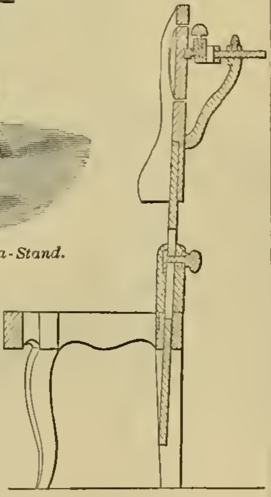
Fig. 3678.



Photographic Camera-Stand.

Pho-to-graph'ic Chair. (*Photography.*) A chair arranged for posing a sitter. The example shows a back vertically adjustable, and a head-rest which works through an opening in the chair-back.

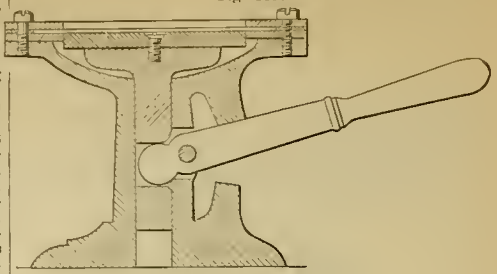
Fig. 3679.



Photographic Chair.

Pho-to-graph'ic Cut'ter. (*Photography.*) An instrument for cutting the margins of photographic prints. It is a substitute for trimming-scissors. The example consists of a die-punch worked by a lever from below two metallic plates, perforated in the form required for the photograph, which is placed between the plates with the face upward.

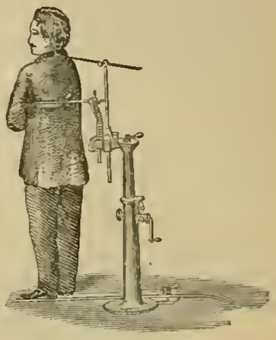
Fig. 3680.



Photographic Print-Cutter.

Pho-to-graph'ic Head-rest. (*Photography.*) A frame with adjustable and extensible rods for the support of the head, arms, or other parts of the person, to hold them rigid during operations.

Fig. 3681.



Photographic Head-Rest.

Pho-to-graph'ic Mi-crom'e-ter. A system of opaque or transparent lines photographically reduced from a series of large and well-defined lines impressed mechanically or otherwise upon the object from which the photograph is taken, and placed in the focus of the eye-glass of a telescope or micrometer.

Pho-to-graph'ic Print'ing. (*Photography.*) The process of obtaining positives on sensitized paper from transparent negatives by exposure to light in a printing-frame.

Paper treated with certain salts of silver darkens on exposure to light. If certain parts of such paper are shielded or screened from the light, these parts will remain white, and the remainder will darken and form a picture. This, by protecting certain parts and allowing light to act on others, is what the photographic negative does. When the picture has been thus formed, it requires to be *fixed*, to prevent the farther action of light. See PHOTOGRAPHY; PRINTING-FRAME; SILVER-PRINTING.

Pho-tog'ra-phom'e-ter. An instrument for determining the sensibility of each tablet employed in the photographic process, in respect to the amount of luminous and chemical radiation.

Pho-tog'ra-phy The art of producing pictures of natural scenes and objects, or of copying delineations and multiplying them, by the agency of light.

Photography depends upon the chemical or molecular changes which the rays of light effect or excite in certain substances. It is now known that a great number of bodies are *photo-chemically sensitive* in a greater or less degree, but some of the salts of *silver*, and of *chromic acid* in conjunction with organic matter, are preëminently so, and are used practically to the exclusion of all others.

The fact was noticed by the alchemists, that *horn silver* (fused chloride of silver) suffered discoloration by exposure to the sun's rays; but the Pomeranian chemist, Sheele, in 1777, was the first to consider philosophically the *action of sunlight upon certain compounds of silver*, and especially to draw attention to the activity of the *violet and blue rays* as compared with the rest of the spectrum.

Ritter, in 1801, proved the existence of *dark rays* beyond *the violet end of the visible spectrum*, by the power they possessed of blackening chloride or silver

Wollaston also published some experiments on the changes which light produced in *gum-guaiacum*, corroborating Ritter's views as to the activity of invisible rays.

Wedgwood, the great potter, was the first person who made any attempt to use sunlight for *copying or delineating objects*. In 1802 he contributed a paper to the Journal of the Royal Institution of England, entitled "An Account of a Method of copying Paintings upon Glass, and of making Profiles by the Agency of Light upon Nitrate of Silver; with Observations by H Davy." He used white paper or white leather moistened with a solution of nitrate of silver, dried, and kept in a dark place. This, on being exposed to light, passed through different shades of gray and brown and became at length nearly black. When the shadow of any figure is thrown upon such prepared surface, it remains white while the exposed parts become dark, therefore a painting upon glass or an engraving used as a screen above such prepared paper or leather gave a copy the reverse of the superimposed design as regards light and shade.

The images given by the camera-obscura Davy found to be too faint to produce an effect upon paper prepared with nitrate of silver, but the *solar microscope* was used with success. All the pictures made in this way had to be carefully preserved from daylight, or the whole surface would blacken, as a necessary consequence, and neither Wedgwood nor Davy ever overcame this difficulty, or found means to *fix* such photographs and render them permanent. To Wedgwood, however, must be accorded the honor of having been the first to produce a *photograph*, in the artistic and technical sense of the word.

Dr. Thomas Young, the originator of the undulatory theory of light, published in 1804 some important researches on the chemical rays.

In 1809, Gay Lussac and Thénard made the exceedingly valuable observation, that a mixture of *chlorine and hydrogen did not combine in the dark*, whereas in diffused daylight they did so rapidly, and in sunlight with explosion.

Bérard, in 1812, made a comprehensive and valuable series of investigations, which was reported on by Berthollet, Chaptal, and Biot, acting as a commission. By them the solar emanations were first regarded as consisting of *calorific, colorific, and chemical rays*.

In 1814, Joseph Nicephore Niepce, of Chalon on the Saone, directed his attention to the production of *permanent pictures* by light. He experimented privately for many years, and in 1827 presented a paper to the Royal Society of London on the subject of his invention; but as he kept his method secret, it could not, according to their laws, be received.

Niepce called his process *Heliography*, and some specimens of his art on plated copper and pewter plates are still preserved in the British Museum.

The sensitive substance with which Niepce worked was *asphaltum*, also called bitumen of Judæa, the remarkable properties of which he appears to have discovered. He proceeded by preparing a solution of the mineral pitch in essential oil of lavender; with this he coated a plate of metal or glass, and when the varnish so applied was dry, he exposed it under an engraving or in the camera-obscura. The action of sunlight for many hours was necessary before the latent image was fit for *development*, to accomplish which he used a solvent (consisting of *oil of lavender* and naphtha) for the unsunned portions of the coating

By treatment with this menstruum, the picture made its appearance, the insoluble portions of the bitumen representing the lights, and the surface of the plate the shadows of the design. A final washing with water was used to remove the traces of the solvent which covered the plate.

The work of this experimenter, judged by our present standards, was doubtless crude, but it is probable that the results he really aimed at were not limited to the making of photographs alone, but extended to the production of *engraved* or *etched plates for printing purposes*, an endeavor which justified him in continuing the use of asphaltum. It is also worthy of remark, that his discoveries formed the basis of a long series of trials in the direction of *photo-engraving* by his nephew Niepce de St. Victor and others, at a comparatively recent period: and of the earliest *photolithographic process*, in 1852, that of Lemercier, Barreswill, and Lerebours, working conjointly. From another point of view, we are justified in according him a high place as a pioneer, because his pictures might well be regarded as *carbon prints* in chemical composition, and as certainly permanent; excelling, in this respect, ordinary photographs, and ranking with the finest developments of the photographic art of the present day. No other attempt at the reproduction of carbon prints was made for thirty-five years after his time.

In 1829, M. Niepce associated himself with M. Daguerre, and no doubt contributed much to the latter's beautiful process.

In the year 1834, Mr. Fox Talbot began the investigations which finally resulted in a valuable working process. On the 31st January, 1839, six months prior to the publication of M. Daguerre's process, Mr. Fox Talbot communicated his photographic discoveries, and in the following February he published a description of his method, to which, as afterwards perfected, he gave the name of *calotype*. He prepared a sheet of paper with *iodide of silver*, by treating it alternately with solutions of *nitrate of silver* and *iodide of potassium*. When dry, and just before use, he covered the surface with a solution of *nitrate of silver* and *gallic acid*, and dried it again, by which means he greatly enhanced its sensitiveness. A very brief exposure of paper so prepared to light produced an effect which, though latent and imperceptible to the eye, was yet susceptible of development by a reapplication of the *gallo-nitrate of silver* to the surface of the sheet. When the picture produced in the camera or under a drawing or engraving was thus *developed*, it was washed with a solution of *bromide of potassium*, the effect of which was to stop all farther change due to light. It was then washed in water and dried.

A *photograph* so obtained was necessarily a *negative*, but Mr. Talbot recognized the important fact that, by the simple exposure of his calotype paper under such a negative and its subsequent development, any number of *positive* prints could be produced.

To Mr Talbot we are therefore indebted for a method of arresting photographic action and *fixing* the image; for the conception and production of a *negative*, and the subsequent *printing* of positive prints by light; and, above all, for the discovery of the wonderful *development* of the latent image by *gallic acid*.

His process, as above given, was greatly improved by himself and others, but our space does not permit of details.

In January, 1839, the announcement of Daguerre's invention was made to the world, but no description was given until the July following, when a bill was passed in the French legislature giving him a pension of 6,000 francs, and 4,000 francs to Isidore Niepce, the son of M. Joseph Nicephore Niepce, above mentioned.

The pictures were produced on *silver plates* or upon sheet-copper plated with silver. The surface was first cleaned and polished with great care; it was then exposed to the fumes of dry *iodine* until a film of *iodide of silver* was produced upon its face. When the proper amount of iodization was obtained, known by the color, the plate was transferred in a suitable dark slide to the camera-obscura, and there exposed in the focus of the instrument to the luminous emanations passing from external objects through the lens. After a sufficient time the plate was carried back to a darkened room, and there exposed in a box of suitable construction to the *fumes of mercury*, evaporating at a low temperature, from 140° to 170° Fah. This treatment gave rise to the gradual development of a picture, the vapor attaching itself to the exposed parts of the iodide of silver in quantities proportional to the actinic action.

The picture on the plate is now to be *fixed* by immersing it in a solution of *common salt*, or, better, in one of *hyposulphite of soda* which dissolves the unchanged iodide of silver and destroys the sensitiveness of the surface to light. The plate, after being washed and dried, is finished, but it must be covered with glass to prevent its injury by friction. The shadows of the picture so produced are formed by the highly polished silver surface, and the lights by the deposit of mercurial vapor.

Such is the *daguerreotype* in its simplest form.

It is impossible to praise too highly this beautiful and wonderful process, or the intelligence and perseverance of its inventor. Many improvements and additions were soon made, which greatly increased its practical value. These consisted in the use of *bromine vapor* conjointly with that of *iodine* in *sensitizing* the plates by Goddard, in 1839; and in the addition of *chlorine* by Claudet, in 1840: the object in both cases being to shorten the time of exposure. The success which followed these and other improvements in the art, as well as in the construction of cameras and lenses, caused the daguerreotype process to become immensely valuable in portraiture, enabling it to hold its ground in every country until displaced by collodion, about 1852 or 1853. M. Fizeau, by the application of a *solution of gold* to the fixed daguerreotype plate, rendered important service. Not only were the results greatly improved in appearance, and as works of art gaining much in brilliancy and force, but their permanency was also assured, the metallic gold replacing the finely divided mercury in part and combining with it, so that its dissipation was no longer an evil to be dreaded.

Mungo Ponton, in April, 1839, published his discovery that paper prepared with a solution of *bichromate of potash*, and dried, was sensitive to light. Without ignoring the presence of the paper, he believed that this was true of the salt itself, but Becquerel showed in 1840 that *organic matter* must be present and in intimate association with the *chromic salt*. Mungo Ponton, in his contribution to the Scottish Society of Arts, must be regarded as having laid the foundation of some of the most important photographic developments of the present day, — *photolithography*, *carbon-printing*, *collography*, and *photo-mechanical printing* generally; but in this connection it must be stated that Mungo Ponton often gets credit for more than he actually did, partly from the fact that his original article is but little known. Fox Talbot, in 1852, first made the attempt to turn his and Becquerel's investigations to practical account, in his own *photo-engraving process*.

For landscape purposes the *calotype* gave valuable results in the hands of amateurs, and it finally took its highest development in the *wax-paper processes* of Le Gray and Fenton; but until glass was used as a support for negative pictures, the business of the professional landscape photographer was a poor one.

In 1848, M. Niepce de St. Victor proposed the use of *albumen on glass* as a vehicle for sensitive salts of silver, and published his method. The value of this idea was quickly recognized, and the process improved by others. Its success depended in great measure on the fact that albumen is coagulated and rendered insoluble by the nitrate of silver used to sensitize it, and that it dries finally to a very hard and transparent film, furnishing a negative from which positive photographs can be rapidly printed by light A consequence of this improvement was the rapid development of all *positive-printing methods* on paper.

In the brilliant series of discoveries and inventions which distinguish the history of photography, perhaps the most important in its effects was the introduction of *collodion*, which took place in 1850. To Mr. Scott Archer of London is due the credit of the *negative-collodion process*, which has made photography the most important art-industry of the world. In justice to M. le Gray, it should be added that he had previously suggested collodion as likely to be of service in photography. In the autumn of 1851, Mr. Archer published a full description of his process, which did not differ essentially from that now practiced.

Collodion is a viscid solution of gun-cotton in a mixture of alcohol and ether. It flows easily on the surface of a glass plate, and *sets* quickly to a gelatinous film, which then dries to a hard, transparent, and insoluble skin, adhering closely to the glass. In addition to its physical characteristics, collodion is well adapted for photographic negatives because of its indifference, chemically speaking, to the sensitive salts, acting only as a medium or vehicle for their successful exposure under favorable circumstances and subsequent treatment Without going into the broad subject of *collodion photography*, a short sketch of its leading features is here given as at present practiced.

A sheet of *glass* of size suitable for the *negative* to be made is thoroughly cleaned by friction with alcohol and rotten-stone, or in some other efficient way. The operator lays hold of the plate, holding it in a horizontal position, and then pours steadily a quantity of *sensitized collodion* upon its upper surface; he then causes the liquid to travel successively from corner to corner of the plate without letting it pass the edge, and pours the excess off into another bottle. The plate, in its upright position, is rocked gently to and fro, so as to equalize any ridges or inequalities otherwise likely to form. By this time the collodion will have *set*, forming a gelatinous film, evenly covering the glass When the plate is thus *coated*, it is *sensitized* by being plunged into an upright bath containing a *solution of nitrate of silver*.

The collodion used for this operation is, as above stated a solution of gun-cotton, but it contains, in addition, certain iodides and bromides of the metals, most usually of potassium, ammonium, and cadmium, but many others are used. The changes which now take place in the gelatinous film of collodion immersed in the negative bath will be easily understood; *metallic silver* takes the place of the alkaline or other metals in the film, and forms there *insoluble bromide* and *iodide of silver*. The coating upon the plate, which was transparent when it entered the bath, is now milky, entangling in its substance the two haloid salts above mentioned.

The plate is next to be lifted from the bath (the room being darkened), drained for a few moments, inclosed in a *plate-holder*, carried to the *camera*, and exposed before the scene or model to be photographed. During this operation, the sensitive coating receives the rays of light forming the picture, as they fall upon the *ground-glass screen* used in *focusing*.

They effect there a mysterious change, the exact nature of which, whether chemical or physical, is still a disputed question among the highest authorities.

The plate having been exposed to the *actinic action* is now carried in the closed plate-holder back to the darkened room, illuminated by yellow non-actinic light only. The most careful examination of the surface will be found to show no trace of alteration, but a change has nevertheless been produced. If we pour over the surface an aqueous solution of a *salt of iron* (generally the protosulphate), to which a quantity of *acetic acid* has been added, the picture gradually undergoes development, a dark deposit forming upon all those places where the light has acted, the density of which is directly proportional to the energy of the chemical rays. To explain this beautiful phenomenon, we must remember that the collodion has brought with it from the negative bath, not only the sensitive salts of silver, but also a quantity of the nitrate solution adhering to and permeating the film In the silver solution, the protosalts of iron, even in the presence of acetic acid, which acts as a retarder, would, in the course of time, cause a deposit of metallic silver in a finely divided state. It is such a deposit which forms the negative picture upon the exposed plate when flooded with the developer, as above described; but the change produced by exposure gives to the sensitive salts the remarkable power of determining the comparatively rapid precipitation of the finely divided metallic silver upon them, in proportion to the change they have undergone. Were the free nitrate of silver washed thoroughly from the plate before exposure, the solution of iron would fail to produce a picture thereon It will be seen, therefore, that the sensitive haloid salts do not themselves participate in the formation of the photographic image.

When sufficiently *developed*, the farther action of the solution is stopped by profuse washing of the plate with water. It is then to be fixed by flowing over it a solvent of the silver salts, a solution of *cyanide of potassium*, or of *hyposulphite of soda*; this removes the milky character of the deposit which the film received in the negative bath, leaving the picture to all appearance as though it rested upon bare glass.

The plate is now to be thoroughly washed, drained, dried, and varnished with one of the many resinous solutions manufactured for that purpose, after which it is ready for the printer.

In the foregoing description many possible and frequently used modifications have been disregarded, as tending to confuse the reader's comprehension of the phenomena, but it is necessary to mention that protosulphate of iron is not the only substance which will act as a developing agent. Notably, pyrogallic acid, which first succeeded the use of gallic acid, as discovered by Fox Talbot, held for many years the first place in the estimation of photographers for this purpose. The use of proto-iron salts was originally recommended by Robert Hunt, in 1844, and is now universal. The use of acetic acid in the developer is to retard the too rapid precipitation of the metallic silver from the mixture of developer and nitrate on the plate; but many other substances, most of them organic, can be and are employed.

To produce *positive photographic prints* from such a *negative*, the following is the method used: A sheet of paper is coated upon one side with *albumen* containing common *salt*, chloride of ammonium, or some other soluble chloride in solution. When dry, this sheet is floated, face downward, upon a solution of *nitrate of silver* contained in a shallow glass or porcelain tray. The action of the solution is twofold: it coagulates the albumen, rendering it insoluble, and decomposes the chloride contained in the same, replacing the alkaline metal with silver, thereby forming sensitive chloride of silver on the paper and nitrate of the alkaline metal in the bath. The sheet is now lifted from the liquid and dried

A suitable piece of paper so prepared is now to be exposed under and in close contact with the finished negative. This is accomplished by pressing them together in a frame made for the purpose. (See PRINTING-FRAME.) The light passes through the negative in quantity depending on the transparency of its several parts, and produces a darkening of the silver salt in the albuminous surface proportional to its intensity. When sufficiently exposed, the color of the paper will be dark reddish-brown, almost black in the deepest shadows.

This sheet of paper is now to be taken from the printing-frame and washed in water to remove the free nitrate, after which it is subjected to the operation of *toning*. For this purpose it is immersed in a very weak solution of a *salt of gold*, the action of which is modified by an admixture of carbonate, phosphate, or acetate of soda, etc. The gold from this solution, which decomposes gradually, is taken up by the photographic image, substituting metallic gold for the metallic silver, forming the picture in the first instance. The consequence is that we obtain a much more pleasing result, and one which is, at the same time, more permanent

As in the case of the negative, this sheet has now to be *fixed* by immersing it in a solution of hyposulphite of soda, which, by its solvent action, removes all unaltered chloride of silver from the albuminous surface.

This finished print is to be long and thoroughly washed in an abundance of pure water, then to be dried, mounted, and glazed or burnished in a suitable press.

It will be observed in the foregoing description, that no developer is required to produce the image (as in the case of the negative), the explanation of which is that chloride of silver in the presence of an excess of nitrate of silver is directly decomposed by the actinic rays, the nature of its sensitiveness being essentially different from that of the analogous iodine and bromine compounds.

In concluding this sketch of the positive printing process, it is well to remark that the coating of albumen, the chief object of which is to give structureless surface to the paper, is by no means essential, inasmuch as all the foregoing operations can be equally well performed on plain paper.

The *negative collodion process*, with its necessary supplement, the printing of positives on paper by direct sunlight, caused a rapid and thorough change in landscape photography, the natural result of the excellence of the work produced and the great facilities offered for its rapid and cheap multiplication. In portraiture, it was not so. Some time elapsed before it was possible to obtain portrait negatives with a sufficiently short exposure and of such quality as to enable them to compare favorably with the best daguerreotypes. Pending the elaboration of the negative process, the *ambrotype*, or *collodion positive*, as it was called in England, became popular and held its place for several years.

An *ambrotype* is simply a thin collodion negative on glass made with a short exposure and developed so as to produce as white a deposit as possible on the lights. Such a picture is not looked at by transmitted light, nor is it valuable as a negative; it is to be backed up with a black surface, generally a black varnish, and regarded by reflected light only. Under these circumstances it appears as a positive, the deposit reflecting and the black backing absorbing the light. Pictures of this kind are rapidly made, and finished directly from the camera, as is the case with the daguerreotype, while the cost is very much less. They are, however, very inferior to good positives on paper, and had to make way for the latter as the negative process improved.

At the present day ambrotypes are rarely to be met with, but *ferrotypes*, or *tintypes*, as they are sometimes called, are produced by a perfectly analogous process, the substantial difference being that the collodion picture is made directly upon a thin iron plate covered with a black enamel or lacquer, which protects both its surfaces from the action of the negative bath and acts the part of the black backing used in the ambrotype.

Ferrotypes are still in vogue, the quickness with which they can be produced and their exceedingly small cost making them popular with the public. Cameras provided with a large number of lenses are employed in their production.

The trouble and difficulty in the efficient working of collodion negatives out of doors created a desire for a means of preserving a collodion plate in a sensitive condition, so as to render it unnecessary to coat, sensitize, and develop the plate where the landscape is taken. Accordingly, a number of preservative and dry-plate processes have been invented. In the first class, the endeavor was to cover the wet collodion with some deliquescent substance, such as nitrate of magnesia, glycerine, etc. Such processes are troublesome and unsatisfactory, and in their turn gave way to dry-plate photography. A great many inventors have devoted much labor to this department of photography. Fothergill, Taupenot, Russell, and Wortley have all produced valuable processes, but the details are too technical and elaborate for introduction here. No dry process gives results fully equal in quality to the work from wet plates, but they offer other advantages which cannot be ignored.

As substantially different methods, by which both negatives and positives can be made, the *collodio-bromide* process by B. J. Sayce, September, 1864, and the *collodio-chloride* process by G Wharton Simpson, about the same time, deserve mention. Sayce's was a negative process on glass: Simpson's, a positive process. Each produces an emulsion of the sensitive salts of silver in collodion, an excess of nitrate of silver being also present. A surface flooded with collodion so constituted is sensitive without a bath, and may be either exposed in the camera or printed upon with a negative. The fundamental distinction is indicated by the respective names, one using the chloride and the other the bromide of silver.

Simpson's process is much used in the production of the so-called porcelain pictures.

Notwithstanding the exquisite beauty of ordinary photographs on paper, they are subject to a reproach which takes immensely from their value as works of art, for they contain within themselves the elements of destruction, and cannot be regarded as permanent. To overcome this difficulty, efforts have been made for the last twenty years to substitute carbon and other pigments for the fugitive tints of the photograph The first to experiment in this direction was M. Poitevin of Paris, in 1855. He used a mixture of *bichromate of potash with organic matter*, such as gum, gelatine, etc., coloring it with *lampblack* or other indestructible pigment. A paper coated with this mixture and dried suffered under a negative a change, the nature of which was to render the organic matter insoluble on the places affected by light. A subsequent washing removed the unchanged gum or gelatine from the surface, leaving more or less intact those parts of the coating on which the light had acted and rendered it insoluble, and with it the coloring matter which had been employed.

M. Poitevin patented another *carbon* process at the same time in England, which differed from the foregoing, inasmuch as a greasy printing-ink was used to furnish the color. This was applied as a lithographer or printer applies his ink to the exposed organic surface; and its retention, more or less perfectly by the design, depended upon the peculiar property which such altered organic matter possesses (for the elaboration of which we are indebted to this investigator) of *attracting and holding greasy substances* and repelling water See PHOTOLITHOGRAPHY.

Mr. Joseph Dixon published this fact in April, 1854, and to him is due the credit of priority, but Poitevin first gave it vitality and practical importance.

Many experimenters followed M Poitevin. The most marked improvement on his crude and unsatisfactory methods was practically made by M. Fargier, who *exposed from the back of the film*, and not from the face, as Poitevin did. He acted on suggestions made by Mr. Blair and others, who pointed out the fact that the depth to which the change to insolubility penetrated into a film or coating sensitized with bichromate depended upon the intensity of the actinic action, and when such change was superficial only, as it must be for the lighter shadows of a photograph, a subsequent washing from the face will inevitably undermine and destroy them.

Mr. Swan of Newcastle-on-Tyne made very valuable changes and improvements in M. Fargier's method, which latter, while it gave good results, was uncertain and difficult to work. Swan was, in fact, the *first to produce a carbon process* practical and admirable in all respects, which has been and is still largely used, furnishing results which fully equal and in many respects surpass the best silver prints. See CARBON PRINTING; GELATINE PROCESS.

He prepared a *sheet of paper with a coating of gelatine and carbonaceous matter* on its surface; a suitable piece of this was immersed in a solution of *bichromate of potash* and dried, by which it was rendered sensitive After exposure, this sheet was mounted with a caoutchouc varnish, face down upon another piece of paper acting as a temporary support; the whole was then immersed in warm water, whereupon the original sheet carrying the pigmented film became detached and floated off, while the gelatine dissolved away gradually from the now exposed surface, leaving eventually the organic matter attached to the second sheet in thickness proportional to the depth to which the light had penetrated the film. It will be seen that the tint, depending on the carbon imprisoned in the altered organic matter, will also be proportional to the intensity of the light passing through the different parts of the negative, and that the finer shades will not suffer destruction as they did in Poitevin's method.

When the warm water had thoroughly developed the picture it was dried, trimmed, and again transferred by pasting it to the *mount* where it was intended to remain, the sheet employed as a temporary support being easily disengaged from the face by the application of a little benzole.

More recently (in 1870), J. B. Johnson made some useful modifications in Swan's method of working, establishing what is known as the *autotype* process.

Another photographic process, quite as distinct in its character as *carbon printing*, but comparatively of little general interest, is known as *aniline printing*, invented by Mr Willis, England, in 1865. This method is designed for copying tracings or drawings, chiefly the former, and reproducing a few copies without alteration in scale and at little cost. Willis dispenses with the camera, glass plates, collodion, nitrate bath, etc., using only a large printing-frame. The tracing itself is used as a screen or *cliché*, under which to expose the prepared paper. The latter is placed in the printing-frame, not in contact with the drawn surface, but with the back of the traced sheet, through which the light has to pass, so as to avoid the reversing of the print This is an expedient which necessarily takes materially from the sharpness of the result. Such a process, so restricted in its scope, would hardly deserve mention were it not that the chemical reactions involved are peculiar in their application to photography.

Mr. Willis sensitizes one surface of his sheet with bichromate of ammonia, adding also other non-essential chemicals to exert an influence on the tone of the resulting picture. After being dried in the dark, the coated paper is exposed for a short time under a positive, after which the sheet is subjected in a closed tray to the fumes of aniline diluted with benzole

The second equivalent of chromic acid in the bichromate of ammonia still existing in those parts of the coated surface undecomposed by light, reacts upon the aniline and gives rise to a dark purple-black color, which is very permanent.

It is obvious that the whole sheet would blacken in the aniline vapor, but for the exposure under the tracing, and that the action of the actinic influence is to decompose the bichromate on the parts of the sheet corresponding to the whites of the drawing, and incapacitate them for oxidizing the aniline, and thereby producing the color required to form the visible picture A simple washing in water is all that is necessary to fix and clear up such reproductions. Aniline prints have a general greenish tinge over their whole surface, due to the presence of sesquioxide of chromium, resulting from the decomposition of the chromic acid

In recording distinctive processes, reference should also be made to the efforts of Becquerel and Niepce de St. Victor to produce photographic pictures in color. Their labors in this direction have been considerable, with but meager results, which can hardly be said to have gone beyond a demonstration of the possibility of getting fugitive reproductions of certain colors on peculiarly prepared surfaces. A sub haloid salt of silver is generally regarded as the sensitive substance required in their experiments.

In addition to the foregoing might be enumerated many mechanical printing processes depending, in their initial stages, on photographic methods. These, however, have arrived at such importance at the present day as to exclude their consideration from the general subject, and they must be sought under their respective heads. See PHOTOLITHOGRAPHY; PHOTO-ENGRAVING; PHOTO-MECHANICAL PRINTING; PHOTO-RELIEF, etc.

In a dictionary devoted to mechanical devices and processes, it would be out of place to expatiate at length on chemical phenomena incidental to the use of apparatus Purely theoretical considerations, therefore, connected with photography have been ignored in the foregoing article, and the labors of Sir John Herschel, Robert Hunt, and others, in the early days of photography, and of such men as G. Wharton Simpson, Hermann Vagel, and M. Carey Lea have not been given the prominence they deserve and should have had in an exhaustive treatise.

Without, however, going into theory, the attention of the reader seeking general information should be directed to the marked differences which manifest themselves in the nature of the sensitiveness of chemical compounds. In one class, the actinic rays have power to effect at once a complete change. This is true of the mixture of chlorine and hydrogen; of the bichromates in the presence of organic matter; of asphaltum; and of chloride of silver, when substances are present (as free nitrate) capable of combining with the liberated chlorine.

To a second class belong the iodide and bromide of silver. The action of light upon them appears to be a sort of polarization, for want of a better word; an incipient molecular change, by virtue of which the particles affected are enabled to determine and accelerate the precipitation of certain bodies (metallic silver and metallic mercury) when offered in an extremely divided state, and to do this with an energy proportional to the intensity of the luminous action or its duration. The daguerreotype and the negative-collodion process illustrate this phenomenon. The production of the picture in both cases is by true *development*, — a term often used, but not applicable in its proper and restricted sense to the bringing out of the picture after the exposure of an asphaltum surface, or of a piece of sensitized carbon tissue. A simple solvent acts in both these cases as the agent for *removing* the unaffected parts. (*Contributed to this work by* Mr. J. W. OSBORNE, *late of Melbourne, Australia, and now of Washington, D. C.*)

The first daguerreotype portrait from life was taken by Professor John W. Draper, in 1839 An announcement was made of it in the "London and Edinburgh Philosophical Magazine," in March, 1840. A full account of the operation was subsequently published in the same journal. The first daguerreotype view taken in America was by Professor John W. Draper, and was a view of the Church of the Messiah, taken from a window of the New York City University. Professor Morse learned the art in Professor Draper's laboratory.

Daguerre made an unsuccessful attempt to photograph the moon. Dr J. W. Draper of New York succeeded, in 1840, in obtaining a photograph of the moon on silver plates with a telescope of five inches aperture He presented specimens to the New York Lyceum of Natural History in 1840. Professor G. P. Bond of Cambridge, United States, made photographs of the moon, in 1850, with the Cambridge refractor of fifteen inches aperture. Many others followed. Mr Rutherford's photographs of the moon are most excellent. Mr. De la Rue, in England, must also be mentioned.

Mr. Rutherford of New York City has been, for some time, photographing groups of stars, by which their positions are exactly recorded, without the error of personal equation. The groups of stars are photographed twice a year, six months apart. The telescope takes directly a field of about two degrees. Some of the groups contain as many as 125 stars, down to the ninth magnitude, taken upon a plate 5½ inches square. A star suspected of proper motion is placed in the center of the plate. The plate is exposed six minutes, and then the telescope is moved slightly, relatively to the object, by stopping the clock. The plate is then exposed six minutes longer, duplicating all the stars upon the same plate, so as to identify them from other spots upon the plate, and verify their positions. With the micrometer, each star is determined in position by its distance from the central star, and by the angle of the line from it to the central star with the east and west line. In order to get rid of any constant error from the direction of the telescope, stars are taken first on one side of the pier and then, when the stars are in a different position, with the telescope upon the other side of the pier. By repeating the groups six months apart, he hopes, by and by, to ascertain the amount of parallax of some of them. An absolute map of these groups for future use is thus obtained. See under the following heads: —

Actinometer.
Albertype.
Albumentype.
Ambrotype.
Amphitype.
Asphaltotype.
Aurotype.
Authotype.
Autotype.
Calotype
Cameotype.
Camera.
Carbon-printing.
Catalysotype.
Chemitype.
Chromatype.
Chronotype.
Chrisotype.
Chrystallotype.
Collodio-chloride process.
Collodiotype.
Crossed lens.
Cyanotype.
Daguerreotype.
Developing.
Diaphanoscope.
Diaphanotype.
Diaphragm.
Dipper.
Duplex type.
Dynactinometer.
Elliotype.
Emolliotype.
Enameled photograph.
Energiotype.
Etching.
Ferrotype.
Fixing.
Fluorotype.
Focimeter.
Focusing-glass.
Foxtype.
Fuming-box.
Gaudinotype.
Gilding.
Graphotype.
Gumming.
Hallotype.
Heliochromatype.
Heliochrome.
Heliograph.
Heliographic engraving.
Heliotype.
Hellenotype.
Hillotype.
Hyalotype.
Ink-printing process.
Intensifying.
Ivorytype.
Kit.
Lampratype.
Leggotype.
Leveling-stand.
Lithotype.
Melanotype.
Negative.
Negative-bath.
Opaletype.
Panotype.
Photo-electrotype.
Photo-engraving.
Photo-galvanograph.
Photo-gelatine printing-process.
Photogenic drawing.
Photoglyphic engraving.
Photoglyptic engraving.
Photograph-enamel.
Photographic camera.
Photographic camera-stand.
Photographic chair.
Photographic cutter.
Photographic engraving.
Photographic head-rest.
Photographic lens.
Photographic micrometer.
Photographic printing.
Photographometer.
Photography.
Photoheliograph.
Photoheliotype.
Photohyalotype.
Photo-intaglio engraving.
Photolithography.
Photo-mechanical printing.
Photo-metallography.
Photometer.
Photo-micography.
Photo-processes.
Photo-relief engraving.
Photoscope.
Photosculpture.
Phototype.
Photo-vitrotype.
Photozincography.
Plate-holder.
Porcelain picture.
Positive
Pressure-frame.
Print-holder.
Printing.
Printing-frame.
Retouching-table.
Screen.
Sennotype.
Sensitizing.
Silver-printing.
Sphereotype.
Talbotype.
Tent.
Tithonotype.
Toning.
Varnishing.
Vignetter.
Vitrotype.

Pho′to-he′li-o-graph. An instrument made for the British government by Dallmeyer of England, for observing transits of Venus. It consists of a telescope, mounted for photography, about eight feet in length, and having an object-glass of four inches in diameter and five feet focal length. At the focus is placed an instantaneous shutter which serves to expose and immediately close an aperture, behind which is placed a combination of lenses, corrected for the chemical rays. The image passing through is enlarged to four inches. The instrument is mounted on an equatorial stand and actuated by suitable clock-work. A similar instrument was used by De la Rue at Kew.

Pho′to-hy-al′o-type. See HYALOTYPE.

Pho′to-in-tagl′io En-grav′ing. A process in which, by photographic means, lines are etched in a plate to be subsequently filled with ink and printed by the copperplate printing-press.

In 1827, following in the footsteps of his uncle, Niepce de St. Victor laid an asphate ground upon a metallic plate, which probably granulated as the menstruum evaporated. This was exposed under a positive, the unaltered asphaltum removed by essence of lavender, and the plate etched with acid. This was analogous to the process disclosed by the elder Niepce to Daguerre when their copartnership was formed, for the purpose of perfecting the sun-pictures to which the name of daguerreotype was subsequently applied. It is tolerably certain that the elder Niepce had not merely the intention of making pictures, but designed to use the process for the production of intaglio etchings. This intention seems to have been lost sight of in the wonderful successes of Daguerre's process. A specimen of his photographic engraving effort is said to be in the possession of the French Photographic Society, and several of his asphate photographs upon metallic plates are in the British Museum.

In the photo-engraving process of Fox Talbot, in 1852, he prepared a metallic plate with a thin coating of bichromated gelatine exposed under a transparent positive, and etched the plate with a solution of bichloride of platinum or perchloride of iron in water. The unaltered portions of the gelatine being pervious to the etching liquid, the plate was dissolved away, while the altered portions, being impervious to water, protected the plate below them. The etching liquid, which corrodes the plate, penetrates the unaltered gelatine, but does not evolve gas, and consequently does not disturb the film of gelatine. He endeavored to obtain half-tones by the interposition of crape, etc. He termed it PHOTOGLYPTIC ENGRAVING.

Paul Pretsch of Vienna, working in London, about 1854, established the photo-galvanographic company in that city. His method consisted in preparing a layer of bichromated gelatine of appreciable thickness, which, after exposure under a *cliché*, was immersed in water and allowed to swell. The gelatine by this treatment produced a number of reticulations, which, in their size and nearness, were somewhat proportionate to the actinic activity of the light. This made a kind of grain, which was copied by electro-deposition, forming an intaglio printing surface which held the ink in its fine lines. He subsequently applied the same principle to the production of relief plates, for which he obtained an English patent, about 1855. He was probably the only man who ever attempted to obtain by photographic means a relief plate for the type-press direct from nature. See PHOTOGALVANOGRAPH.

Duncas Dallas, about 1862, is believed to have operated in substantially the same way, but with better success.

Egloffstein, in New York, worked a process based upon the Fox Talbot method. Eidlitz established the Phototype Company of New York, and his efforts were nearly identical with Pretsch, excepting, perhaps, that he successfully threw down a deposit of copper on the swelled and still moist gelatine.

Pho′to-li-thog′ra-phy. A mode of producing

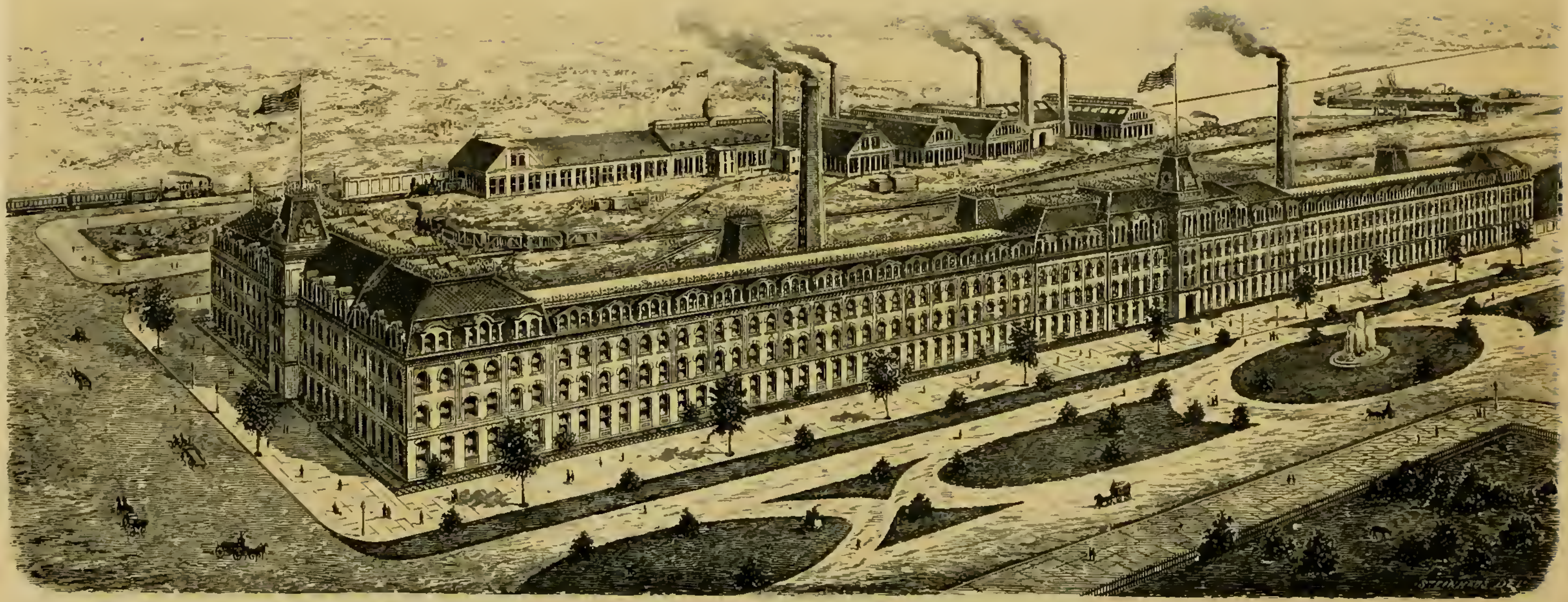


PHOTO-LITHOGRAPH FROM PEN DRAWING.

PLATE XXXIX.*

[Singer Sewing-machine Manufactory, Elizabethport N.J.]

See Page 1687.

by photographic means designs upon stone, from which impressions may be obtained in the ordinary lithographic press.

Indications of efforts in this direction may be credited to the late Joseph Dixon of Jersey City, and to Lewis of Dublin, about 1841. Dixon's attempt was analogous to Poitevin's process, as described hereafter, and Lewis's was an ingenious modification of the daguerreotype process, in which a thin surface of silver applied to an underlying resinous coating was so treated subsequent to the photographic image being produced thereon, by exposure to light and mercurial fumes, as to lay bare portions of the greasy or resinous matter, which was then susceptible of transfer. No specimens or contemporaneous description by either method is known to be extant. The following embrace all the typical photolithographic processes at present known: —

1. Lemercier, Barreswill, and Lerebours of Paris patented in France, July 3, 1852, a method which consisted in an application to stone of Nicephore Niepce's very early experiments to produce a photographic image on metallic plates. They dissolved asphaltum in ether, and coated the clean stone with a thin varnish of the same. By exposing such a surface under a negative the bitumen undergoes a slow change, becoming insoluble in the parts exposed to light. A subsequent washing with ether removes the unchanged soluble portions, leaving the picture visible upon the stone, which is then to be gummed, rolled up, etched, and printed. (See LITHOGRAPHY.) This process preceded that of Macpherson of Rome (October 14, 1852) by only a few months; five years later the Imperial printing-office in Vienna experimented in the same direction. See HELIOTYPE.

2. Poitevin, of Paris, patented in England, December, 1855, a process for producing pictures on stone, based upon Mungo Ponton's discovery, that a sheet of paper saturated with a solution of bichromate of potash and dried, was sensitive to light. Ponton, without ignoring the possible action of the substance of the paper, believed this liability to change to be inherent in the salt itself, but Becquerel subsequently explained its true nature as depending on the organic character of the sizing employed, which was apparently affected by the chromic acid set free by the action of light. It remained, however, for Poitevin to discover and make application of the great fact that organic matter so changed repels water and has an affinity for grease, resembling in this respect the behavior of a lithographic drawing on stone. Joseph Dixon, above referred to, published this fact in 1854, and therefore deserves the credit of priority; but the description he gives of his experiment, and the suggestions made by him, though embracing much of what was afterward elaborated by Poitevin, are hardly sufficient to displace the latter as the inventor of a typical process.

According to Poitevin's description of his process, he coated a lithographic stone with a mixture of albumen, gelatine, gum, or similar organic matter (really selecting albumen), and bichromate of potash. He then dried the surface and exposed it under a negative. He then damped the stone, rolled up with lithographic ink, etched, and printed. It may be here remarked that Dixon's experiment contained the gist, though unperceived by any, of the recent important inventions of Tessié du Motay, Albert, Edwards, and others, inasmuch as he really printed from an organic deposit which lay between the ink and the stone. See PHOTO-MECHANICAL PRINTING; CARBON-PRINT; GELATINE PROCESS; HELIOTYPE.

3. Cutting and Bradford, Boston, Mass., patented a process in England, February 23, 1858, and in the United States, March 16, 1858, which consisted in coating a stone with a solution of gum and bichromate of potash, with an addition of sugar; drying the same and exposing under a transparent positive. After the actinic change was effected they washed the stone with soap-water, which penetrated only the parts unchanged by light, and formed there the lithographic picture susceptible of taking ink. The stone was then treated according to the usual lithographic methods, including probably its etching and gumming.

4. Asser of Amsterdam patented in France, in 1859, the first transfer process. He prepared a sheet of unsized paper or of paper slightly sized with starch, with a solution of bichromate of potash, dried it in the dark, exposed it under a negative, and then washed it thoroughly and dried it. This sheet was now subjected to a high temperature on a metallic plate, then again damped as a lithographic stone would be damped for printing, and rolled up with transfer-ink. The parts affected by light took the ink, in quantity more or less perfectly in proportion to the actinic action. The sheet was then dried and transferred, whereby a delineation on stone was produced. This was rolled up and etched in the usual manner. This was the first transfer-process, but did not prove of practical value.

5. J. W. Osborne patented in Australia, September 1, 1859, and in the United States, June 25, 1861, a transfer-process, in which he prepares a sheet of paper by coating one side with a mixture of albumen, gelatine, and bichromate of potash, and dries it in the dark. This is exposed under a negative, whereby a visible change is produced, the brilliant yellow of the sheet, due to the salt of chromium, being changed to a chestnut-brown. In addition to this visible change, the organic matter becomes insoluble. A coating of transfer-ink is now applied to the whole exposed surface, by passing the sheet through the press face down upon an inked stone. When the sheet is removed the photographic picture is almost invisible. The sheet is then floated, ink side upward, upon hot water, the action of which is to coagulate the albumen, rendering it insoluble, and to swell and gelatinize the gelatine, causing the part affected by light to appear depressed by contrast. The sheet of paper, so floated, is next placed upon a slab, and the superfluous ink rubbed off by a wet sponge. This operation develops the picture. The sheet is then washed, dried, and transferred to the stone in the usual way. The coagulated albumen forms over the whole surface of the paper a continuous film which adheres strongly to the stone during the transfer-process, preventing any shifting and consequent doubling of the lines. This is, for all practical purposes, the first successful photolithographic process, and has been used in the Crown-Lands Survey Office of Victoria since September, 1859, in the publication of maps. Substantially the same process is used in the Ordnance Survey Office of England. The duplication and copying of drawings for the United States Patent Office has been for some years performed by Osborne's process, and in accuracy and speed leaves nothing to be desired.

6. Hannaford of London, in August, 1861, suggested a transfer-process, which he never put in practice, but the essential features of which were subsequently patented in England by Toovey in 1864. A sheet of paper was to be prepared by a solution of gum and bichromate of potash, exposed under a negative, and then transferred damp to a stone, without previous inking. The gum passed over to the stone on all portions corresponding to the opaque parts of the negative, and, as explained in the lithographic process, incapacitated the stone at such parts for the reception of ink. On the removal of the sheet, the application of the roller brought up the picture, which was then etched and printed.

Direct processes upon the prepared surfaces of stone are not now used, all successful photolithographic work being dependent upon the transfer-process. See LITHOGRAPHY.

Pho'to-me-chan'i-cal Print'ing.

A general term embracing all photo-processes in which a printing surface is obtained without the intervention of hand-engraving. (See PHOTO-ENGRAVING.) The processes are very various, and the results obtained are of several kinds.

1. The *surface* printing, allied to the *lithographic*, includes *albertype*, *photolithography*, *photozincography*. See, also, AUTOTYPE; CARBON-PRINTING; GELATINE PROCESS; HELIOTYPE.

2 The *relief-printing* produces plates which may be printed like type, and includes *photogalvanography*, *phototype*.

3. The *intaglio* printing includes the *photoglyptic* process.

4. See WOODBURY PROCESS.

A succinct statement of gelatine and similar organic matter associated with bichromate of potash in photo-mechanical processes may be given as follows: —

1. Mungo Ponton, 1839, first discovered the sensitiveness to light of a sheet of paper treated with bichromate.

2. Becquerel, 1840, determined that the sizing of the paper played an important part in the change.

3. Fox Talbot, 1853, discovered and utilized the insolubility of gelatine exposed to light in the presence of bichromate.

4. Paul Pretsch, 1854, discovered and utilized the quality which such exposed gelatine possesses of not swelling in water.

5. Joseph Dixon, 1854, was the first to use organic matter and bichromate upon stone to produce a photolithograph.

6. Poitevin, 1855, was the first to recognize the fact that bichromated organic matter altered by light took the greasy ink from the roller.

7. Tessié du Motay and Marechal, 1864, were the first to print from a photographic image on bichromated gelatine as from a lithographic stone.

Pho'to-me-tal'lo-graph. See PHOTOZINCOGRAPH.

Pho-tom'e-ter. An instrument for measuring the intensity of light. They are of several kinds.

1. For comparing with the solar light by allowing a small graduated portion only of the solar disk to be seen. — HUYGHENS.

2. By the interposition of dimmed glasses. — RUMFORD.

3. By a comparison of distances at which small circles on white paper are visible. — CELSIUS.

4. By a comparison of the proportionate force of two different lights. — RUMFORD, BOUGUER, and LAMBERT.

a. Ritchie's box with reflectors and two parallel images.

b. Deslaurier's parallel lamps and images.

c. Bunsen's reflecting and transmitting screen; an opaque margin and translucent center, lights being on opposite sides.

d. A modification in which the screen is translucent with a still more transparent central disk.

5 By a comparison of shadows. — PRIESTLEY.

6. By polarization. — ARAGO.

7. By a differential thermometer — LESLIE.

8. By a comparison of illuminated images. — WHEATSTONE.

The photometer is used for measuring the illuminating power of gas. The standard of gas varies according to statute, or, in some places, custom. Some gas corporations have no apparent standard, and drive anything through the mains which will turn the meter and not poison the people too rapidly.

The standard of the London gas companies (and this is understood to be professedly the same with the Metropolitan Gas Company, of New York) is that the gas when burned at the rate of five cubic feet per hour shall give a light equal to the burning of fourteen spermaceti candles, each consuming 120 grains in the same time.

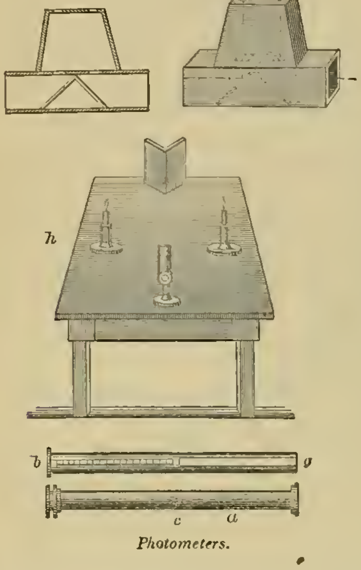
1. Huyghens, in making a relative estimate of the comparative intensities of the sunlight and that of Sirius, employed a tube having a very small aperture at one end, into which was inserted a minute globular lens, which allowed only $^{1}/_{27664}$th part of the solar disk to be seen. He found that this small portion afforded a light equal to that of the star, and therefrom concluded that the star was 27,664 times more distant than the sun; a conclusion from arbitrary premises

2. One *photometer* of Count Rumford consisted of a number of pieces of dimmed glass, which were placed in succession in front of the light until the light was no longer visible. The relative intensity was determined by the number of pieces required to make the light disappear.

Fig. 3682 shows a tube *a* inclosing an inner sliding tube *b*, one half of which is graduated and the other has an opening for the insertion of a slip of glass *g*, photographically graduated in color from transparency to total blackness.

The outer tube is held so that the aperture *c* is presented to the light, which passes through the slip *g* and is reflected to the eye end of the tube by the mirror within it. The distance which the tube must be drawn out to render the light visible measures its intensity and is indicated by the graduations.

Fig 3682.



Photometers.

3 The photometer of Celsius consisted in observing the greatest distance from the eye, on which small circles painted on paper were distinctly visible in different lights.

4. Count Rumford, Priestley, Bouguer, and Lambert all gave their attention to this subject and elicited the following principle: —

Though the eye cannot judge of the proportionate force of different lights, it can distinguish with considerable precision when two similar surfaces presented together are equally illuminated, or when the shadows of an opaque object thrown upon them by different lights are equally dark.

Ritchie's apparatus is founded upon the former idea (Bouguer's); the lights to be compared being separately received by mirrors set at an angle of 45° in a box with a blackened interior surface and reflected therefrom to adjacent disks of oiled paper so that their comparative luminosity may be compared. When one excels the other it is retreated until an equality of luminous effect is established The values are then as the squares of the distances from the reflectors.

Bouguer's photometer (upper figure) is substantially similar, the rays of the luminous objects to be compared being directed into two funnels and impinging upon two disks of uniform translucency. The comparison is made as in the former case. The views are respectively a section and an elevation

h is a simple apparatus on the same principle, formed by simply bending a card. The lights to be compared are placed so that each shall be reflected from a single face of the card, so as not to interfere with the other. The reflections are viewed through a tube placed on the prolongation of the line bisecting the angle of the faces.

Another form of the *light* comparison is adopted in some gasworks where the lights to be compared are thrown upon opposite sides of a screen interposed.

This is Bunsen's photometer, which depends for its action upon the combination of reflected and transmitted light.

"The rays from the two lights to be compared are received on the opposite sides of a screen, one part of which is white and nearly opaque and the other part translucent. When the rays of a single flame only strike against one side of the screen, those portions through which the light passes seem dark and the opaque parts bright. But the opposite effect is produced when viewed from the back of the screen, for then the opaque part seems dark and the translucent part light. On lighting another flame on the opposite side of the screen, the dark part is illuminated while the light passes through the other portion and adds but little to its brightness. Thus, the part that is bright on one side is dark on the other, and the converse. If the light on each side of the screen be equally powerful, the dark part will nearly disappear, for the reflected and transmitted lights combine to illuminate both surfaces equally. This effect is produced by shifting the screen toward the feeble light, and by squaring the distance from each the relative illuminating power of the two is ascertained." — CLEGG.

5. The form of photometer founded upon the comparison of shadows has been ascribed to Count Rumford and to Dr. Priestley. The latter describes it as follows: —

"When two lights of varying intensity shine upon the same surface at equal obliquities, and an opaque body is interposed, the two shadows produced differ in blackness or intensity in a similar degree." The shadow produced by intercepting the greater light, being illumined by the lesser only, the other shadow would be less intense and the strongest light would have the deepest shadow. Thus, when two lights are to be compared, they should be so placed that a ray from each should fall with the same angle of incidence upon the middle of a sheet of paper; by interposing some opaque object the two shadows it occasions may be made to lap over each other; then, if the lights are removed from or brought nearer the paper, until all the shadows are of the same intensity, it will be found that the amount of light emitted by each will be as the squares of the distances from the paper.

6. Arago's photometer is founded on the properties of polarized light

"When two lights are to be compared, the rays from each are polarized by causing them to pass through a plate of tourmaline cut parallel to the axis, or by reflecting them from a plate of glass on which they fall at the polarizing angle. They are then received on a plate of rock crystal, cut perpendicularly to the axis, and observed through a doubly refracting prism. Each light will thus give two images tinged with the complementary colors. The images are then brought into such a position that the red of one falls over the green of the other. If the two lights be equal in intensity, this superposition will produce a white image; if unequal, the image will be slightly colored with red or green, according as the one or the other predominates." — BRANDE.

This ingenious contrivance has been rather a curiosity than a practical apparatus, as it is complicated, and requires considerable trouble in the manipulation.

7. Leslie's photometer is constructed on the assumed principle that light is convertible into heat. The differential thermometer with a black and a clear bulb is placed under a case and successively exposed to the lights under experiment, the rise of the thermometer being observed.

8. Wheatstone's photometer has a small convex reflector, which affords bright images of the two lights under comparison. By causing the bead to traverse, two parallel lines of light are formed and the comparison rendered more easy. The lights are adjusted as to distance till the images have equal luminosity.

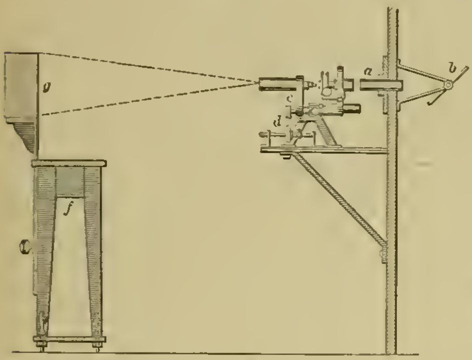
A substitute for the photometer has been proposed in the bromine test, which removes from gas the vapors upon which its luminosity depends. See "Ure," Vol. I. p. 439, American edition.

Pho′to-mi-cog′ra-phy. At the time when photography began to attract attention, efforts were made by Donné to depict microscopic objects by the Daguerrean process, which did not, however, yield satisfactory results. The new process of photography, however, in the hands of such experimenters as Professor Gerlach of Erlangen, Albert of Munich, and Dr. R. L. Maddox of Southampton, was more successfully employed for this purpose. In America, the chief experimenters have been Professor O. N. Rood of Columbia College, Mr. Lewis N. Rutherford of New York, and Colonel J. J. Woodward of the United States Army Medical Museum. The latter has devoted much attention to the subject, and has succeeded in carrying the process to a high degree of perfection. In 1861, Professor Rood, in a paper published in "Silliman's Journal," described the process as then employed by him, by which he had succeeded in obtaining photographs of diatoms and other objects magnified from 460 to 1,300 diameters, using direct sunlight and employing ordinary achromatic objectives with or without eye-pieces.

Mr. Rutherford, in experiments on stellar photography, had employed an achromatic objective having its crown and flint glass lenses so combined as to give a focal length about $\frac{1}{70}$ less than that proper for vision, so as to obviate dispersion of the actinic rays and bring them accurately to a focus. He suggested the application of this principle to the microscope. Colonel Woodward, taking the subject up at this point, perseveringly experimented, bringing the process to the high state of practical perfection in which it is now employed at the Army Medical Museum. The general features of this system consist in dispensing with a camera and the non-use of ground-glass.

The operating-room has two windows, through one of which sufficient yellow light is admitted to enable the operator to work; the lower part of the other window is provided with a shutter 14 inches high, the upper part being blackened In the shutter is a hole in which is inserted a tube *a*, through which the solar light reflected from a plane mirror *b*, or, preferably a heliostat, is thrown upon the achromatic condenser of the microscope; the microscope *c* is placed on a shelf at the window of the dark room, and the light reflected through the tube, which is provided with an achromatic lens of about 10 inches focal length, is thrown upon the achromatic condenser. *d* is the focusing device; *g f*, the negative-holder and its stand. For powers from 200 to 500, a $^1/_8$-inch objective without an eye-piece is used, the power being varied by increasing or diminishing the distance of the sensitized plate from the instrument. A cell filled with ammonio-sulphate of copper, which absorbs the non-actinic rays, is interposed between the large lens and the condenser, and a hood is drawn around the instrument to prevent leakage of light into the room

Fig. 3683.



Woodward's Microphotographic Apparatus (*with Solar Light*).

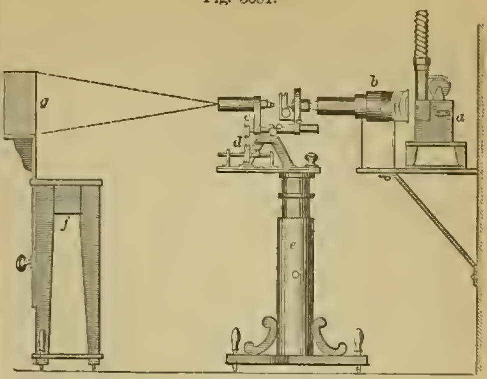
For objects magnified less than 500 diameters, the time of exposure, being less than a second, is regulated by a sliding shutter placed before a slit in front of the microscope, the width of the slit being adjusted to correspond with the required length of exposure. For powers between 500 and 1,500, a $^1/_{16}$-inch objective is employed, dispensing, in general, with an eye-piece or amplifier, and placing the sensitized plate at a distance not exceeding 3 to 4 feet from the microscope. In the case of objects having very minute details, however, it is frequently advantageous to employ an eye-piece or amplifier, rather than enlarge a negative taken with a smaller power.

Though natural sunlight is to be preferred, it may be sometimes necessary, when this is wanting, to employ artificial illumination; for this purpose, the electric, the magnesium, and the oxycalcium lights have been used with success. Of these, the electric light is the best, and for its production Dr. W. employs a Duboscq lamp, operated by a battery of 50 small Grove elements, 10 in a cell

The magnesium light affords an illumination similar to white-cloud light, or that of the sun after passing through ground glass, and is well adapted for photographing soft tissues with powers less than 1,000 diameters; there are no interference phenomena, but with powers exceeding 1,000 diameters the time of exposure becomes inconveniently long.

Fig. 3684 shows the arrangement employed. The magnesium lamp *a* stands on a shelf fastened to the wall; the condenser *b* concentrates the light on the achromatic condenser of the microscope *c*, which stands on a table *e* supported upon three leveling screws. The image received on the plate-holder *g* supported on the table *f* is photographed precisely as in the case of the electric light. The same focusing apparatus *d* is employed, and the ammonio-sulphate cell is invariably inserted. See Dr. Woodward's articles, "American Journal of Science and Arts," Vol. XLII. (Second Series), pp. 189-195. Also "Reports to the Surgeon-General," 1870-71.

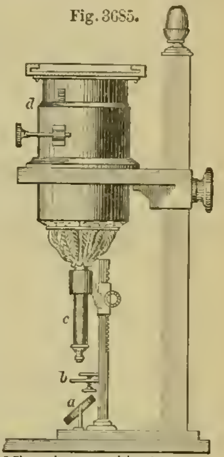
Fig. 3684.



Microphotographic Apparatus (*with Magnesium Lamp*).

Fig. 3685 shows a photomicrographic apparatus from Otto Buchler's "Atelier und Apparat des Photographen" *a* represents the mirror, *b* the object-holder, *c* the microscope, and *d* the dark-chamber, on top of which is the plate-holder. The adjustments are three: one for the object-holder, one for the microscope, and a third for giving the dark-chamber the proper vertical elevation. The arrangements shown at Figs. 3683, 3684, are, however, undoubtedly preferable. See also MICROGRAPH; MICROPANTOGRAPH; NOBERT'S PLATES; MICROSCOPE.

Fig. 3685.



Microphotographic Apparatus from Buchler.

Pho'to-pro'cess-es.

PHOTO-PROCESSES.	Photography.....	Calotype.	
		Daguerreotype.	
		Ambrotype.	
		Silver printing.	
		Collodion.	
		Carbon printing.	
	Photo-mechanical processes......	Photo-engraving	Photo-relief.
			Photo-intaglio.
			Woodburytype.
		Photolithography; Photozincograph.	
		Photo-gelatine printing (Collography.)	

Pho'to-re-lief' En-grav'ing. Properly, one in which, by photographic means and subsequent manipulations, a printing surface is obtained which stands above the general level to receive the ink and may be printed as type or woodcuts.

Paul Pretsch, November 9, 1854, prepared a surface of bichromated gelatine with other less essential chemicals, and exposed under a transparent positive. By plunging this, after exposure, into water, the unaltered gelatine swells into relief, forming a surface which may be copied by the galvanoplastic or stereotype process to form a relief-printing process. Also known as a PHOTO-GALVANOGAAPH (which see).

Poitevin, December 13, 1855, had a process substantially similar, using plaster hardened with protosulphate of iron to obtain a cast.

Osborne and Robertson, in 1860, transferred the photolithographic transfer-sheet to zinc and etched the zinc to make a relief.

Leggo, about 1866, coated the back of a transparent positive with gelatine and bichromate, allowing it to gelatinize only, not to dry, exposed from the face, and finally washed away the unaltered gelatine, leaving a number of depressions, corresponding to the positive parts of the picture. A casting was made from this in the electro-bath or by stereotype.

Woodbury's process, though called *photo-relief*, scarcely comes within the definition. See Woodbury Process.

Pho'to-scope. An instrument or apparatus for exhibiting photographs.

Pho'to-sculp'ture. M. Villème, an eminent French sculptor, is credited with the invention of this ingenious process.

The subject to be modeled stands in a circular chamber, while from 24 circular apertures in the wall provided with as many photographic apparatus 24 photographs are taken, giving that number of portraits from different points of view. By this means, the sculptor, having 24 photographs, representing the subject from as many different points of view (all taken at once), has but to turn the block of clay, after each operation, $\frac{1}{24}$ of a revolution, and then cut in correspondence to the next profile as traced by the pantograph on the clay. After the block has completed a revolution it is transformed into a solid figure of the 24 photographs.

Expedition and accuracy are secured by this means, but no doubt it would and does disgust one of the old school almost as much as taking a cast from life and using the cast as a pattern in a "pattern" lathe to turn a bust out of the marble by automatic devices and steam-power.

Pho'to-type. (*Photography.*) A general term for processes in which sun-pictures, or *light-pictures*, as the name indicates, are made printing-surfaces and thus become the means of multiplying pictures.

The term has been specially applied to the following process: —

An impression on a plate in raised characters derived from a transfer obtained by the photozincographic process. The original manuscript or page of type is photographed, treated with ink, washed and transferred to the plate, which is then *bit in*, so as to depress the surface at points not protected by the ink. (See Photozincography.) For an analogous process, see Photoglyphic Engraving. The resulting plate has a salient impression, and is printed from as with ordinary type.

Pho'to-vit'ro-type. (*Photography.*) A light picture printed on glass.

Pho'to-zin-cog'ra-phy. A process for the production of delineations on zinc by the aid of light, from which impressions can be printed after the manner of zincography. This method of producing and printing facsimiles is identical with photolithography, save in the fact that zinc plates are substituted for stone.

Cutting and Bradford, as well as Osborne, contemplated the production of the printable picture on zinc, as well as on stone; the latter produced copies of maps in this way in March, 1860. To Col. Sir Henry James, however, the credit is due of giving to a process on zinc, elaborated by the employees of the Southampton Map Office, considerable prominence and importance. This process resembles Asser's, but only to the extent that a transfer is employed. In its details it is identical with Osborne's (omitting the use of albumen). Both these inventors anticipated James, and published elaborate descriptions of their processes.

The Southampton office has made a very useful application of photozincography for the production of old historical manuscripts, such as "Domesday Book" and similar documents; but the quality of the results obtained does not appear to have reached a degree of excellence which would justify the extended application of the process to the production of maps.

The only advantage which photozincography possesses over the analogous processes on stone is the lightness and cheapness of the plates. See Lithography; Photolithography; and Zincography.

Phthon-gom'e-ter. A measurer of vowel quantity. (Whewell.) He refers to Kempelen's and Willis's talking-machines, in which acoustic sounds were made to assume "articulate differences," "exhibiting the relation among the vowels."

Phys'e-ter. A filtering-machine consisting of a tub, with a perforated platform about half-way up. The air is withdrawn from the lower portion, and the pressure of the atmosphere forces the liquid through the partition. See Pressure-filter.

Pi-a'no-for'te. (*Music.*) An instrument with a key-board and metallic strings put in motion by hammers. Its usual compass is about seven octaves. Its music is written on two different clefs at once, the F clef for the left hand, the G clef for the right hand.

Its strings are stretched upon a harp-shaped frame, and are struck by hammers moved by keys. The strings are of graduated length, thickness, and tension; are stretched over bridges, and fastened at their respective ends to pegs and tuning-pins, and are arranged, two or three to a note, in a plane parallel to the sounding-board, by which their sonorous vibrations are propagated and enhanced. It is distinguished from its predecessors in the same class by having a hammer to strike the string; the hammer being moved through the intervention of a jack, and retiring from the string immediately after delivering its blow.

"The piano is now, beyond all question, the first of musical instruments, both to the profession and to the cultivated classes of society." — Thalberg.

Another might say the organ, so far as power and capacity and variety of expression are concerned

In tracing the rise and progress of the instrument whose qualities warrant such exalted praise, we shall have to go back to the primitive stringed instruments which had a few strings, representing as many notes and tuned in unison or harmony, as the case may be, with a degree of skill depending upon the ear and attainments of the performer.

We may fairly suppose that the first instrument of this kind was played by the fingers. In process of time, as it was discovered that either thickness, length, or tension would effect the object of a difference of tone, the frame would assume a somewhat triangular shape, the longer strings being the nearest to one side, to which all the strings were parallel.

We have then arrived at the *harp*, which must have been used for ages before it attained the splendid proportions and finished appearance of those found represented in a tomb of the time of Rameses III., 1235 B. C. These figures are called *Bruce's harpers*, from their discoverer, and are illustrated under the section treating of that instrument. See Harp.

The Old Testament Scriptures abound in the names of instruments of the harp kind; the *lyre*, the *psaltery*, and instruments of 10 strings. The Egyptian harps had from 4 to 14 strings as long ago as Amosis, about 1570 B. C., 900 years before Terpander.

The form of the harp-frame, as we have seen, arose from the mode of varying the tone by giving different lengths to the strings, which were of catgut or tendons; to this was added another variation by the thickness of strings. At a very early age, still another mode of varying the tone was discovered; this was by pressing on the string, and thus temporarily shortening it, raising the tone.

We have thus arrived at the guitar, which was common in Egypt. We find it represented on the temple and sepulchral paintings of Thebes, on the obelisk brought from Egypt by Augustus, and which was placed on Guglia Rotta at Rome; also on the sculptures of Nimroud. These guitars had necks, but no frets. The *guitar* is in name and fact closely allied to the harp, its Greek name *kithara* being the original of the word *guitar*, and meaning an instrument of the harp kind. See Guitar.

The *'ood* of the modern Arabs is much like the ancient Egyptian guitar; a neck without frets, a hollow oval body, and perforated sounding-board The tuning-pins of the Egyptian instrument are clearly shown on the obelisk imported by Augustus and upset by the Constable Bourbon in 1527.

After the *harp* and its congeners, the *guitar* kind, whose strings were vibrated by the fingers and thumb, or by a *plectrum*, we find the stringed instruments diverging in two directions, a device being employed in each case to vibrate the strings. We regard the *plectrum* as being, in the main, merely a mode of saving the fingers.

The two devices referred to, which characterize separate families of stringed musical instruments, are the *bow* and the *hammer* Of the first, we have the *violin* series: *viola*, *violin*, *violoncello*, *violone*, or *double-bass*. Of the *hammer* series, we have the *dulcimer*, *virginal*, *clavichord*, *hammer-harpsichord*, and, lastly, the supreme *piano-forte*.

Of the *bow* series, the instruments have necks and the strings are capable of sounding various notes by being stopped to vary their lengths.

Of the *hammer* series, the strings, like those of the *harp*, express but one note each, and are numerous accordingly. The harp was, for convenience, laid prostrate, but retained its shape as it does practically to the present day.

We shall have to notice two variations presently: one in the *substitution of quill-jacks for the hammer*, the other in *uprighting the harp-frame*, as in the upright piano

The *bow series* divaricates from our present subject, and we dismiss it.

First of the hammer series, we notice the *dulcimer*. This has a series of strings tuned to the chromatic scale, and having a compass of two or more octaves. The strings are stretched over a bridge at each end of the box-cover, which forms the sounding-board. The *hammers* are pellets of cork on the ends of elastic rods held in the hands of the performer. This may be the *psaltery* of the Hebrews: it is hard to tell.

The *citole*, or little chest, was a box with stretched strings which were played by the fingers.

Now for a long step: The first stringed instrument in which the hammers were mechanically operated seems to have been the *clavicytherium*, or keyed cithara (*clavis*, a key) (See consecutive statement accompanying Plate XL., page 1692.) In this illustration of the sequence of instruments are also shown the *clavichord* or *monochord* and the *virginal*, all of which preceded the *spinet*, *harpsichord*, *hammer-harpsichord*, and *forte-piano*, as it was first named. Keys were applied to organs in the eleventh century; centuries before they were used on stringed instruments by Guido, of Arezzo, who originated the *clavicytherium*, or *keyed cithara*.

The history of the piano-forte, as we have seen, involves the early history of stringed instruments, as the piano is but a prostrate harp with strings in groups and struck by keys.

Plate XL. shows the series of improvements, beginning with the *lyre*, the invention of which is credited to Hermes (Mercury).

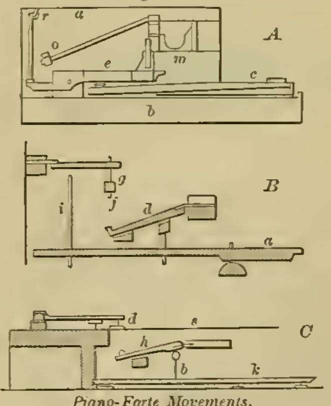
Fig. *a* is from an Egyptian tomb at Beni Hassan, the painting being supposed to represent the arrival of Joseph's family in Egypt, the tomb being contemporary with that event. *b* is from a lyre in the Berlin Museum, which is perfect except as to its strings. *c* is a drawing from a painting in Thebes, showing the use of the invention *d* is a square lyre from a painting in Herculaneum, the figure holding a plectrum. *e* is a bow-shaped twelve-stringed *harp*, from an Egyptian painting copied by Wilkinson *f* is from an Egyptian picture representing a figure playing on a harp with triangular frame and perpendicular strings. (See HARP, for cut of Bruce's harpers.) *g* is a medieval *cithara*. *h* is a *psalterium*, from an illuminated MS. of the fourteenth century. *i* is a *dulcimer*, from the "Musurgia seu Praxis Musicæ," by Ottomarus Luscinius, Strasburg, 1536. The dulcimer of old Assyria had strings of varying lengths passing over the sounding-board, and was slung by a strap in front of the performer while marching. It was played by a plectrum. It is known as the *kanoon* by the Arabs and Persians, who twang the lamb's-gut strings with small plectra, one attached to the forefinger of each hand. The dulcimer played with mallets is used in rural fêtes on the Continent of Europe, and known as a *hackbret* (*hackboard*, or chopping-board, the shape of which it resembles); *sackbut*, in our translation of Daniel. *j*, a *citole*, from a drawing preserved in the British Museum.

> "A *citole* in hire right hand hadde she."
>
> CHAUCER.

k, a *clavicytherium*, or keyed *cithara*, which had quilled plectra attached to the keys: the strings were of catgut. The illustration is from the "Musurgia," just cited. The *clavichord*, also known as the *monochord*, was a square instrument, and had keys on which were vertical pieces of brass pin-wire which could be pressed against the strings, which were also of brass. These pins, therefore, formed wrest-pins for the strings, which vibrated only while the key was held down, a close damper being fixed behind which acted upon the string when quitted by the pin, the key, in fact, forming one of two bridges, between which the strings vibrated. This instrument played an important part in the history of music for six hundred years. It was Bach's favorite instrument: it formed part of Mozart's traveling equipment. It is said by Blount ("Glossographia," 1656) to be so named "because the strings are wrested up with a *clavis*, a key." *l* is the *clavicymbal*, in which the strings are disposed harp fashion. Its strings are of steel wire, sounded by quill plectra on the keys. The illustration is from the "Musurgia." *m* is the *manichorde*, from a drawing by Mersennus, 1636. It was a superior form of *clavichord*, with 49 or 50 keys and 70 strings, which rested on 5 bridges, some of the strings being in unison. It had a hammer of brass and a cloth damper to stop the vibration after the note had been struck. It was long and narrow, and the sounding-board took up half the length of the instrument. *n* is a *virginal*, taken from a stained-glass window of the Elizabethan period. It had strings of various lengths, one to each note, of iron or steel. The strings were struck by small pieces of quill affixed to minute springs adjusted in the upper part of the jacks, which were planted in the keys and directed perpendicularly upon the strings. The name is derived from the instrument being deemed suitable for girls, or from its being used in accompanying hymns to the Virgin. *o* is a triangular *virginal* from the "Syntagma Musicum" of Prætorius. The instrument is frequently mentioned in works and inventories of the fifteenth and sixteenth centuries. Shakespeare refers to it. *p* is a curious drawing of an upright virginal from a collection of pen-and-ink drawings of ancient musical instruments, executed at the latter end of the sixteenth century. The virginal of Mary Queen of Scots was of oak inlaid with cedar and elaborately ornamented with figures of warriors, ladies, and birds. The colors are yet bright. *q* is the *spinet*, named from *spina*, a thorn or quill, the tone being produced by a crow's quill inserted in the tongue of the jack. As described by Mersennus ("Harmonicorum," Paris, 1636) it had 49 strings, of which the lower 30 were made of latten (flat brass wire) and the remainder (19) of steel or iron. The note depended on the size of string and tension, there being one note for each string, and but 5 or 6 sizes of strings. The *spinet* was always triangular, and had the wires carried over a bent bridge; the strings of the *virginal* usually went direct to the screw-pegs. The illustration is from Bonanni's "Gabinetto Armonico," 4to, Rome, 1722. *r* is the *harpsichord*, which is, in fact, a large-sized *spinet*, but it differed from the latter and from the *virginal* in having two strings to a note. The illustration is from the work of Mersennus just quoted. "The action of the harpsichord was simply a key and what is called a jack, which is a piece of pear-tree with a small movable tongue of holly, through which a cutting of crow-quill was passed to touch the string when the jack was in action." (BURNEY.) Thus the mechanism of the jack was similar to that in the virginal and spinet. Hans Ruckers joined to the two strings in unison a third one of shorter and finer range tuned an octave above the others. He mounted his instruments partly with catgut strings and partly with steel wire; he added a second key-board to reach but a single wire, and extended the compass to four octaves. Pedals were introduced about the middle of the eighteenth century, to work *stops*, as they were termed (pedals were previously used on organs), — the *forte* stop, which raised the dampers; the *soft* stop, which partly stopped the vibrations of the strings: and the *buff* stop, which interposed a layer of cloth or soft buff leather between the strings and the jacks. Tarquin of Paris first substituted buff leather for the quills in 1768. Schobert had a double tier of strings with additional sounding-board. Wieglet introduced metallic tongues in 1724: Silbermann, a mechanism like the clavichord to strike the string at its midlength, by which the harmonic sounds were heard at the same time the whole string was sounded. Stein invented the *vis-a-vis*, or double harpsichord, which was played by a performer at each end. Burney refers to a transposing harpsichord of 1760: "By drawing out the keys the hammers are transferred to different strings, by which means a composition is transposed half a note, a whole note, or a flat third lower at pleasure." In 1730 Harris took an English patent for his harpsichord, "with two sets of strings, on which may be played either one unison or two; or two unisons and an octave together, and the Fortes and the Pianos," etc. Plenius, in 1741, also refers to the "forte and piano" capacity of his instrument. In 1774, the patent of Merlin described a "new-invented kind of compound harpsichord, in which, besides the jacks with quills, a set of hammers of the nature of those used in the kind of harpsichords called *piono-forte*, are introduced," etc.

The *hammer-harpsichord*, so called from the substitution of hammers for plectra, was the first *piano-forte*, and invented by Cristofori of Florence, 1711. It had a row of leather-topped hammers, which vibrated on a rod and struck the string from below. A projection on the hammer near its axis was struck by "a tongue of wood placed upon a lever that meets the key

Fig. 3686.



Piano-Forte Movements.

A, Bartolommeo Cristofori of Florence, 1711. *B*, Mason, London, 1755. *C*, single action.

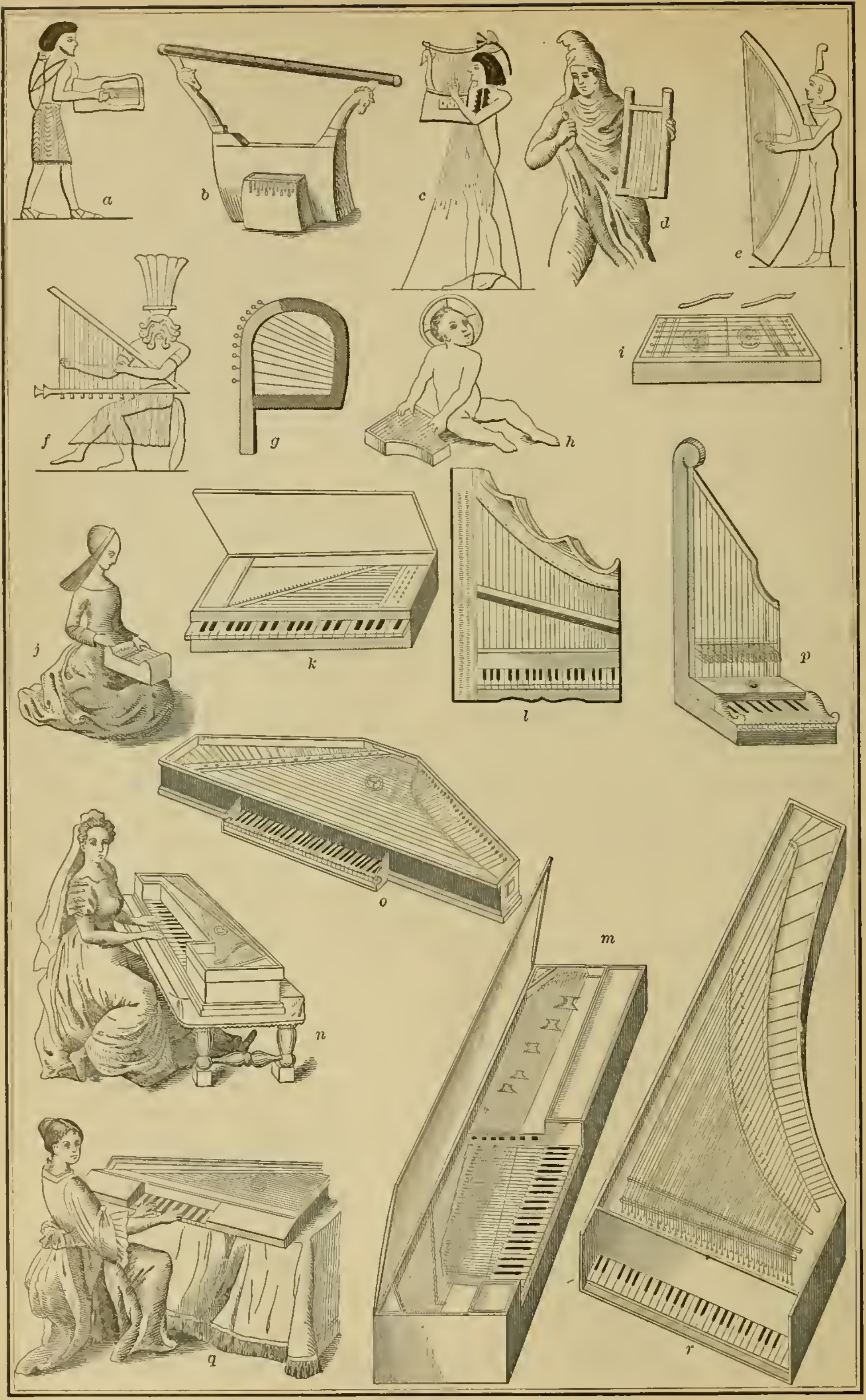


PLATE XL. PICTORIAL HISTORY OF THE PIANO-FORTE, See page 1691.

From the Lyre of Egypt, 2000 B. C., *to the Harpsichord of the 18th Century* A. D.

(From authentic sources.)

and that is raised by it when pressed by the key." (See Rimbault's "Piano-forte," London, 1860.) A long description by Scipione Maffei and a cut were published in the "Giornale de' Litterati d' Italia," Venice, 1711 (Tom. V. p. 144).

In *A*, Fig. 3686: *a*, string; *b*, frame of key-board; *x*, key with a pad on the end which comes beneath the lever *e*, which has a jack or hopper to force the hammer *o* upward when the key is depressed; *m*, the hammer rail; *r*, the damper which leaves the string when the key is touched and returns when the pressure on the key is removed. The hammer is leather-faced, and is caught by a silken string.

Marius of Paris submitted four of his instruments for examination by the Academy of Sciences in 1716, calling them *clavecins à maillets*. The hammers had leathern faces, and in one the hinged hammer was impelled against the string by the key and retreated from it, although pressure on the key remained.

Schröter's claim dates in 1718. The hammer was leather-headed and moved on a pivot, and rested near its axis upon a leather-headed pin screwed into the farther end of the finger-key. When the key was struck, the hammer was thrown up against the string and then retreated, allowing the string to vibrate. A clothed hammer being made to strike the strings, the *jack* no longer acting as a hammer, but transferring the motion of the key to the hammer, making the jack a *hammer-lifter* instead of a striker.

In each of these cases the particular value of the invention was the command possessed by the player of giving a sound more or less forcible by the force of the blow on the key, — a thing scarcely possible in the spinet and harpsichord, where the string was twanged by a passing crow-quill. The ability to modulate the sound was spoken of as capacity for *forte* or *piano* effects, and the transposed words in the article in the Venetian journal (1711), quoted above, which speaks of "the *piano* and *forte*" as being heard, and also "gradations and diversity of power, as in a violoncello," refer to the same versatility of expression.

The name *forte-piano* occurs in Harris's English patent, 1740, but the instrument was a *harpsichord*.

Silbermann made two hammer-harpsichords in 1736. His instruments, called forte-pianos, were played by Bach at Frederick the Great's palace at Potsdam. Bach regarded them as too coarse, and preferred the clavichord, "which was," as Forkel says in his Life of Bach, "poor in tone, but on a small scale extremely flexible." After Silbermann came his pupil Stein, upon whose piano-fortes Mozart so loved to play (1777). Frederici, a fellow-pupil of Stein's, made the first square piano.

The farther history of the piano introduces the name of Sebastian Erard of Strasburg, who invented the *escapement*, which effected precision in the stroke of the hammer. He died in 1831. Ignace Pleyel, another noted maker of pianos in Paris, died the same year. Zumpé made large numbers in England, 1766, and following years. The movement invented by Mason, an English clergyman, about 1755, is shown at *B* (Fig. 3686). *a* is the key rocking on a round bar and kept in place by a pin; *d* is the mallet with a hinge of vellum; *f* is the string on which rests the damper *g*, except when the key is depressed, raising the pin *i* beneath the damper-lever, which has a vellum hinge. The names of Broadwood, Stodard, and Collard are familiar as English inventors and makers in succeeding years. Geib, in 1786, invented the *grasshopper action*. In America we have Steinway and Chickering, Knabe and many others, who have made improvements in details of construction and produce instruments of a high class.

The illustration (*C*, Fig. 3686) shows what is known as the *single action*, in which the hammer *h* is hinged to a bar and is operated by the lifter *b* on the inner end of the key *k*. At the extreme end of the key is the *sticker*, which raises the damper *d* when the key is struck. As the key is restored to its normal position, the damper falls and hushes the sound of the string *s*.

The damper existed previously in the clavichord, but was not movable vertically so as to leave the string when the hammer struck.

The *piano-forte*, as such, was introduced to the English public on the stage of Covent Garden Theater in 1767. On a play-bill of that date occurs the following: —

"*For the Benefit of* Miss Brickler, 16*th of May*, 1767. At the end of the first act Miss Brickler will sing a favorite song from 'Judith,' accompanied by Mr. Dibdin on a *new instrument called the piano-forte*."

From this time its success was assured, and the harpsichord makers changed their movements, substituting *hammers* for *plectra*, *percussion* for *twanging*.

"There are three forms of the piano-forte, viz., the *grand* and the *square*, in which the strings are placed in a horizontal position, and the *upright*, in which the strings are vertical.

"The form of the *grand* piano is the same as that of the harpsichord, and was suggested by the varying length of the strings. This form is well adapted to the introduction of the best kinds of mechanism, and is always chosen for first-class instruments. Each note is produced by the simultaneous vibration of three strings; but, in order to lessen the cost of the instrument, a form of grand piano has been constructed, in which there are but two strings to each note; such are the *bi-grand* and *semi-grand*. There are also *boudoir* or *cottage grands*, which have shorter strings and occupy less room.

"The form of the *square* piano is oblong rectangular, the same as the German clavichord, and is probably the first shape in which the piano appeared. It remained an inferior instrument until the mechanism of the grand was introduced into it, thus leading to the variety called *grand-square*. It is difficult, in this instrument, to strengthen the framing sufficiently, and the oblique position of the action with respect to the strings and keyboard is also an objection; nevertheless, this form is the best substitute for the grand.

"The *upright* piano was patented by Stodart in England in 1795. It was at first a grand, set on end, raised on legs two or three feet above the floor, and struck at the lower end. This, the *upright-grand*, as it was termed, was unwieldy from its great hight, and was superseded by the *cabinet*, invented by Southwell in 1807, in which the frame was brought down to the floor and the blow given at the upper end of the strings by means of levers and long vertical rods communicating from the key to the hammer. It formed an elegant piece of furniture, and continued long in favor. Still, however, its great hight (6 feet) and length of action were unfavorable to delicacy and ease of touch. About 1812, Mr. Robert Wornum introduced an upright piano-forte, the hight of which was from 4 to 5 feet; this was the *harmonic*, a name afterward changed to *cottage*. In 1827, its hight was still farther reduced to 3½ feet from the floor, forming the *piccolo*, which has served as the model for many others of different names and about the same size." — Tomlinson.

The square piano is much more generally used than any other in this country, while in England and on the Continent the cottage form appears to meet with most favor.

The piano-forte comprises four distinct parts: the *framing* and *sounding-board*; the *stringing*; and the striking mechanism, or *action*.

The framing, having to resist the tension of all the strings, equivalent in a full-sized grand piano to a force of about 25,000 pounds, requires to be made of great strength.

It was formerly constructed solely of timber; the strings were looped at one end around studs driven into a block of wood termed the string-block, their other ends being wound around a series of iron *wrest-pins*, inserted into another piece termed the *wrest-plank*. These were separated by a trussed framing, arranged so as to resist as completely as possible the tendency of the strings to draw these two parts together. It was, however, found that, owing to the great strain, even the most seasoned timber was liable to become distorted, causing the instrument to get out of tune. This defect also precluded the use of heavier strings for the purpose of increasing the power of the instrument. As a remedy, the system in general use of combining wood and metal in the framing was invented. This was adopted in part by Broadwood in 1808, and in 1820 Stodard patented the first complete system of metallic bracing, also including a means of counteracting the expansion and contraction of the strings under varying temperatures by means of a series of tubes which expanded or contracted simultaneously with them, but in an opposite direction.

The general features of the combined framing of wood and metal, as applied to a grand piano-forte, consist in attaching the studs to which the rear ends of the strings are secured to an iron plate curved to the form of the hollow side of the instrument, and called the *string-plate*. From this metallic bars extend parallel with and above the strings to the *wrest-plank*. The bars are firmly connected at their ends to the string-plate and wrest-plank, and secured at intervals throughout their length to the timber framing below, to which the string-plate is also firmly fastened; both the bars and string-plate are usually of wrought-iron or steel. Seasoned and well-dried oak glued up in several thicknesses to insure greater permanence of form is employed for the wooden parts of the framing.

The cast-iron string-frame is credited by the English writers to Pleyel & Co. of Paris.

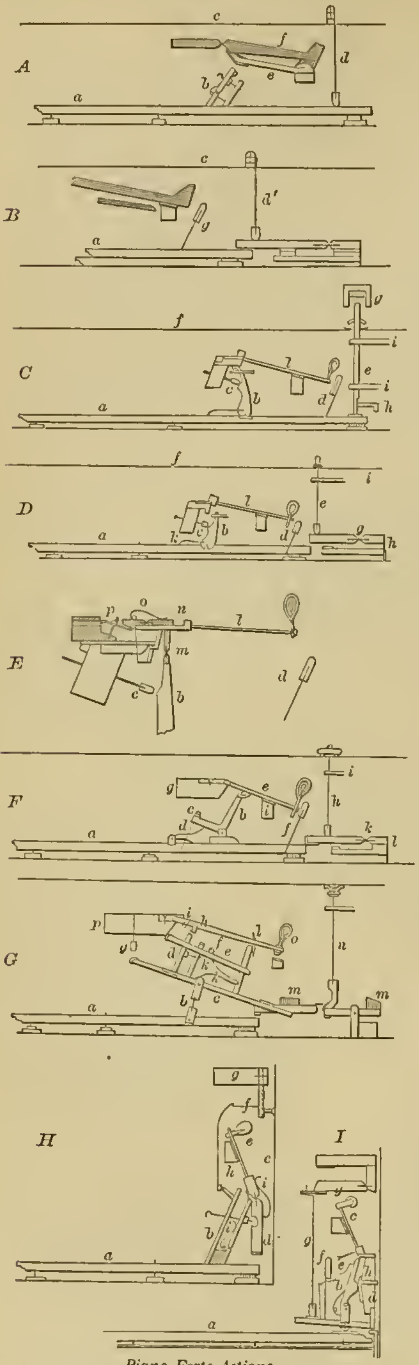
In order to enable the hammers to strike the wires, an opening is necessary completely across the wooden framing under the strings; this is spanned by small thin arches of metal abutting on one side against the wrest-plank and on the other against a transverse rail, called the *belly-rail*, which forms a portion of the main body of the framing, taking the thrust caused by the tension of the wires. Of late years, framings entirely composed of metal have been extensively employed in the United States.

Owing to the wide and deep space required for the keys and action in square pianos, the strengthening is effected by bolting down the wrest-plank and string-plate upon a strong bed of timber extending from beneath the keys, so as to form the bottom of the instrument. One or more metallic bars above the strings also extend from the wrest-plank to the string-plate. Framings exclusively of iron are also used in this class of instruments.

The upright piano requires no aperture for enabling the hammers to strike, and its framing is, therefore, simply sustained by vertical bars at the back of the instrument, to which the wrest-plank and string-plate are attached, and which receive the force exerted by the tension of the strings in the direction of their length. Iron braces behind these are sometimes added, or they are replaced by metallic tubes.

The *sounding-board* or *belly* is a boarding of light wood about one fifth of an inch thick, occupying in a grand piano the whole area of the instrument, in a square piano about two fifths of its length, placed below the strings, or, in upright instruments, behind them. It must be made of wood free from knots or imperfections, and cut in a particular direction of the grain. Its edges are attached to the framing, leaving its middle free to vibrate under the impulse received from the strings. It is supported by bars glued on to its back; but if these are made sufficiently strong to resist the tension of the strings, it is so stiffened as to prevent the requisite vibration; if otherwise, it is gradually forced out of shape so that its surface becomes curved, impairing the tone of the instrument. To remedy this, Mr. Dreaper of Liverpool applied hollow chambers to the back of the sounding board, adjusted to any desired pressure by screws.

Fig. 3687.



Piano-Forte Actions.

M. Pape, for this purpose, placed the sounding-board at the lower side of a frame to the upper part of which the strings are attached, so that their effect should be to extend rather than compress the sound-board. This arrangement also admits of its being made of larger size, so as to increase the resonance.

The pitch of a note depends on the number of vibrations communicated to the air in a given time.

In the piano-forte the vibrations of the various strings, their intensity of sound, and their quality or timbre, are regulated in three different ways: by varying their length, their weight, or their tension It is an established fact that of two strings of equal weight and tension, one which is half the length of the other produces a sound an octave higher, the intermediate notes between these being produced by strings varying in length according to a scale which has been ascertained by experiment.

The same result may be attained by varying the tension; in this case, the vibrations are in proportion to the square root of the force employed in stretching the strings. In strings of the same length and tension, but differing in weight, the vibrations are in direct inverse proportion to the respective weights of the strings. The relative pitch may be obtained by either of these modes, but in practice the piano-forte maker adopts them all, in order to produce the proper timbre and volume, as well as the required pitch.

In a grand piano-forte there are fourteen different thicknesses of steel wire, those for the bass being wrapped with thin copper wire, and each diminishing, but not uniformly, in length and tension, as well as in thickness, from the lower to the upper notes. Three strings were formerly employed for each note in the grand piano and two in the upright. Latterly, however, it is common to have but two strings for each middle and one for each lower note in the grand piano. Uprights have usually two strings for each note.

In 1827, Messrs. Collard patented a mode of applying the strings, differing from that previously in use; it consisted in employing but one hitch-pin of double the usual size, and passing the string from one tuning-pin to the other around this hitch-pin in one continuous piece of wire. By this the wires are prevented from twisting, and it obviates the danger of their snapping at the noose around the hitch-pin.

Another improvement consisted in giving the string an upward bearing at the striking end by employing perforated plates instead of the common form of bridges over which the string passed, the distance between them regulating the length of its vibrating part. The free end of the string was extended upwardly after passing through the perforated bridge, so that the upward blow of the hammer tended to force it against its seat in the bridge, instead of lifting it therefrom, as before.

Wornum, in 1819, reduced the strings to a uniform size and tension, wrapping those of the lower notes with wire to produce a lower tone.

This system, though possessing some advantages, never came into general use.

The mechanism by which the impulse is given to the key by the finger of the performer is termed the *action*. Those first employed were of the simple construction just described, known as *single action*. In this the hammer would not reach the string unless the key was struck with considerable force, so that it was impossible to play very *piano*, while, if it was attempted to remedy this defect by bringing the hammer nearer the string, there was danger of its not falling back, technically called *blocking*. This difficulty was obviated by the invention of the *hopper* (*b*, Fig. 3687). This is an upright jointed piece attached to the back end of the key, which, when the key is pressed down, engages in a notch on the under side of the hammer, lifting it so near that a very slight additional pressure causes it to strike; at this moment the upper joint of the hopper coming in contact with a fixed button, escapes or *hops* from the notch, allowing the hammer to fall away from the string. This is termed the *double action*, and still continues to be used in square and upright piano-fortes. In case the key was struck with too much force, however, the hammer was liable to rebound from the bed on to which it fell and strike the string a second time, impairing the tone of the note. To remedy this, a projection, the *check*, was fixed to the back end of the key, catching the edge of the hammer as it fell and preventing it from rising again. These actions, however, did not admit of the same note being struck twice in succession until the key had risen to its original position, so that the hopper could again engage in its notch. Various contrivances have been devised for enabling the quick repetition of the same note, all of which effect the object by holding the hammer up close to the string, while the key rises so that the hopper may sooner engage with it and repeat the note with less effort of the finger and greater rapidity.

Fig. 3687, *A* illustrates the square piano-forte action with the *Irish* damper, so called from its inventor Southwell, an Irishman; and *B*, the operation of the *check* and crank-damper. *a* is the key; *b*, the hopper; *c*, the string; *d*, Irish damper; *d'*, crank-damper; *e*, under-hammer; *f*, hammer; and *g*, check.

The common *grand* action is shown at *C*. *D* represents Broadwood's grand action, and *E* the improvements thereto by Southwell *a*, key; *b*, lever; *c*, button; *d*, check; *e*, damper; *f*, string; *g*, crank for damper; *h*, damper pedal-lifter; *i i i i*, rails and socket: *k*, spring; *l*, hammer; *m n*, block passed through the hammer-butt; *o*, a spring pressing against n, so that when the lever passes the notch in the foot of the hammer it is caught by *m*, retaining the hammer at the proper hight; *p*, a spring which determines the force with which the hammer shall strike.

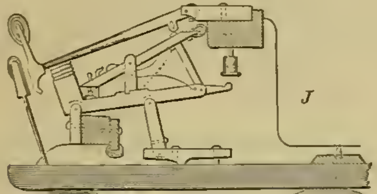
Collard's (properly, Stewart's) grand action is shown at *F*. *a*, key; *b*, hopper; *c*, button; *d*, hopper-spring; *e*, hammer; *f*, check; *g*, hammer-rail; *h*, damper; *i i*, rails; *k*, crank for damper; *l*, damper pedal-lifter.

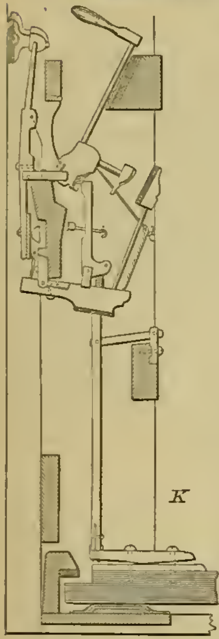
G is Erard's grand action. *a*, key; *b*, lifter; *c*, hopper-lever; *d*, hopper; *e*, hammer-sustaining lever; *f*, spring stop; *g*, hopper-button; *h*, butt against which the hopper strikes; *i*, two small wire stops which act against *e*; *k k*, springs acting upon hammer-lever and hopper-lever; *l*, check; *m m*, leaden balance-weights; *n*, damper; *o*, hammer; *p*, hopper-rail.

In addition to these may be cited two actions of Wornum's, designed for upright pianos; the first, *H*, known as the *unique*, and the second, *I*, as the *double* or *piccolo* action. In the first, *a* is the key; *b*, hopper; *c*, string; *d*, hammer-rail; *e*, hammer; *f*, damper and wire; *g*, damper-rail; *h*, ruler; *i i*, springs. In the latter, or double action, *a* is the key; *b*, hopper and springs; *c*, hammer; *d*, hammer-rail; *e*, tie and wire; *f*, check; *g g*, damper and wire; *h*, setting-off screw.

Many other forms, based on general principles similar to those illustrated, have been devised by inventors both in Europe and America. Prominent among these is the improvement of Pape, which consists in placing the action mechanism above, instead of below, the sounding-board, so that the blow of the hammer acts on the string from above, and no opening is required in the sound-board; by this arrangement a superior quality of tone is produced and the strength of the instrument increased.

Fig. 3688.





Steinway's Piano-Forte Actions.

In this the hammers are placed under the keys, and are worked from their front ends immediately below the part struck by the fingers, so that the thrust is transmitted directly downward in a nearly vertical direction. This arrangement also allows longer strings to be employed in proportion to the length of the case, or a shorter case with the same length of string, than in the usual piano-forte actions.

J K are, respectively, the horizontal and upright piano-forte actions of Steinway and Sons.

Others might be mentioned would space permit, embracing the peculiar constructions of instruments whose fame is wider than the continent, such as the Chickering, Knabe, Weber, Hallet and Davis, Schomacker, and others. On the stringing and construction of pianos, see "Lehrbuch des Pianofortebasses," Weimar, 1872

In Pepys's diary, October, 1664, another form of stringed instrument played by keys is thus described: —

"To the musique meeting at the post-office, where I was once before. And thither anon come all the Gresham College, and a great deal of noble company; and the new instrument was brought called the Arched Viall, where, being tuned with lute-strings and played on with keys like an organ, a piece of parchment is always kept moving; and the strings, which, by the keys, are pressed down upon it, are grated in imitation of a bow by the parchment; and so it is intended to resemble several vialls played on with one bow, but so basely and harshly that it will never do."

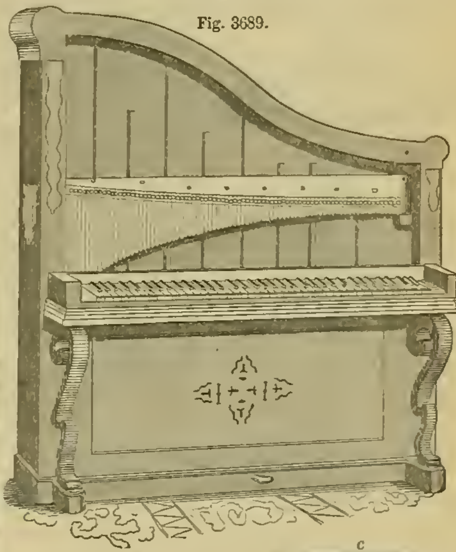
The self-acting piano has a pin cylinder turning horizontally on its axis, acted upon a coiled spring, and regulated by a fly-wheel. The pins have a determinate arrangement on the cylinder, like those of a barrel-organ or musical box, and act upon levers which actuate the hammers. Certain adjustments are made for piano and forte effects. Rolfe's English patent specifies a number of improvements.

The *violin attachment for piano-fortes* was patented in England about thirty years since by Todd. It is attached in addition to the usual hammer action, and is brought into use as required, being intended to confer upon the strings the violin tone, as a pleasing variation or accessory. This is effected by the pressure of the foot of the player upon a pedal, which puts in motion an endless band covered with resin, the band being made to rub against the particular wire appertaining to the key which is depressed by the finger of the player.

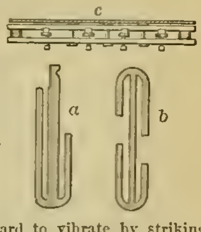
A writer has taken the trouble to give the actual material used in constructing a piano-forte: In an ordinary instrument there are fifteen kinds of wood, namely, pine, maple, spruce, cherry, walnut, whitewood, apple, basswood, birch, mahogany, ebony, holly, cedar, beech, and rosewood, from Honduras, Ceylon, England, South America, and Germany. In this combination, elasticity, strength, pliability, toughness, resonance, lightness, durability, and beauty are individual qualities, and the general result is *voice*. There are also used of the metals, iron, steel, brass, white-metal, gun-metal, and lead. There are in an instrument of seven and a half octaves 214 strings, making a total length of 787 feet of steel wire, and 500 feet of white (covering) wire. Such a piano will weigh from 900 to 1,000 pounds, and will last with constant use (not abuse) fifteen or twenty years. The total manufacture of pianos in New York alone averages 15,000 per annum. — *Exchange*.

Fig 3689 illustrates an instrument patented July 11, 1871, by Messrs Atkins and Drewer, in which steel hooks *a b*, having one or more prongs, are employed in place of strings, the general arrangements of the key-board, action, and sounding-board resembling those of the upright piano. The hooks are attached to a metallic frame *c*, composed of two bars connected by pillars which alternate with the hook-supports, and cause the sound-board to vibrate by striking against it. When the hooks have more than one prong, each prong must be tuned to a different octave. A kind of *glockenspeil*.

Fig. 3689.



Steel-Bar Piano.

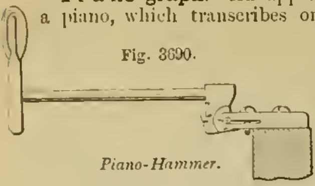


Pi-a′no-for′te Ac′tion. The motion-work of a piano-forte, including the key and hammer and the parts intervening. See Figs. 3687 and 3688.

Pi-a′no-for′te Ham′mer. The percussor in the piano movement which is impelled by the key and strikes the string.

Pi-a′no-graph. An apparatus attached to a piano, which transcribes on prepared paper the piece played on the piano.

Fig. 3690.

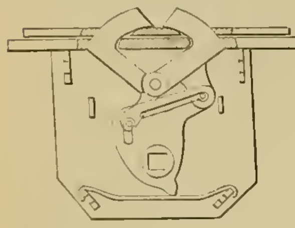


Piano-Hammer.

Pi-a′no-jack. (*Music.*) A feed-hand which drives the hammer in a piano. See Fig. 3687.

Pi-a′no-lock. One with curved or hooking bolts which clasp the keeper-plate of the piano-lid. In the illustration, the lock has two curved bolts, pivoted to a common center, and operated by the key through the medium of a tumbler-plate, which, describing the arc of a circle, passes through a plate screwed upon the lower surface of the lids of the piano.

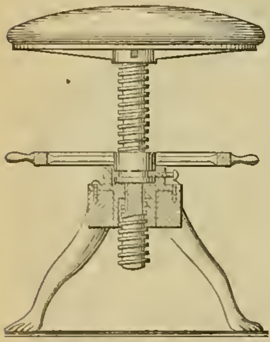
Fig. 3691.



Piano-Lock.

Pi-a′no-move′ment. The mechanism by which the vibration of the key is made to act upon the string. The *action.* See Figs. 3687 and 3688.

Fig. 3692.



Piano-Stool.

Pi-a′no-stool. A round-seated stool, capable of elevation or depression to suit the performer. In the example, the seat is vertically adjusted, without being rotated, by means of the hand-wheel and the sleeve-nut upon the screw-stem of the seat.

Pi-az′za. (*Architecture.*) *a.* A covered walk; a colonnade or arcade.

b. A central court in a building.

Pi′ca. (*Printing.*) A size of type between *Small Pica* and *English.*

Long Primer, 89 ems to a foot.
Small Pica, 83 ems to a foot.
Pica, 71 ems to a foot.
English, 64 ems to a foot.
Great Primer, 51 ems to a foot.
Double Pica, 35 ems to a foot.

The name is derived from the *Pie,* or table used before the Reformation for finding out the service for the day. *Pica* is the standard of measurement in casting leads, cutting rule, and regulating the price of work. Pica is also the unit of sizes for type above *Great Primer;* as *Two-line Pica, Four-line Pica,* etc.

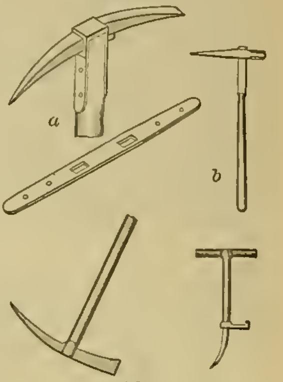
Pic′co-lo. 1. A small upright piano, about 3½ feet high. Used for certain brilliant effects.

2. A small flute having a pitch an octave higher than the ordinary flute. An *octave-flute.*

Pic′co-lo-flute. (*Music.*) A wind-instrument like a flute, but one octave higher, and having nearly the same compass. A *piccolo.*

Pick. 1. A tool with a bent iron head, which has a point at each end and an eye in the middle, through which the handle is inserted perpendicularly. It is the tool of the quarryman, road-maker, and cellar-digger. In the example, it is shown connected to the helve by an iron strap.

Fig. 3693.



Picks.

The pick *b* of the miner is a somewhat smaller and neater implement, adapted to work in circumscribed situations. It is made of cast-steel with polished points light, medium, and heavy weights, from 3½ to 8 pounds. See MINERS' TOOLS.

The foot-pick is used in prying out stones, in setting hedges, gardening, or otherwise. It is 3¾ feet long, and the tread is adjustable, but is ordinarily about 16 inches from the point.

The push-pick acts by thrust and endwise blow.

The lower figure on the left is a pickaxe.

2. A tool for dressing millstones. See MILLSTONE-PICK.

3. (*Weaving.*) The mode of estimating the rate of a loom as so many *picks* per minute. The *pick* is the blow which drives the shuttle, and is delivered upon the armed end of the shuttle by the *picker-head* on the end of the oscillating *picker-staff.*

Looms of 1800 ran about 60 picks per minute. In 1860, the power-loom was run at 220 picks per minute.

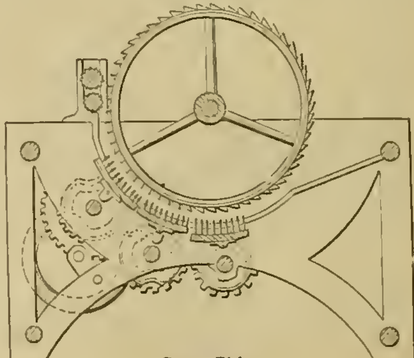
4. (*Printing.*) Foul matter and hardened ink collecting on type.

Pick′axe. An implement resembling a pick, except that one end of the head is broad and made sharp, so as to *cut.* See PICK.

The pickaxe of the United States artillery service is of iron, pointed at both ends with steel. Length of each blade, 6.5 inches; width of axe edge, 3 inches; handle (hickory), 1.5 inches by 1.25 inches; 30 inches long; weight, 6.5 pounds.

Pick′er. 1. (*Cotton-manufacture.*) A cotton-

Fig. 3694.



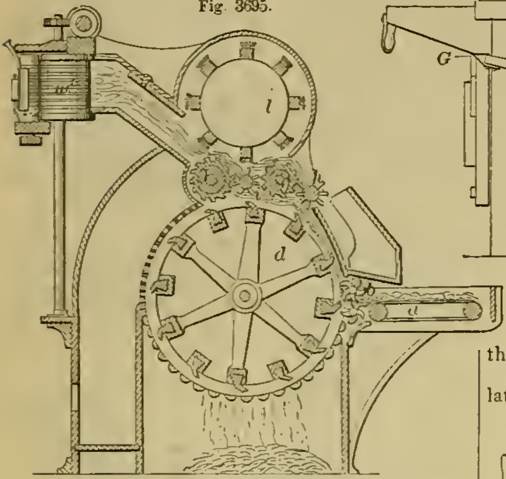
Cotton-Picker.

cleaner. A machine for opening the tussocks of bale-cotton, reducing it to a more fleecy condition, and separating from it dirt, burs, and other refuse.

In the machine, Fig. 3694, the cotton is fed in between rollers, caught by the teeth on the revolving drum, and drawn down against the teeth of the comb-plates, which act in succession upon the material, and each is cleaned by the withdrawal of its teeth through openings in a segmental apron partially surrounding the oblique-toothed picking-cylinder.

In Fig. 3695, the cotton or wool is fed into the machine by the endless apron *a* between rollers *b*, and is seized by the teeth of the picker *d*, which revolves in a slatted cylinder whose intervals allow dirt and dust to pass off, the operation being assisted by the centrifugal action of the air, resulting from the rapid rotation of the picker. The fiber is seized by other cylinders *f g*, and delivered from them by the pickers *h i*, which, in turn, are cleared by the brush-blower *l*, which drives the fiber up the spout to the condensing rolls *m'*, which deliver it in a lap.

Fig. 3695.



Cotton Picker and Cleaner.

In another form, the fleecy cotton from the willower is passed between fluted steel rollers, when a *beater* of two steel arms on a rapidly revolving shaft breaks it into fine fleecy masses. These fall on cylindrical sieves of wire, by the rotation of which they are carried in an even web to another series of rollers and beaters. When this process has been repeated several times, the *lap* or web of cotton passes between heavy iron rollers and is wound on a core of wood furnished with journals at the ends. See COTTON-CLEANER.

2. (*Cloth.*) A machine or an implement for *burling* cloth.

3. (*Husbandry.*) A machine for picking cotton from the boll in the field. See COTTON-PICKER.

4. (*Ordnance.*) A priming-wire for clearing the vent.

5. (*Menage.*) An instrument for dislodging a stone from the crease between the frog and the sole of a horse's foot, or between the heel of the shoe and the frog.

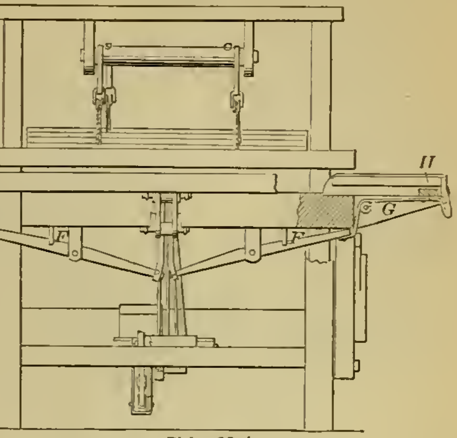
6. (*Founding.*) A light steel rod with a very sharp point, used for picking out small, light patterns from the sand.

7. (*Weaving.*) The upper or striking portion of a *picker-staff* which comes against the end of the *shuttle* and impels it through the *shed* of the *warp*. It requires a tough and somewhat resilient material; the former that it may last, the latter that it may not injure the shuttle. Raw-hide is frequently used.

The usual form is a staff sweeping in a vertical plane, and operated opportunely by means of the lay, or through gearing, according to the construction of the loom.

In Fig. 3696, the picker-blocks are operated from the lay by a system of rollers and straps. Pulling on the straps raises the ends of the levers *F F* in alternation, causing them to pull the straps *G G*, which actuate the picker-blocks *H*.

Fig. 3696.

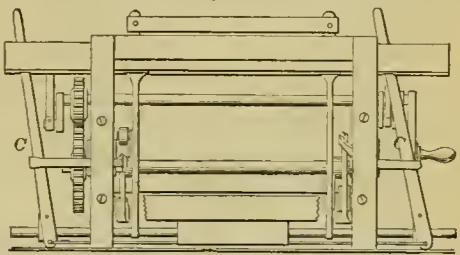


Picker-Motion.

Pick'er-mo'tion. (*Weaving.*) The system of parts involved in impelling the shuttle through the shed. See PICKER.

Pick'er-staff. (*Weaving.*) The bar which oscillates on an axis at its lower end, and by a sudden jerk imparts motion to the shuttle. The staffs in the example are shown at *C*, and are moved automatically by the motion of the lay.

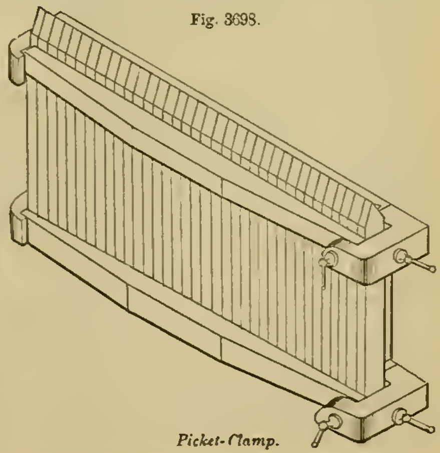
Fig. 3697.



Picker-Staff.

Pick'et. 1. (*Fortification.*) *a.* A stake with a

Fig. 3698.



Picket-Clamp.

sharpened end, used in laying off ground for fortifications.

b. A stake sharpened at both ends; one driven into the ground and the other acting as an obstacle to the advance of an enemy.

2. (*Husbandry.*) A pale of a fence.

3. (*Surveying.*) *a.* A staff used with a surveying chain by the leader and follower, being passed through the end rings.

b. A marking stake to indicate positions or stations.

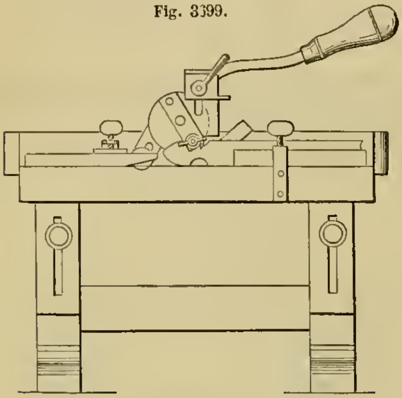
4. (*Menage.*) A stake to which a horse is tethered.

Pick'et-clamp. A device to hold pales while being dressed to shape.

Pick'et-pin. (*Menage.*) An iron pin about 14 inches long, having a rounded head and a ring near the head, to which the lariat rope is fastened. It is driven into the earth, the rope permitting the horse to graze for a limited distance around it.

Pick'et-point'er. A machine for dressing the heads of fence pickets or pales. In the example, an oscillating plate, carried on the frame on which the pickets are placed, has a cutter attached to either the upper or under part of its face, according as a convex or concave cut is to be made.

Fig. 3399.



Machine for sharpening Fence-Pickets.

Pick-ham'mer. A hammer with a pointed *peen*, used in *cobbing*; that is, spalling off the inferior portions from blocks of ore. A *pick.*

Pick'ing. 1. (*Fiber.*) *a.* A process in which deviled wool is examined for foreign matters and impurities. *Burring* is a substitute operation.

b. See Picker.

2. (*Metallurgy.*) Rough sorting of ore.

Pick'ing Cloth. One of the finishing processes of cloth. It is subjected to a strong light, and all blemishes removed from its surface by tweezers. Spots which have escaped the action of the dye are touched with dye by a camel's-hair brush. *Burling.*

Pick'ing-peg. (*Weaving.*) The piece which strikes the shuttle and drives it through the shed. In one form of hand-loom, the picking-peg is drawn by a cord. In the power-loom the driver is on a vibrating staff.

The *picker* is the invention of John Kay, about 1750, and the shuttle thus operated was called a *fly-shuttle*, from the rapidity of its movement as compared with the hand-shuttle.

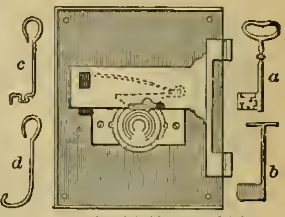
Pick'ing-stick. (*Weaving.*) The picker-staff for driving the shuttle of a power-loom.

Pick'le. 1. (*Founding.*) A bath of dilute sulphuric acid to remove the sand and impurities from the surface; and at the present day this treatment is by no means confined to small castings. It saves much labor and improves the appearance of the work. Dilute nitric acid is sometimes used for brass.

2. The pickle for brass castings previous to lacquering is dilute nitric acid.

Pick'lock. A flexible or a bent wire or small rod, which avoids the wards of a lock and serves to open it.

Fig 3700.

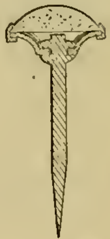


Ward-Lock with Key and Picks.

The illustration shows an expensive form of ward-lock used some years since on the strong-room of a bank. The wards are shown, surrounding the central key-pin, and from the appearance of the key, shown at *a*, it is evident that these wards must have been rather complex. A burglar employed an instrument shaped like that at *b*, having on one of its faces or sides a layer of wax and yellow soap; this instrument being introduced through the keyhole and turned a little way round, brought the soft composition in contact with the ends of the wards, and these ends thus left their impress on the composition. A false key was then made, as at *c*, which has a vacuity where there is a cavity in the true key; and by this instrument the lock was opened. The flexible instrument *d*, by passing round the wards, might open such a lock.

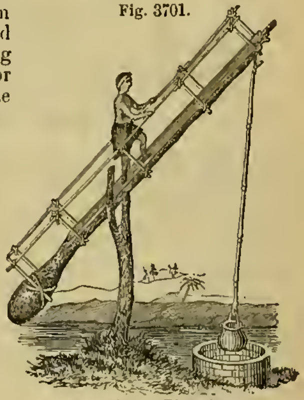
Pi-co'tah. A kind of *sweep* used in India to raise water for irrigation, the beam having a stepped foot-way, along which the operator walks to oscillate the beam.

Fig. 3702.



Picture-Nail.

Fig. 3701.



Hindoo Picotah.

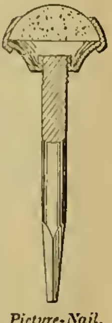
Pic'ture-nail. An article of household hardware. It has a shank capable of being driven into a wall while the head is yet detached. Afterward, the porcelain, glass, or gilt head is screwed to the shank.

Pi. (*Printing.*) Type mixed indiscriminately.

Pie. A fruit or meat pasty. Our interest in it concerns the machinery involved.

In the works of the New York Pie-Baking Company, the ground-floor is used as a retail department. In the rear are the bakery, store-rooms, ice-house, wagon-sheds, etc. In the basement are the ovens, ten in number, measuring ten by twelve feet, also a rotary oven, which will bake nine hundred pies per hour. The first floor above contains the engine, boiler, and delivery rooms. The second floor is the pastry department, where the mixing of the dough is done, and the third floor is devoted to the preparation of fruit, etc. On this floor is a huge range, capable of cooking ten barrels of fruit at once, also two copper steam-kettles with a capacity of two barrels each. An elevator hoists and lowers the pies and material of which they are composed.

Fig. 3703.



Picture-Nail.

The weekly consumption of materials is 140 barrels of flour, 42,000 pounds of sugar, 5,000 pounds of lard, 500 barrels apples, 60,000 pounds pumpkins and squashes, 60,000 eggs, 500 bushels berries in their season, 800 pounds beef for mince, 1,500 pounds cocoanut, 100 boxes lemons, and spices accordingly. They also have in constant use about 150,000 pie-plates, and give employment to 100 workmen, running 35 wagons.

Pie-board. A board on which dough is rolled thin for making pastry.

Piece. (*Bookbinding.*) A tablet of leather occupying a panel on the back.

Piece-dyed. Cloth dyed after weaving.

Pie-droit′. (*Architecture.*) A pier attached to a wall. It has neither cap nor base, and therein differs from a pilaster.

Piel. An iron wedge for boring stones.

Pier. (*Architecture.*) 1. *a.* A detached pillar or wall supporting the ends of adjoining trusses or spans; or the springers of adjacent arches. See Caisson, for mode of sinking piers.

The term *standing* pier is sometimes applied to the isolated structure; *abutment* pier to a wall from which springs the landward arch of a bridge.

The piers of the bridge of Semiramis across the Euphrates at Babylon were made of hewed stones secured by iron cramps and melted lead. — Diodorus Siculus.

Fig. 3704 is a sectional view of a pier made in sections.

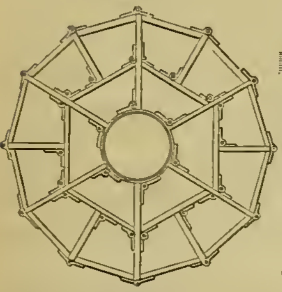
b. The portion of a wall between the windows or doors.

c. An upright projecting portion of wall, similar to a pilaster, throwing the intervening sunken portions into panel. See Rubble-masonry.

d. A buttress.

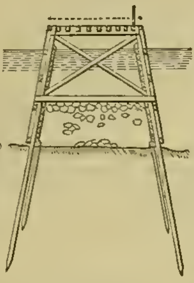
2. A mole or jetty extending out from the land into the water, adapted to form a landing-place for passengers or merchandise from ships which float in the deep water alongside the pier or wharf.

Fig. 3704.



Sectional Pier.

Fig. 3705



Hull-Pier.

They are variously constructed. Some are founded on piles, with cross-timbers, braces, and sheathing; floor-timbers afford a road for the traffic. The wooden structure is sometimes filled up with stone, like a dike; at other times it is of the nature of trestle-work.

Many elegant adaptations of iron to this work are found in Europe.

Piers of regular masonry are also common. They are founded on piles and built after the manner of bridge piers, with coffer-dams and the usual accessories.

Pier-arch. (*Architecture.*) An arch supported on a pier.

Pier′cel. A gimlet for opening vent-holes in casks of liquor.

Pierc′er. 1. A bow-drill.

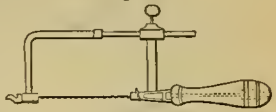
2. (*Founding.*) A vent-wire.

3. The sailmaker's awl.

Pierc′ing-file. A sharp and narrow file to enlarge a narrow drilled hole.

Pierc′ing-saw. A thin blade fastened by screw-clamps in a light frame, and used for piercing gold and silver smiths' works. Holes are drilled in the plate and the saw introduced; being then secured in the frame, the blade is reciprocated and caused to follow the lines of the templet or those which are inscribed thereon. A *buhl-saw.*

Fig. 3706



Piercing-Saw.

Pier-elle′. A mass of stones filling a ditch and covered with clay.

Pier-glass. A large looking-glass between windows, frequently standing on a *pier-table.*

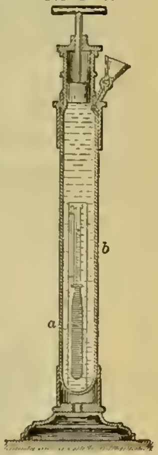
Pierre Per-due′. A foundation formed of masses of stone thrown in at random, as in the construction of the Plymouth Breakwater, the Rip Raps, the foundation of Fort Sumter, and many other public works in various countries.

Pi-e′tra Du′ra. A species of inlaid work composed of hard stones, such as agate, jasper, chalcedony, carnelian, and lapis-lazuli, set in a slab of marble, generally black. The marble is worked to a thickness not much exceeding the eighth of an inch; the design is drawn upon it and cut out with the saw and file. The hard stones, formed to the desired shapes by the usual processes of gem-cutting, are accurately fitted into the spaces thus cut out, and the whole is attached as a veneer to a thicker slab.

Pi′e-zom′e-ter. An instrument invented by Oersted for measuring the compressibility of liquids.

It consists of an elongated bulb *a* having a graduated stem of small bore. The instrument is filled with any liquid up to a certain mark on the stem, and a globule of mercury is placed above the liquid It is then placed in a cylindrical vessel *b* filled with water, to which pressure is applied by means of a screw piston. The number of graduations through which the globule of mercury is thus caused to descend indicates the apparent diminution in bulk of the liquid; that is, the excess of its contraction over that of the bulb which contains it. This depends on the quality of the glass of which the bulb is composed; its amount is ascertained and the proper correction is applied by deducting the increase in volume due to the difference of the two expansions, from the indication of the mercurial index; this gives the absolute contraction of the liquid.

Fig. 3707.



Piezometer.

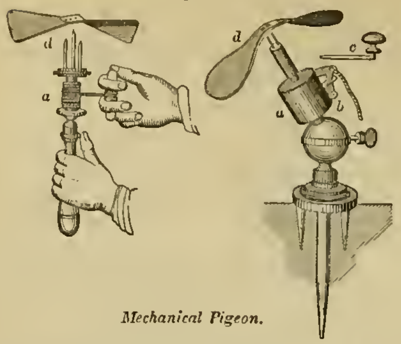
Pig. An oblong mass of metal as run from the smelting-furnace.

A main channel, called the *sow*, is scraped in the floor, into which the metal flows from the *tapping-hole* of the furnace; on each side of this are shallow ditches to receive the metal from the main stem, and the laterals are called *pigs* from a fanciful resemblance to the sow and pigs of the main trunk and the laterals.

Pig′eon, Me-chan′i-cal. A device intended to practice sportsmen in the art of shooting birds on the wing.

It consists of a thin strip of sheet-iron *d*, six or more inches long, having wings bent after the manner of screw-propeller blades; when rapid rotation is imparted to the device, it rises in the air, its appearance when in motion resembling that of a flying bird. The rotary motion may be given either by rapidly pulling a string wound around a spool *a* or by means of a spring contained within a cylinder *a* and compressed by turning a pin or key *c* inserted in a hole in the pronged axis on which the

Fig 3708.

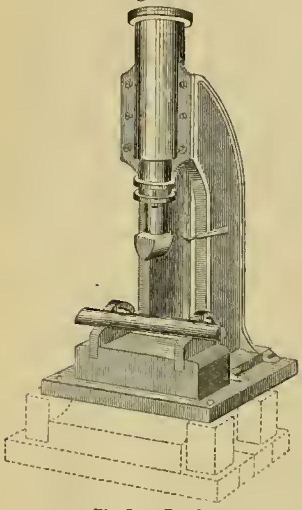


Mechanical Pigeon.

" pigeon " is placed; the spring is released by pulling the trigger *b*, to which a string of any desired length may be attached.

Pig-i'ron Brēak'er. A form of power hammer for breaking pigs of iron into pieces fit for charging into a furnace. It is otherwise done by sledges.

Fig. 3709.



Pig-Iron Breaker.

Pig'ment. A coloring material. A *paint*, *dye*, or *stain*.

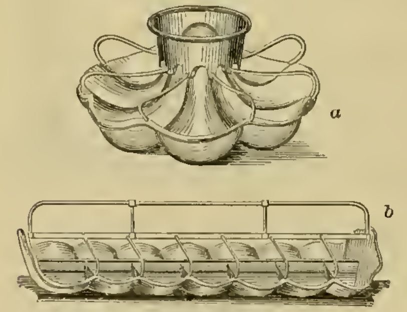
Pig'ment-print'ing. A style of calico-printing in which ordinary pigments are mechanically attached to the cloth by albuminous cement.

Pig-nose Vise. A hand-vise with narrow, pointed jaws.

Pig'tail. (*Nautical.*) A form of knot worked on the end of a cable or rope. See Knot.

Pig-trough. In Fig. 3710, *a b* are two varieties of cast-iron troughs, designed to prevent pigs from wasting the food or interfering with one another while eating. This is effected by curved bars at a proper hight between each division of the trough.

Fig. 3710.



Pig-Troughs.

Pike. A shaft of wood armed at the end with a sharp metallic head. A spear. A weapon used in repelling boarders. A *boarding-pike*.

In all times down to the invention of the bayonet it has formed a weapon for infantry in line or in mass. After the invention of the bayonet it was, for a time, mingled with the bayonets It is not now to be found in the armies of Europe in the hands of infantry.

Pi-las'ter. (*Architecture.*) A square pier, like a flat column, built against a wall, and having cap and base.

Flank pilasters are known as *antæ*.

A *piedroit* is a pier against a wall, and having neither base nor cap.

Pile. 1. (*Hydraulic Engineering.*) A beam or timber driven into treacherous ground to form a foundation for a structure, or to form part of a wall, as of a coffer-dam or quay.

Piles are known by their structure.

Hollow pile.
Pneumatic pile.
Screw-pile.

Or, —

Close pile.
False pile.
Filling-pile.
Foundation-pile.
Gage-pile.
Guide-pile.
Sheathing-pile.
Sheet-pile.

A *pneumatic* pile is one driven by the atmospheric pressure when the air is exhausted from within it.

A *hollow* pile is a cylinder which is sunk by excavation proceeding inside.

A *screw* pile has an auger at the lower end, and is sunk by rotation aided by pressure beyond its own weight, if necessary.

A *close* pile is one of whole timber, set closely to the others on each side.

A *false* pile is an additional length given to a pile after driving.

A *filling* pile is to fill the space between gage-piles.

A *foundation* pile is one for supporting a structure.

A *gage* pile is a preliminary pile to mark the desired course.

A *guide* pile limits the field of operations.

A *sheet* pile is of half-timbers in contact, filling the gaps between gage-piles.

A *sett* is a temporary prolongation at the upper end when a pile has passed beyond the stroke of the hammer.

A *wale* is a horizontal string-piece to bind the piles.

The *refusal* of a pile intended to support a weight of 13½ tons can be safely taken at ten blows of a ram of 1,350 pounds falling 12 feet, and depressing the pile .8 of an inch at each stroke.

Pile-cap; a beam connecting the heads of piles.

Pile-hoop; a band around the head to prevent splitting.

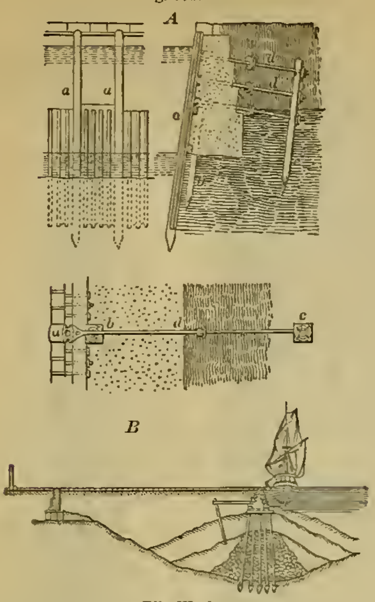
Pile-shoe; the metallic point.

The quay at Lorient is erected upon a bed of mud of unfathomable depth, and in this case both the wall and the platform behind it are carried upon piles driven with the broad end downward.

In Fig 3711, *A* is an elevation, plan, and section of the system of cast-iron piling employed in the construction of wharves at Deptford and Blackwall, England. The main piles *a a* have rabbets on each side, into which the sheeting is driven, and are secured at the back by stays and a thick bed of concrete; *b* is a guide-pile; *c*, a stay-pile; and *d*, land-ties. In driving, a piece of timber two inches thick was placed on each pile to relieve the jar of the ram, which weighed 15 cwt., and was allowed to drop but four feet.

The piles used in extending the quay of Rouen (*B*) were from 12 to 15 inches thick, and were driven with a monkey of 1,200 pounds falling 20 feet, delivering a blow equal to a pressure of 300,000 pounds. The heads of the piles were cut off 6 feet below low water, and stones were piled in. Caissons were sunk on to the piles, and in them the masonry was constructed. Each pile was calculated to support 18,633 pounds of masonry, and an

Fig. 3711.



Pile-Work.

estimated addition of one half for merchandise gave each pile a load of 27,000 pounds.

The quay was advanced 120 feet from the original wall. Sand and gravel were filled in behind the new wall, and the area was paved.

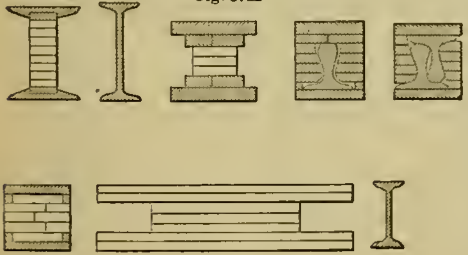
Hollow Pile. In situations where piling cannot be used to advantage, wrought or cast iron cylinders have been sunk vertically by digging away the soil from below them, the workmen operating inside and sending the earth up the iron shaft, which is like a well-curb. The water is pumped out as the work proceeds, and the sections of pipe are added from time to time, being fastened together by flanges and bolts. This plan has been frequently adopted in well-digging.

In the construction of the Terrace Pier, Gravesend, England, Redman constructed his foundations by sinking cast-iron cylinders in the manner stated, and filling them with a concrete of sand and pozzuolana, which made solid stone columns.

In the foundations of the Town Pier, Gravesend, England, erected 1834, Mr. Clark used a system of cast-iron piles. Under the site of each column were driven three cast-iron piles, on which an adjusting plate was firmly keyed, forming a broad base for the support of the column, which was adjusted to its correct position, and bolted down to the adjusting plate.

2. (*Iron-working.*) A pile of iron bars for reheating or balling consists of a number of pieces cut by shears to the size best adapted for the finished bar required, and then built up one over the other, according to the bulk required. The *pile* or *fagot* is then charged into the balling-furnace.

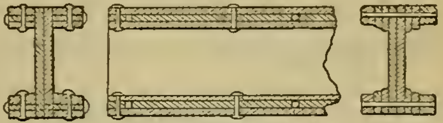
Fig. 3712



Piles for Rolling.

Piles are sometimes made up approximating a peculiar form required, as in some of the examples, and the various qualities of iron are so disposed in the different parts of the pile as to bring them where a special quality is desirable. See also FAGOT; BEAM; IRON, ANGLE, pp. 1198, 1199.

Fig. 3713.



Piles for Rolling into Beams.

3. A series of plates, as of zinc and copper alternately, in an exciting solution. A *voltaic pile.*

4. A stack of arms. See STACK.

5. A regular heap of shot or shells.

6. The *reverse* of a coin. The side occupied by the *arms.*

Formerly, the planchet was placed on a stake on which was a *cross*, and the *pile* or punch with the *arms* was driven by a hammer. The *cross* is now superseded by the *head*, which occupies the *obverse.*

7. (*Fabric.*) A fabric in which the warp is formed into loops which project from the face of the goods. When left in this condition, the goods, according to material and quality, may be, —

Uncut velvet.
Beaverteen.
Brussels carpet.

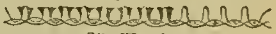
When cut, it may be, —

Turkey, Persian, or Wilton carpet.
Cut velvet.
Velveteen.
Plush.

In *pile-weaving*, in addition to the usual warp and weft threads, a third thread is introduced in the course of the weaving, and is thrown into loops by being woven over wires of the breadth of the cloth.

In *Brussels* carpet and *uncut velvet* the wires are simply withdrawn and the loops left standing. In *Wilton* carpet and *velvet* the threads are cut by passing a sharp knife along a director groove on the upper surface of the wire. This forms a nap, and is found in certain carpets, velvet, velveteen, fustian, etc.

Fig. 3714.



Pile-Weaving.

In the *Imperial Brussels* the figure is raised above the ground and its *pile* is cut, but the ground is uncut. In the *Royal Wilton* the pile is raised higher than in the common Wilton, and is also cut.

See under the following heads: —

Bearing-pile.
Beetle-head.
Bridge-pile.
Close pile.
Dolly.
False pile.
Fender-pile.
Fistuca
Gage-pile.
Galvanic pile.
Guard-pile.
Guide-pile.
Monkey.
Monkey-engine.
Pile-carpet.
Pile-drawer.
Pile-driver.
Pile-fabric.
Pile of iron bars for reheating.
Pile-saw.
Pneumatic pile.
Punch.
Ram.
Ringing-engine.
Screw-pile.
Sett.
Sheathing-pile.
Sheet-pile.
Short pile.
Stay-pile.
Stilts.
Tongs.
Voltaic pile.
Wall.

Pile-bridge. A bridge whose roadway is constructed on piles. An excellent plan over extensive shallow waters but little obstructed by ice, as that of the Wilmington and Baltimore Railroad over Gunpowder River, and many other places.

Cæsar's bridge (page 379) was also a pile-bridge with trestle superstructure.

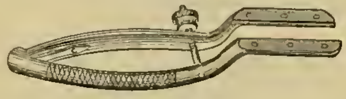
Pile-cap. (*Hydraulic Engineering.*) A beam connecting the heads of piles.

Pile-car'pet. A carpet made like Brussels Carpet (which see), excepting that the loops are cut, forming a *pile* or downy surface. For *pile* or *Wilton carpet* the wires are flattened, and have a groove along the upper surface, which forms a director for the knife, which cuts all the loops and liberates the wire.

Pile-clamp. (*Surgical.*) An instrument for removing hemorrhoids.

In the example, the two blades are made to close perfectly parallel by means of a screw, so as to equally compress the mass to be separated. This is afterward removed by the knife or by strangulation. The surfaces of the blades, which are applied to the integuments of the patient, are faced with ivory to prevent heat being communicated to the sensitive parts during the process of cauterization

Fig. 3715.

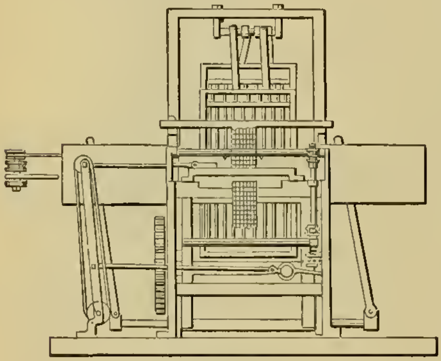


Pile-Clamp.

Piled-fab'ric Loom. One for weaving velvet, Brussels carpet, or plush.

In some cases, as in the example, two united piled fabrics are woven simultaneously and cut apart by a revolving knife operating in connection with a guard-finger in the loom to form velvet and similar goods. To vary the length of the pile, the guide-bars are set nearer or farther apart.

Fig. 3716.

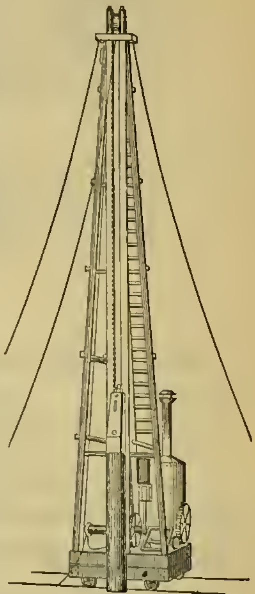


Piled-Fabric Loom.

Pile-draw'er. (*Hydraulic Engineering.*) When not too firmly imbedded, piles may be drawn by means of a simple lever. A screw set in a strong framing and turned by a windlass or crab may also be employed. Still greater power may be attained by the employment of the hydrostatic press. In tide-waters, a barge or scow can be made fast to the head of the pile at low water; this is a very effectual mode if the boat have sufficient elevating capacity. In either case, the attachment must be very secure. This is sometimes effected by boring a hole through the head of the pile and inserting an iron pin, projecting on either side; over the ends of this are passed iron rings or loops made fast to the lifting rope or chain. When the whole of the pile is below water, so that it is not accessible for this purpose, an elliptical iron collar is slipped over the head of the pile, and is caused to bind by hauling on the rope, the angles of its upper and lower edges bearing against the wood.

Pile-driv'er. (*Hydraulic Engineering.*) A machine having a rising and falling weight to drive a pile into its bed.

Fig. 3717.

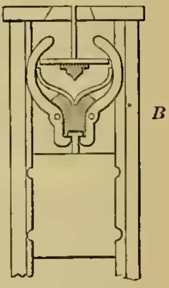


It is suggested that the *fistuca* whereby Cæsar drove the piles of his bridge over the Rhine must have been something similar to our machine, in which a weight is alternately lifted and dropped on the head of the pile.

Fig 3717 is a view of a steam pile-driver, in which the *monkey* is raised by a steam-hoist and automatically detached on reaching its hight. A pair of nippers, as seen at *B*, engages the hook on the top of the weight, and is kept in a closed position by springs. As the handles of the nippers reach the slot in the bar above, they are pressed together, releasing the jaws from the hook of the weight and allowing it to drop on the head of the pile

Some conception of the rapidity with which piles are driven by this machine may be formed, when it is stated that a pile measuring 60 feet in length and 14 inches square can be driven 45 feet into stiff soil, down to the rock below, in four minutes; and such is the good effect resulting from the blows being given by a great mass of 30 cwt. striking quickly but with small velocity of actual impact, that the head of the pile requires no hoop, and presents, after being driven, a neater appearance than it had when it was first placed under the hammer.

Fig 3718 is another kind of apparatus. *A* is an end; *B*, a side elevation; *O*, a plan of Nasmyth's steam pile-driver. The driving-apparatus *a b c* and pile are raised by a windlass operated by a small detached steam-engine, the former resting on the shoulders of the pile; the lifting-chain is then detached and steam from the boiler is admitted through the jointed pipe *d* into the cylinder *b*, alternately above and below the piston, the ram *c* giving a rapid succession of blows to the head of the pile until driven to the required depth, the jointed pipe *d* gradually following its downward movement. The pile and driver are guided in their descent by clamps, which loosely grasp a guide-rail at the side of the main upright.



Pile-Driver.

In Shaw's pile-driver, the monkey is sustained at its highest elevation by means of a ratchet and pawl, while a cartridge and cap are placed in a recess in the head of the pile. The pawl being withdrawn. the monkey falls upon and explodes the cartridge. The force of the explosion raises the monkey to the hight from which it fell, where it is automatically arrested by the detent arrangement

The effective force of the fall is said to be much increased by the action of the powder. One man places the cartridge in position and releases the monkey, or, as it is sometimes called, the *ram*. See Gunpowder-hammer.

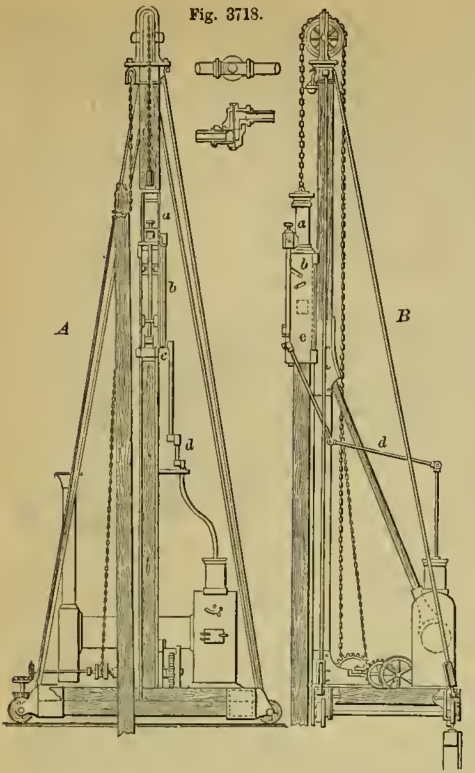
Pile-fab'ric. One in which a looped weft is formed by wires, to be afterward cut, as in velvet and in Wilton carpet, or left in loops, as in Brussels carpet.

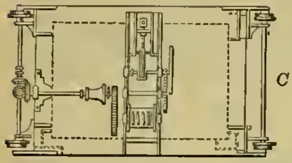
Pi-len'tum. A light vehicle, something between a cab and a carriage.

Pile-pier. (*Hydraulic Engineering.*) One supported on piles.

Pile-saw. The saw for cutting off piles below the surface of the water was invented by Labelye in planning the operation for establishing foundations for the piers of the Westminster Bridge, 1738, and improved by De Cessart, when building the bridge

Fig. 3718.



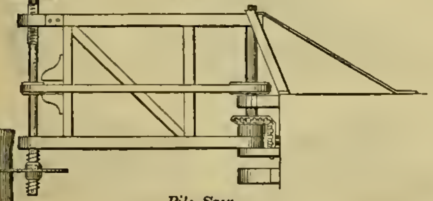


Pile-Driver.

of Saumur, 1756–64. In a simple form the machine consists of a frame composed of two longitudinal and three transverse timbers; to the central transverse piece are attached two uprights projecting above and below the frame, the saw being inserted between their lower ends, and their upper ends connected by a tension-rod for stretching the saw; handles are attached to the longitudinal piece of the frame, through which a reciprocating motion is given to the apparatus by the workmen, who stand on a platform.

Fig. 3719 is Vogler's pile-sawing attachment for boats. The circular saw is keyed on an upright shaft in a frame rigged outboard from the boat; it is secured between spiral springs above and below, which yield to the movements of the boat while cutting is going on, and is driven by belting from a shaft at that side of the frame nearest the boat, and rotated by bevel-gears operated by machinery on board.

Fig. 3719.



Pile-Saw.

Pile-shoe. (*Hydraulic Engineering.*) An iron joint at the foot of a pile, to enable it to penetrate hard ground. It may be a hollow pyramid of cast-iron; or two wrought-iron straps crossing at right angles may be secured to the foot of the pile.

Pile-sup-port'er. A *suppository* for preventing protrusion of the rectum.

Rabbi Moussa Ben Maimon wrote on hemorrhoids. He was known over Europe as the "Great Sage" Maimonides, and often designated by his initials R. M. B. M., or, briefly, Rambam. He was born at Cordova, A. D. 1135, but emigrated to Egypt, and became physician to Sultan Saladin. See Suppository.

Pile-warp. A warp which is woven in loops on the face to form a nap.

Pile-wire. (*Weaving.*) The wire around which the warp-threads are looped to make a pile-fabric. When the pile is to be cut, like velvet or plush, a groove on the top of the wire acts as a director for the knife.

Pile-with-draw'ing Ma-chine'. (*Hydraulic Engineering.*) A machine, usually a screw, worked by levers in the manner of a capstan, and connected by chain to the pile. See Pile-drawer.

Pil'ing. 1. (*Metallurgy.*) Building up pieces of sheared or scrap iron into a pack suitable for heating in a balling or reheating furnace, which forms the pile into a *loop* suitable for rolling. See Pile; Fagot.

2. (*Leather.*) Unhairing hides by piling or hanging up in a *stove*, so called.

Pill. Medicine in the form of a small ball, larger than a pellet.

Large pills of metallic antimony constituted a favorite ancient remedy, which were administered and passed through the system with no more effect than so many little pebbles. Indeed, the same pills were used over again, and half a dozen such globules lasted for an unlimited time, being inherited in the family and performing innumerable supposed cures upon successive generations. This was not so very long ago.

Pills in a box and rolls of material for making them were found in an apothecary's house in the disentombed Herculaneum.

Pil'lar. 1. (*Architecture.*) A column or pier forming an upright insulated support for a superstructure. The word is rather applicable to those of the Gothic and other irregular styles of architecture than to the Grecian and Roman orders, which are somewhat determinately proportioned and known specifically as columns.

A round pillar is a *column.*

A square pillar is a *pier.*

A flat pillar with a narrow return and apparently built into a wall is a *pilaster.*

A pier, similarly placed but without cap or base, is a *piedroit.*

2. (*Mining.*) The post or mass of coal or ore left for the support of the ceiling of a mine. The worked space is called *room.* Thus, *pillar and room* is equivalent to the usual technical phrase, *post and stall.*

3. (*Shipbuilding.*) A vertical post beneath a deck-beam.

4. The nipple of a fire-arm.

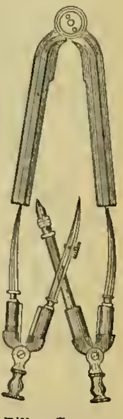
5. A frame on which the tobacco-pipes rest in a kiln.

6. (*Horology.*) One of the posts in a watch or clock which separate and yet bind together the *plates.*

Pil'lar-block. A corruption from Pillow-block (which see). See also Plumber-block.

Pil'lar-com'pass. A pair of dividers, the legs of which are so arranged that the lower part may be taken out, forming, respectively, a bow-pen and bow-pencil, or, by in-

Fig. 3720.



Pillar-Compass.

verting them in their sheaths in the upper part of the leg, a compass with a pen or pencil point is formed.

Pil'lar-file. A narrow, thin, flat hand-file with one *safe* edge.

Pill-box. One for containing little balls of medicine.

Some pill-boxes are made from *scaleboard* covered with paper. Plank have been cut into scales 120 to the inch, but $^1/_{30}$ of an inch is a more usual thickness. The scale is cut into pieces the size of a box, grooved half-way through where the sides and ends turn up, formed, the corners glued, and covered with thin paper. The after addition of bright-colored paper gives the box an ornamental appearance.

Pasteboard is used in the same way as scaleboard as a foundation for pill-boxes.

A veneer somewhat thicker than scale is cut into pieces for boxes, one die cutting the top, another the bottom piece, and others the sides of the box and cover. The sides are bent to shape by machinery, glued to the top and bottom respectively and the ends fastened by small tacks.

Paper boxes are made by winding a sheet of sized paper on a cylinder, drying, and cutting the resulting tube into rings as long as the hight of a box. Circular or oval bottom and top pieces are then glued in and held firmly by the covering paper. See Paper-box Machine.

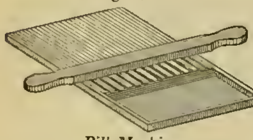
Wooden boxes are made with great rapidity by machinery. A straight grained stick is turned to the required size in a mandrel, and the cavity of the box bored out before the box is sawed off. The shoulder to receive the cover is cut by a mandrel. The cover is made in a similar manner, bored to fit the shoulder of the box. The completed boxes are cut off by saws or revolving cutters.

Pil'lion. 1. A woman's soft saddle.

2. A pad carried behind the saddle.

Pill-ma-chine'. An apparatus used by apothecaries for making pills of proper and uniform size. The ingredients, mixed to a doughy consistency with treacle or other substance, are formed into an elongated roll on the flat part of the slab by the aid of a flat stick; the roll is then divided by being pressed on the corrugated part of the slab, and the pills rounded by rolling with the fingers in sugar or other pulverized material to prevent adhesion.

Fig. 3721.

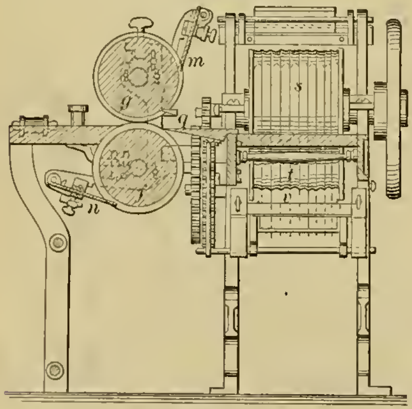


Pill-Machine.

Pills are frequently made by simply rolling the mass on a flat surface and cutting the roll into equal lengths, indicated on a graduated slip of porcelain, called a *pill-tile.*

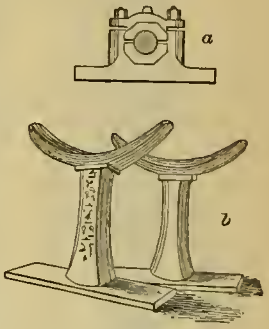
In Fig 3722, the mass is fed between the grooved rollers *f g*, by which it is cut into cylindrical slips, which are rolled by hand across the table *q* to the rollers *s t* at right angles to the first pair, and revolving with unequal velocities in opposite directions. This movement, combined with the rotary motion imparted by the hand, gives a rounded form to the pills as they are cut to size by the rollers *s t*, from which they pass along an incline to the farther compartment of a receiving-box, cuttings and pills under the proper size falling into the first compartment through a grating *v*. Scrapers *m n* are attached for cleaning the rollers.

Fig 3722.



Pill-Machine.

Fig. 3723.



Pillows.

Pil'low. 1. (*Machinery.*) *a.* The rest or bearing (*a*) of a gudgeon. A *brass;* usually, however, of bronze (copper, 96 to 108; tin, 11) and not brass (copper and zinc).

Other materials have been used: —

Babbitt-metal (which see).
Hard cast-iron.
Soap-stone.
Unseasoned green thorn-wood
Box-wood.
Green oak soaked in oil.
Compressed paper.
See Pillow-block.

b. The socket of a pivot. An *ink* or *step*.

2. (*Shipbuilding.*) A block of wood on which the inner end of the bowsprit rests.

3. (*Fabric.*) A kind of fustian having a four-leaved twill.

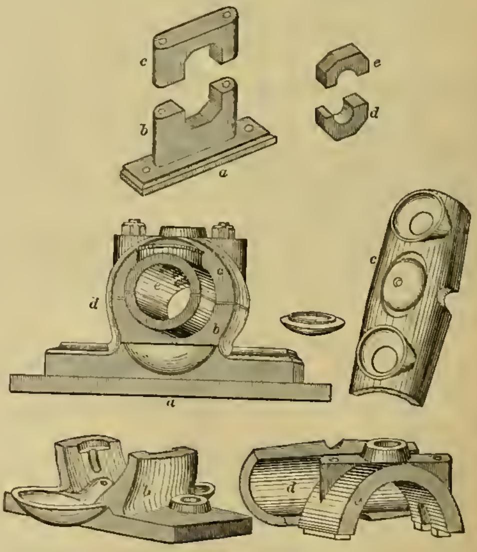
4. A cushion for the head.

The ancient Egyptians used a head-rest for a pillow (*b*), very similar to that now used in China and called a "head-stool," or rather by its equivalent in Chinese. It *looks* uncomfortable, but no doubt was preferred to our kind of pillow in a hot climate.

These Egyptian head-rests are mentioned by Porphyry. They were made of wood or alabaster. They are still used in China, Japan, Abyssinia, Ashantee, and Otaheite. Wood, stone, and earthenware are the modern as they were the ancient materials. They are from 4½ to 10 inches high.

Many of them are preserved in the British Museum. One of wood, 6¼ inches high, and inscribed with the name and titles of Mas-khar-haô. Another of arragonite, 6⅞ inches high, with a fluted column, and the name and titles of Atai in front.

Fig. 3724.



Pillow-Block.

a, base. *b*, pedestal. *c*, pedestal-cover.
d, pillow. *e*, cap.

Others might be cited. It appears to have been a regular piece of household furniture.

The Egyptians were not ignorant of the use of soft pillows. A cushion with a linen cover and filled with the feathers of water-fowl is preserved in the British Museum.

Michal, when she sought to save her husband David from the fury of her father Saul, took an image and laid it in the bed, pillowing its head upon a bolster of goat's hair covered with a cloth

Cushions and pillows are common in the East, formed of sheep's fleeces or goat-skins stuffed with cotton.

Pil'low-block. (*Machinery.*) An iron cradle or bearing to hold the *boxes* or *brasses* which form a journal-bearing for a shaft or roller.

Pil'low-lace. A lace made with bobbins or pirns upon a pillow. *Bobbin-lace.*

It was originally made of silk or thread woven into a net with hexagonal or octagonal meshes. Afterward, it was ornamented with a thicker thread called *gimp*, so interwoven with the meshes as to form flowers and curved designs. The pillow is hard stuffed and covered with parchment, on which the design is drawn. To form the meshes, pins are stuck into the cushion and the threads woven or twisted round them. The pattern on the parchment indicates the spots for the insertion of the pins, and also shows the places for the gimp, which is interwoven with the fine threads of the fabric. The work is begun at the upper side of the cushion by tying the threads together in pairs, each pair being attached to a pin. The threads are twisted and crossed and secured by the pins, which determine the meshes.

Pill-tile. A corrugated metallic slip for rolling pills on, to divide them accurately.

Pi-lon'-mill. A stamp-mill. The term is more particularly applied to the mill for incorporating the ingredients of gunpowder.

Pi'lot. The *cow-catcher*, or frame in front of an engine to push obstructions from the rails.

Pi'lot-cloth. (*Fabric.*) A heavy indigo-blue woolen cloth for overcoats and seamen's wear.

Pi'lot-en'gine. A locomotive sent in advance of a train, as a precaution.

Pil-u'li-er. (*Pharmacy.*) *a.* An instrument for rolling and dividing pills.

b. An earthen pot for pills.

Pi'lum. (*Pharmacy.*) A wooden, iron, bell-metal, marble, agate, porcelain, or glass instrument for triturating substances in a mortar. A *pestle.*

Pin. 1. A small piece of headed and pointed wire used as a dress fastening.

The pins used by the ladies of ancient Egypt were usually of bronze; more expensive ones were of silver or gold.

A collection of twenty-five bronze pins from the subterranean vaults of Thebes are in the Museum of the Louvre. A number are also in the Abbott Collection, New York City.

Some of the ancient Egyptian pins are 7 or 8 inches long, and have large golden heads or a band of gold at the upper end, these latter being probably used as hair-pins.

The ancient Mexicans also used pins, but generally employed the thorns on the agave as a substitute.

The pins mentioned in the Bible were those of metal for fastening the hanging around the court of the temple, and were like tent-pins; and others of wood, mentioned by Ezekiel, which were in fact wooden pegs driven into a wall to hang clothes upon.

The Roman pins had round, square, perforated, or ornamented heads: were usually of bronze; were from 1½ to 8 inches long, and were sometimes of wood, ivory, or bone. Hair-pins were common for holding up the knot of braided hair.

Before the invention of pins there were many pretty and ingenious devices for fastening the dresses and ornaments of both sexes, such as ribbons, loop-holes, laces with pearls and tags, clasps, hooks and eyes, and skewers made of gold, silver, and brass. From the latter pins were derived, being only miniature skewers. The first mention of brass pins in the English statutes is in 1483, when their importation was prohibited. An act of Henry VIII., A. D. 1543, indicates the clumsy things they were: "No person shall put to sale any pinnes, but only such as shall be double-headed, and have the heads soldered fast to the shank of the pinne, well smoothed, the shank well shaven, the point well and round filed, canted and sharpened."

The mode of making them was much improved about 1560.

Catherine Howard, queen of Henry VIII., it is said, used brass pins brought from France.

Before the introduction of Wright's pin-making machine, 1824, the following was the process: Brass wire was straightened by drawing it between pins set in zigzag order on a bench, and was then cut into lengths for six pins. These were taken a number at a time, and pointed at one end by grinding on a coarse and a fine grindstone. A length for a pin was then cut from each wire, and the process was repeated till the pieces of wire were used up. The heads were made from pieces of a fine wire coiled around a mandrel, which was then slipped out of the coil. Two convolutions were cut off for each head, and were then annealed. These bicoils were put in a tray before little boys, who fastened them on to the pins by a foot-worked hammer and an anvil. The pins were then cleansed by boiling in sour beer, wine lees, or tartar, and tinned by being laid in alternate strata with grain tin and boiled; washed, winnowed with a fan, and finally inserted by hand in the papers

Of late years iron wire has been largely substituted for brass in the pin manufacture, making a cheaper though less enduring article.

In Wright's patent, the main shaft of the machine gives motion in its rotation to a number of sliders, levers, and wheels, which work the different parts of the apparatus. A slider pushes forward pinchers, which draw wire from a reel at every rotation of the shaft, and advance such a length of wire as will produce one pin. A die cuts off this length by the descent of its upper jaw, and the latter then opens a carrier, which takes on the wire to the pointing apparatus. Here it is received by a revolving holder, while a bevel-edged file-wheel, rapidly turning, gives to the wire its first rough point. It proceeds immediately by a second carrier to a finer file-wheel, by which the process of pointing is finished. A third carrier transfers the pin to the first heading-die, and by the advance of a steel punch one end of the pin-wire is forced into a recess, whereby the head is partially produced. A fourth carrier removes the pin to a second die, where the heading is completed. When the heading-bar retires, a forked lever draws the pin from the die and drops it into a receptacle beneath. This completes the production of the pin so far as the machine is concerned, but it has yet to be whitened, polished, sorted, and stuck.

The first process is effected by rolling them in a rotating barrel containing sawdust: after removal from this they are placed in kettles, between perforated plates of tin, which form alternate layers with the pins. Very dilute nitric acid is added, and boiled for three hours, when the pins, covered with an almost infinitely thin coating of tin, are withdrawn, being then of a dull whitish hue. They are again rolled in a barrel with hot sawdust to give them the final polish. The perfect and imperfect pins are then separated by a series of belts having a combined horizontal and oscillating movement, which retain the defective ones on the belts until arriving at their ends, while those of perfect form, having no hold on the belts, are shaken off into a receptacle below.

To separate those of different sizes, they are transferred to an inclined plane, down which they slide to a horizontally revolving wheel provided with sets of steel fingers, each of which is adapted to grasp pins of a particular length and distribute them into separate receptacles.

Having been sorted, they are next stuck into the papers. This may be effected by the hand-machine or the power-machine

In the former the pins are placed in a hopper, and are caught by their heads between conductors which convey them through a goose-neck to a slide having as many notches as there are to be pins in a row; when these are filled the slide is withdrawn, a crimper seizes the paper and holds it while the pins are driven through.

In the power sticking-machine the pins are placed upon a slowly revolving table, from which they drop into a revolving cylinder having longitudinal ribs, which transfer them to an endless chain, the links of which are notched so as to receive the pins, which hang by their heads and are carried forward to a gate, where they are driven into the paper, which is simultaneously crimped and held to receive them.

Pins of peculiar forms and sizes are made for specific purposes. Among these may be mentioned *diaper*, *dress*, *cloak*, *scarf*, *shawl* pins, whose names indicate their duty.

Besides these are others used in the toilet or about the work-table, such as the *breast*-pin, *hair*-pin, *sewing*-pin, etc.

2. A peg or bolt of wood or metal, having many uses. Among these may be cited, —

a. A *bedstead*-pin, projecting from the rail to hold the cord.

b. A *belaying*-pin, for coiling ropes upon.

c. A *coupling*-pin, uniting the draw-heads of adjacent railway-cars.

d. A *tent*-pin, to which the ropes are fastened.

e. A *treenail.*

3. The axis of a sheave.

An axis of a joint, as of the gimbal or compass-joint.

4. A *clothes*-pin, to grip a garment to a clothes-line.

5. The bull's-eye of a target.

6. The peg of a stringed instrument on which it is wound in tightening.

7. The *linch*-pin of an axle.

8. The turning axis of a capstan, crane, windlass, etc.

9. (*Locksmithing.*) The part of a key-stem which enters the lock. See Key.

10. (*Joinery.*) The smaller member of a dovetail which fits into the *socket* or receiving portion.

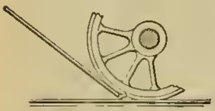
11. To swage by striking with the *peen* of a hammer; as splaying an edge of an iron hoop to give it the flare corresponding to that of the cask.

Pi'na. (*Spanish.*) The pile of wedges or *bricks* of hard silver amalgam placed under a *capellina* and subjected to heat, for the expulsion of the mercury. See Amalgamator.

Pin'cer. See Pinchers.

Pinch-bar. A lever with a fulcrum-foot and projecting snout; applied beneath a heavy body to move it by successive small raisings and shiftings.

Fig. 3725.



Pinch-Bar.

Pinch'beck. A brass for cheap jewelry: copper, 5; zinc, 1. Named after the introducer. See Alloy.

Pinch'ers. An instrument having two handles and two grasping jaws, formed of two pieces pivoted together. Pinchers are adapted for special work, such as drawing nails, for shoemakers' use (see cut).

C, common pinchers.

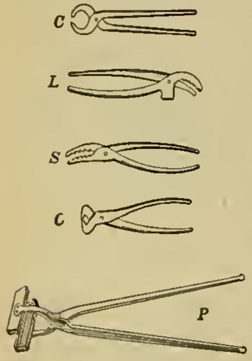
L, lasting-pinchers.

S, shoemakers' pinchers.

C, cutting-pinchers.

P, pinching-tongs for making glass *drops* for chandeliers.

Fig. 3726.



Pinchers.

Pinch'ing. A term applied to moving a heavy object, such as a gun, mortar, log, or bed-plate, by small heaves of the handspike, which describes arcs of a circle nearly horizontally. See Pinch-bar.

Pinch'ing-bar. A crow-bar for moving an object by successive short hitches. A *pinch-bar.*

Pinch'ing-nut. A *jam-nut* screwed down upon another nut, to hold it in position. A *check-nut* or *lock-nut.* See Nut-lock.

Pinch'ing-pin. (*Steam.*) A portion of the devices by which a slide-valve is packed or tightened upon its seat.

Pinch'ing-tongs. (*Glass-making.*) Used for making chandelier-drops, etc. Each jaw of the tongs carries a die, between which a lump of glass heated to plasticity is compressed; a wire between the jaws makes the hole by which the drop is suspended. It is afterward cut and polished on a leaden lap. See Pinchers.

Pin-cop. (*Spinning.*) A yarn, roll-shaped like a pear, used for the weft in power-looms.

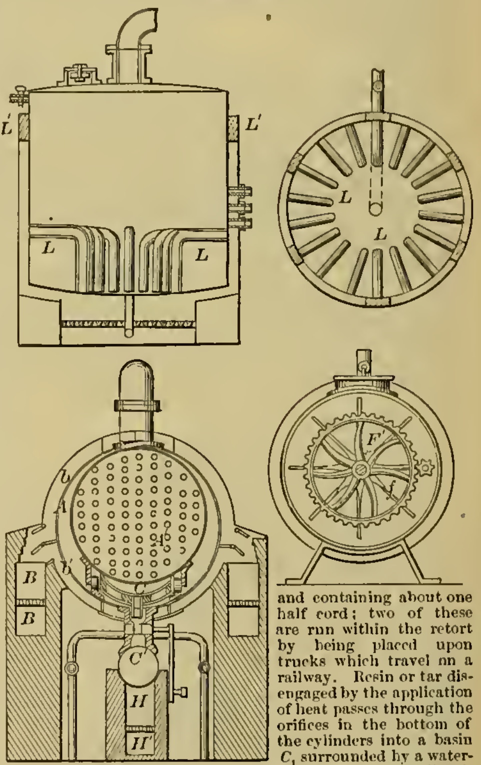
Pin-drill. A drill for countersinking. The central portion is a plug, which fits in the hole previously bored, and around it is an annular cutting portion, which makes the depression for the head of a bolt, rivet, or screw. In a certain modification, the drill is steadied in position by a center-pin, which bears in a hole made by a center-punch retiring into the stock as the drill advances into its work.

Pine-leaf Fab'ric. This is described in the "Journal of the Franklin Institute," 1852, page 412 *et seq.* The green leaves are used in preference at Breslau for making this pine-tree wool, which was extensively used from 1842 for mattresses, coverlets, etc. Five hundred of these coverlets were purchased for the hospital of Vienna in the former year, and shortly afterward at other places. It was particularly useful as stuffing for beds and for upholstering, as it was offensive to insect vermin. The leaves are treated by heat and chemical reägents to separate the fibers and remove the resin. The invention is credited to M. Pannewitz. "Bib. Univ. de Genevi," June, 1852, page 165. See also English patent, No. 1002, 1853. See also Belgian patent, "Genie Industriel," Paris, 1864, page 104, where the process is fully described.

Pine-wood Still. An apparatus for obtaining tar, resin, and the volatile products of pine-wood by distillation.

Mellen's consists (1) of a cylindrical retort *A* surrounded by flues *b b'*, and heated by a furnace *B B* on each side; the wood is placed in cylinders *A'* perforated at their heads and bottoms, and containing about one half cord; two of these are run within the retort by being placed upon trucks which travel on a railway. Resin or tar disengaged by the application of heat passes through the orifices in the bottom of the cylinders into a basin *C*, surrounded by a water-jacket, and is finally allowed to flow into the pitch-chamber *C'*, heated by the furnace *H H*. The volatile products, turpentine or pyroligneous acid, pass over into a condenser, from whence they are drawn off into a rotating agitator *F' f*, where they are mingled with purifying agents. This process complete, they are transferred to the still *L L L' L'*, which is surrounded by a fire-jacket, and has radial flues in its lower part; in this they undergo the final distillation.

Fig. 3727.

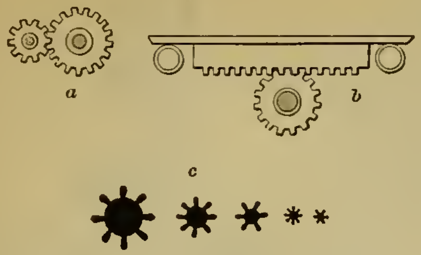


Pine-Wood Still.

Pine-wool. Fiber obtained from the leaves of *Pinus sylvestris*, from which *vegetable flannel* is made. See Pine-leaf Fabric.

Pin'ion. Of two cog-wheels in gear, the lesser is called the *pinion.* It may be *spur*, *bevel*, *miter*, etc. The pinions of watches are made from pinion-

Fig. 3728.



Pinions.

a, pinion and spur wheel; *b*, pinion and rack; *c*, pinion-wire

wire, turned down at the parts which are not destined to mesh with the coäcting wheel.

Pin'ion-file. (*Watchmaking.*) A knife-file employed by watchmakers.

Pin'ion-gage. (*Watchmaking.*) A fine calipers.

Pin'ion-wire. (*Metal-working.*) Wire formed into the shape and size required for the pinions of clocks and watches; it is drawn in the same manner as round wire through plates whose holes correspond in section to the shape of the wire. See PINION.

Pink. (*Nautical.*) A ship with a very narrow stern; used in the Mediterranean.

Pink'ing-i'ron. A cutting-tool for scalloping the edge of ribbons, flounces, paper for coffin trimmings, etc.

Pink-salt. (*Dyeing.*) Ammonia combined with perchloride of tin, used in calico-printing.

Pink-stern. (*Nautical.*) Said of a vessel with a very narrow stern.

Pin-lock. One of which the bolt is a round protruding pin, as in some forms of locks.

Pin'nace. *a.* A man-of-war's boat, next in size to the launch; it is carvel-built, usually 28 to 32 feet long, has a beam .29 to .25 of its length, and is rowed by 6 or 8 oars.

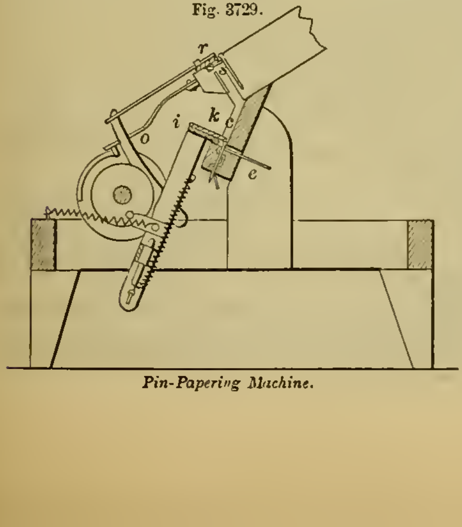
b. A small schooner-rigged vessel provided with oars or sweeps; vessels of this kind of 60 to 80 tons burden were formerly employed by the French for coast defense, and carried one long 24-pounder and 100 men.

Pin'na-cle. (*Architecture.*) An ornament placed on the top of a buttress as a termination to an angle or gable of a house, church, or tower; also a summit or lofty apex.

Pin'ning-in. (*Masonry.*) The filling in of the joints of stone walling with spalls of stone.

Pin-pa'per-ing Ma-chine'. In Fowler's machine the pins, fed from an inclined table, are separated and arranged into a row by reciprocation of the stop-bar *r* and toothed cut-off *s*; falling into grooves *c*, they are conducted to the spring door *k*, which is swung open by the vibratory movement of the rake *i* to the crimper, and forced through the paper by a downward motion of the rake.

Fig. 3729.



Pin-Papering Machine.

Pin-rack. (*Nautical.*) A frame placed on the deck of a vessel, and containing sheaves around which ropes may be worked, and belaying-pins around which they may be secured.

Pin-tail. The iron pin in the axletree of a limber, to which the trail-eye of the gun-carriage is attached for travel. *Pintle.*

Pin'tle. A pivot-pin, such as that of a hinge.

a. The *hook* portion of a rudder hinge which is driven into the stern-post and receives the *brace* of the rudder. 1, *pintle;* 2, *brace* (Fig. 3730) with *jaws* which clasp the rudder.

A dumb-pintle at bottom is the step of the rudder on the framing. The rudder is *wood-locked* above to prevent unshipping. See Fig. 3730.

b. A bolt to prevent the recoil of a cannon.

c. The bolt on which a chassis oscillates in traversing.

d. A plate with projections of the nature of dowel-pins placed between the lengths which constitute an upright post.

e. A king-bolt of a limber or wagon.

f. The pin on which the leaves of a hinge vibrate.

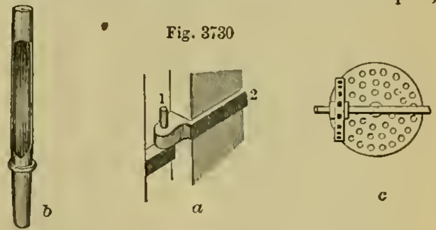
Pin-tool. A tubular cutter (*b*, Fig. 3730) for making pins for sash, blind, and door makers. The stuff is got out in the square, and is cut round by forcing the tool against it in the direction of the grain. The stuff is pine, poplar, or other soft wood. Hard-wood pins for *dowels*, etc., are turned. See ROD, PIN, and DOWEL.

Pin-vise. (*Clock-making.*) A hand-vise for grasping small arbors and pins.

Pin-wheel. A contrate wheel in which the cogs are pins set into the disk.

The disk-wheel *c* has three concentric rows of pins, either of which may be made to engage the mortise-wheel, according to the speed required.

Fig. 3730



b, *Pin-Tool.* *a*, *Pintle.* *c*, *Pin-Wheel.*

Pipe. 1. A tube for conveyance of water, air, or other fluid.

Clay pipes were used by the Romans for aqueducts, drains, hollow walls, and domes. The pipes had contracted ends to enter the sockets of the adjoining ones. In the thermæ of Antoninus the pipes were cylindrical; in the baths of Titus, square; in the fountain of Egeria, conical and fitting into each other.

Pipes are now made of cast and wrought iron, copper, lead, tin lined lead, various kinds of clay and concretes, glass; wood treated with antiseptics or with resins, paraffine, etc., to render it water-proof; folds or plies of scaleboard or paper treated as stated.

" Through pipes of metal, water both warm and cold, to suit the season of the year, was delivered into baths of marble." Description of the palace of Abderrahman III. at Zehra, Spain, about A. D. 757. Talk about a house "with all the modern conveniences"!

Rule for the Computation of the Weights of Cast-Iron Pipes (HORATIO ALLEN).

To the inner diameter of the pipe add the thickness of the pipe in inches, and multiply the sum by two times the thickness, and the product will give the weight in pounds per foot.

Weight of Riveted Iron and Copper Pipes, from 5 to 30 Inches in Diameter, from 1/8 to 5/16 in Thickness, 1 Foot in Length (Haswell)

Diameter.	Thickness.	Iron.	Copper	Diameter.	Thickness.	Iron.	Copper.
Inch.	Inch.	Lbs.	Lbs.	Inch.	Inch	Lbs.	Lbs.
5	1/8	7 12	8.14	9	1/4	25.01	28.58
	3/16	10.68	12.21		1/4	26.33	30.09
	1/4	14.25	16.28	10	1/4	27 75	31 71
5 1/2	1/8	7.78	8.89	10 1/2	1/4	29.19	33 22
	3/16	11.66	13.33	11	1/4	30.49	34.85
	1/4	15 56	17.78	12	1/4	33.13	37.86
6	1/8	8.44	9.64	13	1/4	35.88	41
	3/16	12.65	14.46	14	1/4	38.52	44.02
	1/4	16.88	19.29	15	1/4	41.26	47.15
6 1/2	1/8	9.1	10.4		5/16	51.57	58.94
	3/16	13.65	15.6	16	1/4	43.9	50.17
	1/4	18.2	20.8		5/16	54.87	62.71
7	1/8	9.78	11.18	17	1/4	46.53	53.18
	3/16	14.68	16 78		5/16	58 17	66.48
	1/4	19.57	22.37	18	1/4	49.17	56.2
7 1/2	1/8	10 49	11.99		5/16	61.47	70 25
	3/16	15.73	17 98	20	5/16	68 07	77 79
	1/4	20.89	23 87	24	5/16	81.33	92.95
8	3/16	16 7	19.08	25	5/16	84 57	96.65
	1/4	22.26	25.44	28	5/16	94 56	107.95
8 1/2	1/4	23.59	26 96	30	5/16	101.14	115 59

The above weights include the laps of the sheets for riveting and calking.

The weights of the rivets are not added, as the number per lineal foot of pipe depends upon the distance they are placed apart, and their diameter and length upon the thickness of the metal of the pipe.

Table of Standard Dimensions of Wrought-Iron welded Tubes (Haswell).

Nominal diam.	External diam.	Thickness.	Internal diam.	Internal circum.	External circum.	Length of pipe per sq. foot of internal surface.	Length of pipe per sq. foot of external surface.	Internal area.	Weight per foot.	No. of threads per inch of screw.
In	Ins.	Ins.	Ins.	Ins.	Ins	Feet.	Feet.	Ins.	Lbs.	
⅛	.40	.068	.27	.85	1.27	14.15	9.44	.057	.24	27
¼	.54	.088	.36	1.14	1.7	10.5	7.075	.104	.42	18
⅜	.67	.091	.49	1.55	2.12	7.67	5.657	.192	56	18
½	.84	.109	.62	1.96	2.65	6.13	4.502	.305	.84	14
¾	1 05	113	.82	2 59	3.3	4.64	3.637	.533	1.13	14
1	1.31	.134	1.05	3 29	4.13	3.66	2.903	.863	1.67	11½
1¼	1 66	14	1 38	4.33	5 21	2.77	2.301	1 496	2.26	11½
1½	1 9	.145	1.61	5.06	5.97	2.37	2.01	2.038	2.69	11½
2	2.37	.154	2.07	6.49	7.46	1.85	1.611	3.355	3.67	11½
2½	2.87	.204	2.47	7 75	9 03	1 55	1.328	4 783	5.77	8
3	3 5	.217	3 07	9.64	11	1.24	1.091	7.388	7.55	8
3½	4	.226	3.55	11.15	12 57	1.08	0.955	9.887	9.05	8
4	4.5	237	4 07	12.69	14 14	.95	0.849	12.73	10 73	8
4½	5	.247	4.51	14.15	15.71	.85	0.765	15.939	12.49	8
5	5 56	259	5.04	15.85	17.47	.78	0.629	19.99	14.56	8
6	6.62	28	6 06	19.05	20 81	.63	0 577	28.889	18 77	8
7	7 62	.301	7 02	22 06	23.95	.54	0.505	38 737	23 41	8
8	8.62	.322	7.98	25 08	27.1	.48	0 444	50.039	28.35	8
9	9.69	344	9	28.28	30.43	.42	0.394	63 633	34.08	8
10	10.75	.366	10.02	31.47	33.77	.38	0 355	78.838	40.64	8

The following list includes pipes known by their material, mode of manufacture, purpose, construction, or form; also machines and tools for making or using them. See under the following heads: —

Blast-pipe.
Burras-pipe.
Chain locker pipe.
Clay-pipe.
Cock.
Concrete-pipe.
Coupling.
Drip-pipe.
Earthen pipe.
Eduction-pipe.
Exhaust-pipe.
Faucet
Feed-pipe.
Flange-pipe.
Flute-pipe.
Gas-pipe.
Hawse-pipe.
Heating-pipe.
Iron pipe.
Laminated pipe.
Lead pipe.
Locomotive smoke-pipe.
Main.
Mouth-pipe.
Organ-pipe.
Pandean-pipe.
Pipe-clamp.
Pipe-clearer.
Pipe-coupling.
Pipe-cutter.
Pipe-grab.
Pipe-joint.
Pipe-molding.
Pipe-prover.
Pipe-socketing machine.
Pipe-threader.
Pipe-tongs.
Pipette.
Pipe-valve.
Pipe-vein.
Pipe-vise.
Pipe-wrench.
Pitch-pipe.
Reed-pipe.
Screwed tubes.
Service-pipe.
Socket-pipe.
Smoke-pipe.
Smoking-pipe.
Stand-pipe.
Steam-pipe.
Stone pipe.
Sub-aqueous tube.
Suction-pipe.
Tapping water-pipe.
Thimble-joint
Tile-machine
Tin-lined lead-pipe.
Tobacco-pipe.
Tube-drawing.
Tube-welding.
Union.
Valve.
Water-pipe.
Welded tube.
Wooden pipe.
Wrought-iron pipe.

2. (*Music.*) A tube of wood or metal used in wind-instruments, as the *Pandean*-pipes, the *organ*, etc.

Many straight tubular instruments have specific names, as the *flute, flageolet, clarinet*, etc. See list under Musical Instruments. The pipe is among the most ancient of wind-instruments. See Flute.

Ptolemy, in his "Harmonics," explains how the acuteness and graveness of notes is produced: "In strings and pipes, other things remaining the same, those which are stopped at a smaller distance from the bridge give the most acute note; and in pipes, those notes which come through holes nearest to the mouth-hole are most acute."

The ancient pipe (*tibia*) had various forms; was made of reed, of boxwood bored with a gimlet (*terebrato buxo*), or of bone; that of asses preferred by the Greeks. It is suspected that the clarinet, flageolet, and flute forms were all known and used; the bagpipe also. One form of single pipe had a mouth-piece set in at right angles. The Pandean-pipe or syrinx is very ancient. The double pipe was rather a pair of pipes, and was used for air and accompaniment. They were distinct and of different pitch, say bass and treble; known as *tibia dextra, tibia sinistra, male* and *female;* low and high.

The mouth-pieces of the musical pipes were made of a reed growing in a lake above Celænæ in Phrygia. (Strabo.) Pliny also mentions it The double pipe was a very common instrument with the Egyptians and Greeks, and still survives as the *zumára* of modern Egypt.

Among the pipe-instruments of the Japanese we recognize the analogues of the Pandean-pipes, the flute, and the flageolet.

Organ-pipes are of two kinds: —

1. The *flute-pipe* or *mouth-pipe*, which has a lip to cut the wind escaping through an orifice in a diaphragm. See Mouth-pipe.

2. The *reed-pipe*, wherein the sound is first produced by the vibration of a metallic tongue. See Reed-pipe.

Mouth-pipes are technically said to have *bodies*, and reed-pipes *tubes.*

The *pitch* of the note depends upon the length of the pipe above or beyond the *mouth.* The longer the pipe, the graver the tone, and conversely.

Doubling the length of the pipe gives a note an octave lower. Halving the length of a pipe gives a note an octave higher. Stopping the end of a pipe lowers the pitch one octave, the effect being to double the length, as the wind is obliged to return on its tracks and find an exit at the mouth, after having twice passed the length of the pipe.

"Tomlinson on Acoustics" gives the following table: —

	Length of open pipe in feet.	Vibrations per second.
The lowest audible note, C below, is produced by....................	32	32
The lowest C of a grand piano is produced by....................	16	64
The lowest C of the violoncello is produced by....................	8	128
The tenor C is produced by.......	4	256
The middle C. the note of the C clef, is produced by....................	2	512
C on the third space in the treble clef is produced by.............	1	1,024
C in alt is produced by............	½	2,048

The length of a pipe for a given octave being 1, the lengths for the intervals will be as follows: —

The upper C..............	1/2	F..........................	3/4
B..........................	8/15	E..........................	4/5
A..........................	3/5	D..........................	8/9
G..........................	2/3	The lower C..............	1

The quality of the tone, the *timbre*, depends on the size of the pipe, the material of which it is made, the form of the body or tube, and the nature of the construction, whether *reed* or *mouth.*

Different woods give tones differing in respect to mellowness and clearness.

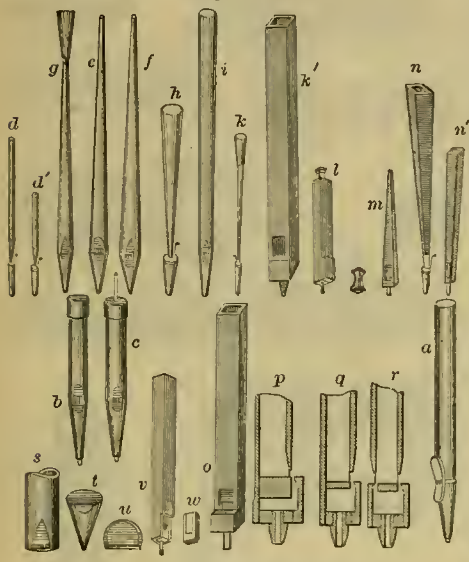
It has been noticed, that while the sides of a wooden pipe vibrate violently in the process of *speaking*, the front and back remain perfectly quiet.

The thickness of the material, its toughness and elasticity, exert an influence on the tone of metallic pipes without at all affecting their pitch. The size and proportions of the mouth also affect the quality of the sound emitted by the pipe. The standard proportions are, for the width of the mouth one fourth the diameter of the pipe, and for its depth one tenth of the same diameter; but these are varied to produce different effects. A wide and high mouth produces a round, powerful tone; a narrow mouth a sharper tone; and a narrow and low mouth a delicate tone. If, however, the upper lip be too high, the pipe will either sound slowly or not at all; and if the mouth be too narrow, it will speak an octave above the correct note.

Pipes are either round or rectangular in cross-section, and these two classes are divided into several varieties. The principal kinds of round-bodied pipes are cylindrical, conical, conical surmounted by a bell, inverted cone, inverted cone surmounted by a bell. Cylindrical pipes are either *open* (*a*, Fig. 3731), *stopped*, or half stopped, the first being more numerous in all organs. The stops called *open diapason*, *principal*, *fifteenth*, and *mixture*, among others, are usually composed of pipes of this shape.

Stopped cylindrical pipes (*b*) are closed at top by a metallic cap. They are rare in English, but quite common in German organs, under the names of *gedacht* and *quintation*.

Fig. 3731.



Organ-Pipes.

Half-stopped pipes (*c*) have a perforated cap, in which a small tube is inserted.

In certain stops cylindrical pipes perforated with one or two holes near the top or about midway of the body are employed.

Though usually of metal, it is common in Germany to make cylindrical pipes of wood; these produce a very superior tone.

Some soft-toned *reed*-stops, as the *clarinet* (*d*) and *vox humana* (*d'*), are cylindrical.

Conical pipes vary considerably in taper. *e* represents the German *spitz flote*, which tapers to about one half its greatest diameter The *gemshorn* (*f*) has a still greater diminution at the top Conical pipes with a bell at top (*g*) are used in the *viol de gamba* stop of English organs.

Inverted conical pipes (*h i*) are largely employed in most organs, the greater portion of those of the reed stops having this general form. Flue-pipes are also in some cases made in this way. Inverted cones with a bell (*k*) are employed for the *hautboy* and its octave.

Four-sided pipes are common in most organs; they are either *open* (*k'*) or partially or entirely *stopped*. Open pipes of this class are frequently introduced in the bass of the *dulciana* and *open diapason*. Some stops, as the *claribella*, etc., are exclusively composed of open pipes.

Four-sided *stopped* pipes (*l*) are closed at the upper end with a *stopper* fitting within the tube and provided with a handle. In half-stopped pipes a perforation is made through the handle and stopper. Pipes of this kind are generally used in the treble of certain stops, the larger sizes seldom being bored.

Pyramidal pipes (*m*) are sometimes used in the bass of tops composed principally of metallic conical pipes; in some instances, entire stops are made up of them.

Inverted pyramidal pipes (*n n'*) are frequently used in the large reed-stops, 16 to 32 feet; small reed-stops, as the *bassoon*, are frequently composed of pipes of this kind.

In stopped and half-stopped wooden pipes the stopper is covered with leather at the top and sides, to make a tight joint.

The mouth is formed by beveling off the front board (*o*), so that its lower edge constitutes the upper lip, and leaving an opening between it and the cap, the upper edge of which is the under lip.

Sometimes the mouths of *block pipes* are inverted. In this arrangement, the inner surface of the front board is beveled (*p*), and the block extends as far as the outer surface of the body. *Languid* wooden pipes (*q*) have a plate or languid (Fr. *langue*, tongue) of wood substituted for the block. Large pipes are often of this kind The *double-mouthed* pipe (*r*) has a mouth on each side placed opposite each other, producing, it is claimed, greater strength of tone.

The gravity or acuteness of the note produced, in other words, the *pitch*, depends, in pipes of the " mouth " or " flue " class, upon their length In the reed kind, on the contrary, it depends on the size of the mouth-piece and the vibrations of the tongue; thus, an open-flue pipe must have a body of eight feet length to produce the CC sound, while the tube of the reed-pipe may be only eighteen inches long. In instruments of the accordeon class, the tube is entirely dispensed with, the note being formed by the tongue alone; the tube, however, greatly increases the strength and fullness of the sound.

An open metallic flue-pipe consists of three parts: the *body*, *foot*, and *language*, *languid*, or *languette* The *body* (*s*) is the part above the mouth. It is formed by rolling a sheet of metal around a mandrel, the edges forming the seam being soldered together; on the front or opposite side, an indentation, the *leaf*, is formed at bottom, the lower part of which is cut away, leaving an opening, the *mouth*; the lower edge of the leaf is termed the *upper lip*. The *foot* (*t*) is an inverted cone, formed in a similar manner, and having a corresponding indentation, called the *under lip*, which conducts the wind to the mouth through an aperture at the apex of the cone. The foot also serves as a support to the pipe, for which purpose it is made of extra thickness and strength.

The *language* or *languid* (*u*) is a flat piece of strong and thick metal immediately over the top of the foot and just inside the mouth. Its front edge is straight, like those of the upper and under lips, but is placed slightly behind the latter, so as to leave a narrow opening, the *wind-way*, between. This edge is also beveled and indented, to direct the *sheet of wind* fairly against the upper lip.

Stopped metal pipes have a cap either tightly fitting but movable or soldered on over the body.

Half-stopped pipes have a small cylindrical tube or chimney soldered into a hole in the center of the cap, somewhat increasing the freedom and strength of the tone. Metallic flue-pipes are frequently furnished with pieces of metal, called *ears*, projecting from each side of the mouth.

An open wood pipe (*v*) consists of the *body*, *block*, *cap*, and *foot*. The body is a rectangular tube formed of planed boards, and is usually oblong in cross-section. A nearly square pipe gives a full and weighty tone; one that is narrow and deep, a soft and sweet tone; while a shallow and wide pipe yields a powerful and hollow tone. The proportions vary from square to 2 by 1, or nearly so, according to the effect to be produced.

At the lower end the body is closed by the block, which is nearly divided in two by the throat; over this is fastened the cap (*w*), a piece of wood hollowed out on one side, the upper edge of which slightly recedes to form a wind-way. The pipe-foot is a rectangular or cylindrical tube inserted through an opening in its bottom to admit wind and support the pipe.

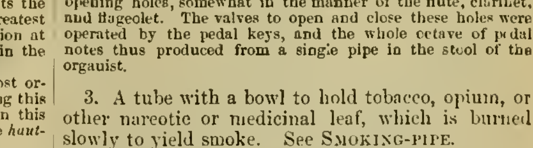
Ducce's organ at the English Exposition of 1851 was so arranged as to produce the 12 pedal notes from a single stopped pipe, 4 feet long. The notes ranged from 16 feet C, and besides the range of depth far beyond what the length of pipe would seem to justify, the pipe was made to speak several notes by opening holes, somewhat in the manner of the flute, clarinet, and flageolet. The valves to open and close these holes were operated by the pedal keys, and the whole octave of pedal notes thus produced from a single pipe in the stool of the organist.

3. A tube with a bowl to hold tobacco, opium, or other narcotic or medicinal leaf, which is burned slowly to yield smoke. See SMOKING-PIPE.

Pipe-box. (*Vehicle.*) The box of a *hub* or *nave* which receives the *arm* or *spindle* of the axle.

Pipe-clamp. A vise or holder for a pipe. See PIPE-VISE.

Fig. 3732.



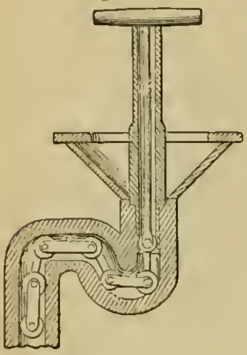
Pipe-Clamp.

The example shows a tool to hold a deep-well pipe to prevent it from slipping in while an additional length is being attached.

Pipe-clay. A white clay whose excellence depends upon its freedom from iron.

Pipe-clear'er. An implement for pushing out an obstruction from a bend in a pipe. A force-pump is usually employed, but in some cases a jointed thrusting implement is used, as in the example.

Fig. 3733.



Pipe-Clearer.

Pipe-coup'ling. A means of uniting two pipes to make their tubular portions continuous. Such couplings are usually in line, lateral connections being by angular or bent sections or by branching sections.

a b show respectively the *faucet* end and the *spigot* end of a pipe.

c shows the common mode of entering the *spigot* end of one pipe into the *faucet* end of another one, the joint being made by running lead and compacting by the cold chisel and hammer.

d has a set screw in one section bearing against a flange on the spigot section.

e is for wooden pipe. A circular metallic section has sharp flanges which enter the contacting ends of the pipes to be united.

In *f*, the parts are halved into each other by socket and tenon, and fastened by screws.

g is a view of a coupling-section having conical tubular ends which enter the ends of the pipes to be united, and which are forcibly driven upon the cones.

h has a double socket-section into which the ends of the pipe are driven and then fastened by keys.

i j are two views of a hose-coupling, in which the sections are drawn together against a packing-ring by rotation, a stud on one section traversing a spiral groove in the other.

k has sections with slots traversed by a transverse locking key.

l is a hose-coupling, in which the ends of the hose are clamped between a pair of sleeves and a double-ended coupling-section.

In *m*, a flange on the end of one pipe abuts against the end of the other pipe, inside a coupling-sleeve which screws on to a thread on one of the pipes. A packing-ring is between the abutting ends of the pipes.

n is a screw-coupling in which the parts screw together against a packing-ring.

o shows the plunger-pole used in Cornish mines. It consists of a stuffing-box, gland, and bolts.

p is the pipe-coupling used in the Westinghouse air-brake for coupling adjacent cars When the cars are uncoupled, the valves seat themselves instantly; when the cars are coupled, the air-way is open.

q is a flexible coupling shown in three views.

The Croton aqueduct pipe, which carries the water across the Harlem River, is 850 feet long, and is cast in 8-foot lengths, which are united by hollow ball-and-socket joints *r* is formed by providing one end of the pipes with a concave flange, which receives the conjoining pipe-end, having annular ribs upon it. The space between the pipe-end and the flange is packed with lead. The joint is thus rendered secure without screw-bolts.

The method adopted by Mr. Ward for laying the pipes was as follows: A large open boat was provided, in which was carried a supply of pipes and melted lead At the stern a small supporting frame was placed. The pipes were jointed together in the boat, and, as fast as completed, pushed out over the stern into the water, thus forming a flexible string of pipes, which sank and rested upon the river-bottom as the boat progressed. The depth of water in the Harlem River where the pipe lies is 40 feet.

The water-mains of London are or were united by cylindrical, turned joints, a little whiting or tallow being used to close the joint perfectly and permitting expansion and contraction of the pipe with changes in the temperature of the water. See also HOSE-COUPLING.

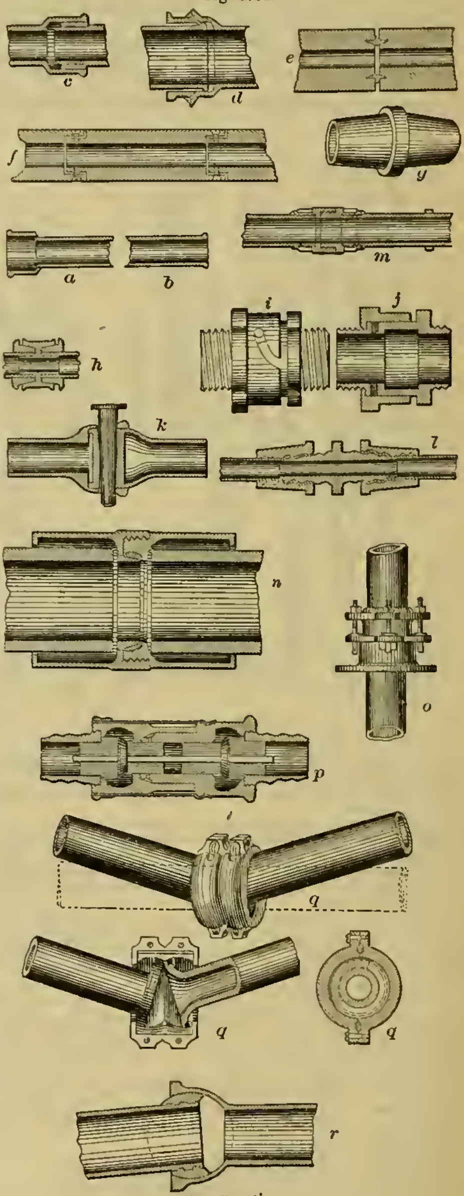
There are several forms of lead-joints in which the spigot end is forced against a cast leaden gasket so as to crush the latter and form a tight joint.

Machines are also made for connecting pipes; O'Neill's twisting-jack, for instance. In this case the contacting ends of the sections or lengths forming the water or gas main have lugs and inclined faces which pass each other and then by a twisting action are made to draw longitudinally and compress the leaden gasket, which makes the joint air and water tight.

Pipe-cut'ter. A tool for cutting off gas or water pipes. It has a hook which passes beneath the pipe and forms a rest while the cutting chisel or disk is driven down the pipe, around which the implement is then revolved.

In Fig. 3735, a sharpened disk within a block is fastened to the end of the screw-rod, and the pipe, being clamped between the disk and the hook, is cut by turning the instrument around the pipe.

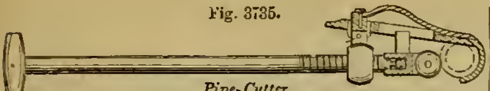
Fig 3734.



Pipe-Couplings.

In Fig 3736, the tube and its bushing are made to encircle the pipe, and the cutter is forced into the side of the pipe by turning the screw The pipe is then severed by turning the instrument around upon it.

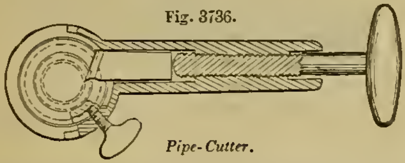
Fig. 3735.



Pipe-Cutter.

In Fig. 3737, the movable jaw is hinged to a nut which traverses the threaded shank, and operates in opposition either to the socket end of the shank or to a cutter inserted therein.

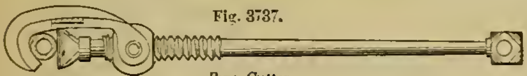
Fig. 3736.



Pipe-Cutter.

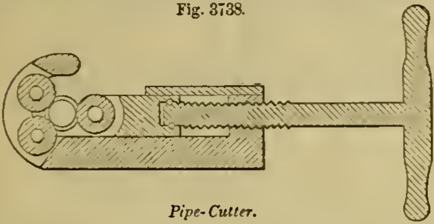
Fig. 3738 is a tool with three revolving cutters set in such a relative manner that two of the cutters are in a stationary part or body of the tool, and the adjustable cutter is held by a movable part or stock of wrought-iron, which is held by a screw. See also PIPE-CUTTER and THREADER, Fig. 3744.

Fig. 3737.



Pipe-Cutter.

Fig. 3738.

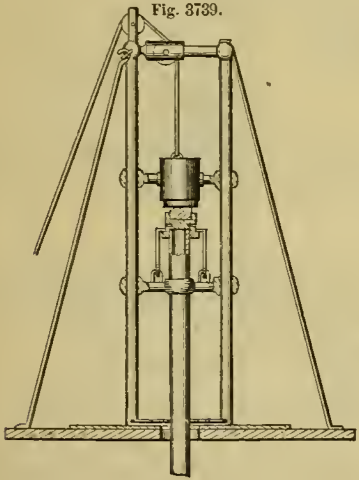


Pipe-Cutter.

Pipe-driv′er. An implement of the general form of a pile-driver, used for forcing into the ground pipes for what are known as "driven wells."

A drive-head is temporarily attached by a stirrup to the upper end of the pipe to receive the blow of the *monkey*. The stirrup is connected with the bar which glides on the guide-rods.

Fig. 3739.

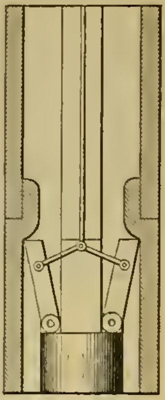


Pipe-Driver.

Pipe-grab. A tool to let down into a well-pipe to enable it to be hoisted to the surface. See GRAB.

Some are made to clutch the outside, others the inside, as in the example, in which pawls or wedges on the end of a draw-rod are lowered into the well-tube and expanded against its sides for the purpose of withdrawing it.

Fig. 3740.



Pipe-Grab.

Pipe-joint. A means of connecting adjacent ends of pipes. See PIPE-COUPLING.

Pipe-loop. (*Harness.*) A long narrow loop for holding the end of a buckled strap.

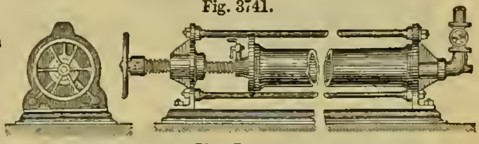
Pipe-mold′ing. A machine for making clay or concrete pipes. See TILE-MACHINE.

Pipe-or′gan. One having musical *pipes*, in contradistinction to one having vibrating tongues, and known as a *reed*-organ.

Pipe-prov′er. An apparatus for the purpose of proving steam and water pipes by means of hydraulic pressure. It comprises a metallic bed-plate, on which are fixed two cast-iron head-stocks connected by strong wrought-iron bolts, cast-iron follower with square thread screw, and hand regulating-wheel, screw water-valve, and air-cock. Also a gun-metal pressure-pump inclosed in an iron cistern, and a pressure-gage.

The method of using the apparatus is as follows: The pipe is placed between the head-stocks in contact with rubber rings, and the joints made by screwing up the follower by means of the hand-wheel The pipe is rapidly filled with water from any convenient source above the machine by opening the water-valve, when the proof-pressure may be applied by the pump.

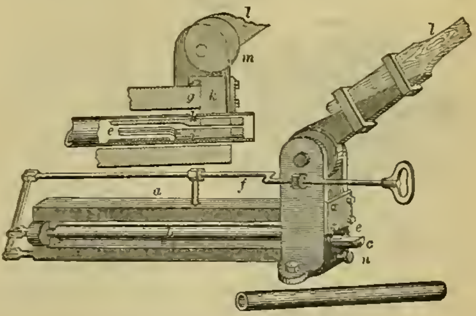
Fig. 3741.



Pipe-Prover.

Pipe-slot′ting Punch. Brigden's machine for punching holes or slots in metallic tubes consists of a frame *a* in which is fixed a strong hollow mandrel *b*. A semicircular wedge *c* is fitted into the mandrel and connected by a rod *e* to a lever at the other end of the machine operated by the rod *f*. The frame, mandrel, and wedge are slotted at *g h i*, forming a

Fig. 3742.



Brigden's Pipe-Slotting Punch.

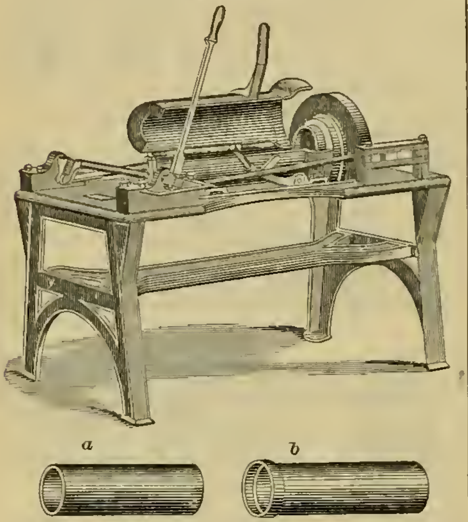
series of openings through which the punch *k* may work.

In using the apparatus the pipe is slipped over the mandrel, and by forcing the rod *f* inward the wedge *e* is caused to enter the pipe and resist its tendency to be bulged inwardly under the action of the punch. The lever *l* is depressed, operating the eccentric *m* and forcing the punch through the upper side of the pipe; the piece of metal cut out is driven through the aperture *h* into *i*. An upward movement of the lever *l* permits a spring to lift the punch, and the rod *f* is pushed inward to withdraw the wedge, after which the pipe may be removed. By a reverse movement of the rod, a small projecting pin on the frame *a* is caused to push the chip out from the pipe out through the longitudinal slot *n* in the wedge.

Pipe-sock′et-ing Ma-chine′. A machine for finishing the molding process of clay or concrete pipes by making a socket on one end to receive the smaller end of an adjacent pipe when laid.

a shows the pipe before socketing; *b*, afterward. The pipe *a* is placed in the bed of the machine, and the upper clamp brought down and locked. The head-piece, which has the counterpart form of the socket, is then brought forward by the lever, expanding the clay into the shape of the *former*.

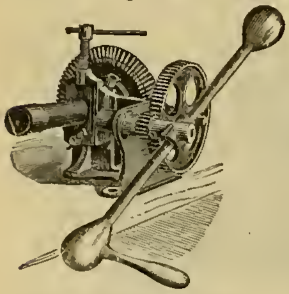
Fig. 3743.



Pipe-Socketing Machine.

Pipe-thread′ing Ma-chine′. 1. A machine of the nature of a screw-stock to cut a thread on the end of a wrought-iron pipe. The figure shows the "Chase" machine fitted for hand-power, motion being transmitted to the several parts by means of gearing; the pipe is shown projecting toward the left, and is held stationary by the adjustable jaws of the pipe-vise. The pipe passes through the center of the gear-wheel, the rotary motion of which is imparted to the die in the die-box by means of studs or guides upon which the die-box freely slides forward as the die passes upon the pipe.

Fig. 3744.

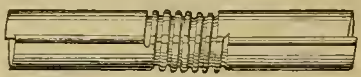


The Chase Pipe-Cutting and Threading Machine.

When *cutting* pipe, the tool-post with the cutter has automatic feed, cutting the ends of the pipe squarely and smoothly.

2. (*Sheet-metal.*) A machine for impressing a spiral groove upon a sheet-metal tube, such as a stove-pipe, so that the end of adjacent sections may be screwed together, as in the example. The same is done with some kinds of sheet-metal covers for fruit-jars.

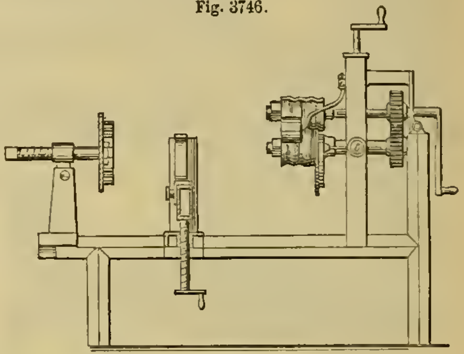
Fig. 3745.



Screw-Threaded Stove-Pipe.

Fig 3746 is a machine in which sheet-metal pipe is passed between the two rotating circumferentially ribbed cylinders, the ribs of the cylinders meshing together. As the cylinders rotate they impress the thread upon the pipe.

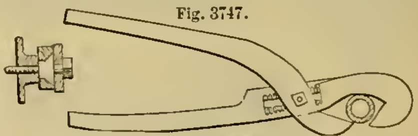
Fig. 3746.



Machine for Threading Sheet-Metal Pipe.

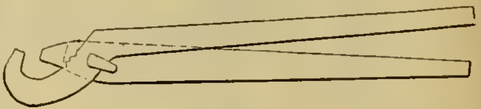
Pipe-tongs. A pair of tongs with one short jaw adapted to grasp a pipe or rod. Their range of grasp is but limited, and a number are provided for varying sizes of pipes. Their grasp is more tenacious than that of a monkey-wrench.

Fig. 3747.



Pipe-Tongs.

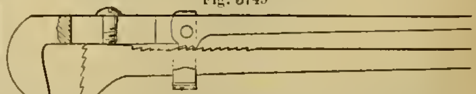
Fig. 3748.



Pipe-Tongs.

Figs 3747, 3748, 3749, show three of the numerous forms of pipe-tongs. See also PIPE-WRENCH.

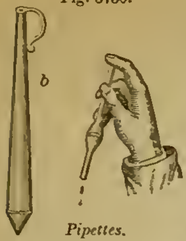
Fig. 3749



Pipe-Tongs.

Pi-pette′. A small glass open-ended tube, used

Fig. 3750.



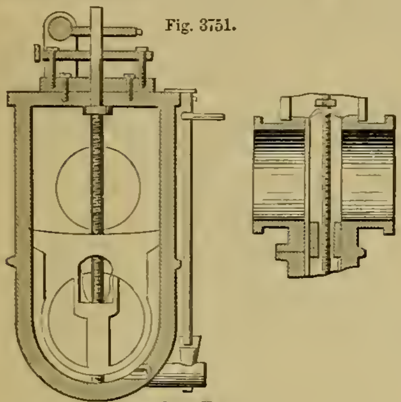
Pipettes.

for transferring small quantities of liquids. Called also a *drop-tube,* from its being used for this purpose. As the pressure of the finger on the upper end is relaxed, the liquid drops from the contracted orifice at the lower end. The *velinche* or *tâte-vin,* which is intended for a *sampling-tube,* may also be used as a *drop-tube.* It is sometimes called a *wine-taster* or *thief-tube.*

Pipe-valve. A stop-valve in a pipe.

In the example, the valve is vertically operated by a worm-wheel and screw-shaft, and when opened slides into a box beneath the main; the water in the box is discharged by a faucet. There are many kinds. See list under Valve.

Fig. 3751.

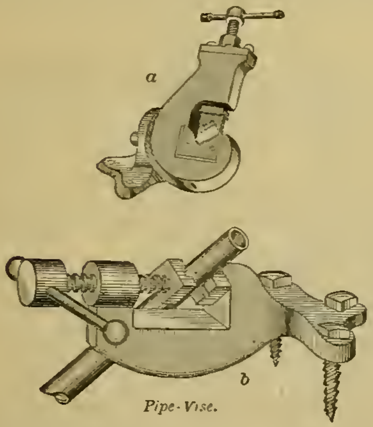


Stop-Valve.

Pipe-vein. (*Mining.*) A vein which contracts and expands, instead of preserving uniform size. The expansions are *bunches.*

Pipe-vise. An implement for holding a pipe while being threaded or otherwise fitted. *a* and *b* are different patterns, both for bench use.

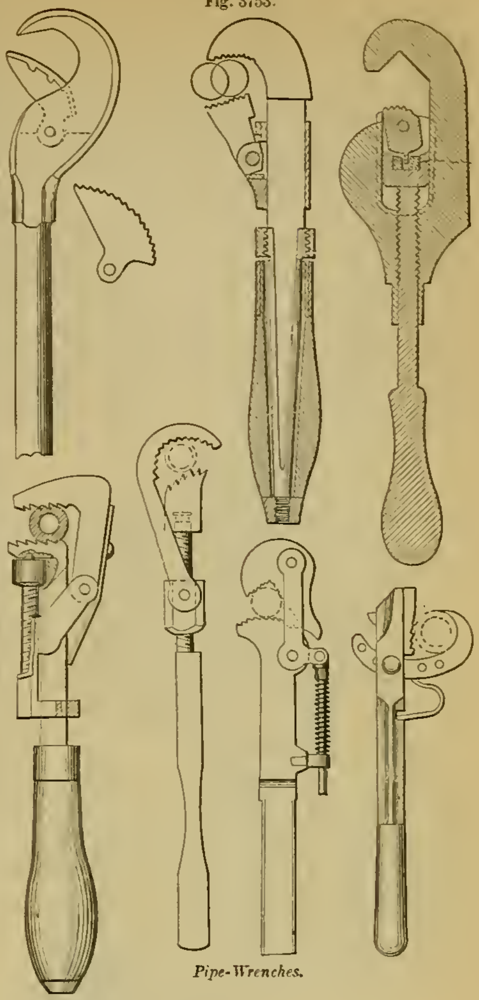
Fig. 3752.



Pipe-Vise.

Pipe-wrench. An implement with a movable and a relatively fixed jaw, so arranged as to bite together when they are made to grip the pipe, and are revolved in a certain direction around it. The figure shows several kinds, which will be understood without specific description.

Fig. 3753.

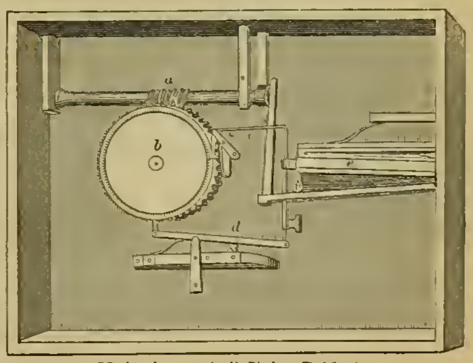


Pipe-Wrenches.

Pip'ing. 1. (*Harness.*) A leather covering to a trace-chain.

2. In a musical toy, — the "piping bulfinch," — on touching a spring the bird is caused to jump out of a box, move its wings and beak, and seemingly

Fig. 3754.



Mechanism of the "Piping Bulfinch."

pipe a tune. The sound, however, is not emitted by the bird, but comes from a concealed pipe operated by mechanism similar to that shown in the figure.

An endless screw *a*, turned by hand or clock-work, rotates a toothed wheel carried by the cylinder *b*, which is set with studs arranged like those on the cylinder of the musical box or barrel-organ, so as to play one or more tunes, by means of two jointed levers *c d* operating a piston in the pipe to produce the required notes; air is supplied to the pipe by a bellows *e* worked by an eccentric on the endless-screw shaft.

Pip′ing–i′ron. A fluting-iron.

Pi-qué′. (*Fabric.*) A cotton goods, figured or plain, and with a crimped surface resembling cordings.

Pi-quée′. (*Fabric.*) Marcella. A heavy cotton goods for vesting, etc.

Pi-qué′–work. A minute kind of buhl-work; inlaying metals in metals, usually.

Pi-ram′e-ter. An instrument for measuring the power required to draw a carriage upon a road or track. A *dynamometer.*

Pirn. 1. A quill or reed.

2. Yarn wound on a shuttle.

3. The bobbin of a spinning-wheel.

4. The wheel of a fishing-rod.

Pi-rogue′. (*Nautical.*) *a.* A large double canoe formed of a hollowed trunk of a tree, or of two canoes united.

b. A narrow ferry-boat having two masts and a lee-board.

Pis-ci′na. (*Architecture.*) A niche in the south side of the altar for a water-basin.

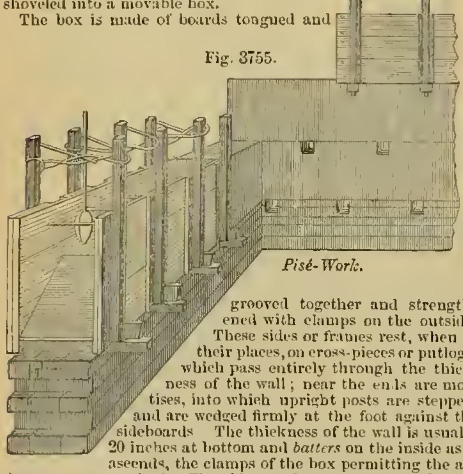
Pi-sé′–work. A mode of forming walls of rammed clay. The conformation of the walls is given by means of boards on each side, and after one layer is formed and partially hardened, the boards are lifted to form bounds for another layer.

It is allied to the adobe method; but the clay, instead of being formed in blocks, is rammed into place, where it becomes dried by means of the sun and air. In some parts of England and France the practice is universal in houses of moderate and humble pretensions.

The *formacei*, or earth-walls, described by Pliny as existing in Gaul and Spain, are of this character. See Wall, Concrete; Béton, etc.

The best material for pisé-work is clay with small gravel-stones interposed through it. It is made plastic by moistening and beating, and then shoveled into a movable box.

Fig. 3755.



Pisé-Work.

The box is made of boards tongued and grooved together and strengthened with clamps on the outside. These sides or frames rest, when in their places, on cross-pieces or putlogs, which pass entirely through the thickness of the wall; near the ends are mortises, into which upright posts are stepped, and are wedged firmly at the foot against the sideboards The thickness of the wall is usually 20 inches at bottom and *batters* on the inside as it ascends, the clamps of the box permitting the adjustment as required. The sides or frames are made 10 feet long and 3 feet deep; the uprights, 5 feet long, including the tenons, so that they project above sufficiently to enable them to be secured by ropes. The wedges are 9 inches in length, 1½ at the base, and 5 inches at top. The bottom of the boards incloses about 2 inches of the top of the wall already made. The sides are held apart by transverse stays, which may be shifted from time to time for the convenience of the workman, who is wetting, working, and ramming the material as it is thrown in. Three or four inches of material is spread at a time, and is then well tramped and rammed The frame is shifted from time to time, until all the wall is built on a given level to a certain hight; after an interval for drying, another thickness is laid on. Door and window ways, sleepers, and joists are built in as the work proceeds.

Pis′tol. A form of fire-arm adapted for use with one hand. The modern form of pistol is a breech-loader, using metallic cartridges.

It is said to have been invented at Pistoia, in Tuscany, by Camillo Vitelli, in the sixteenth century. The German cavalry seems first to have used them, and their use caused the lance to be abandoned. At the battle of Ivry, 1590, it appears that the French gentlemen of the king's army lost ground by the change, finding it difficult to meet the charge of the enemy's lancers without taking open order and — scattering.

The general appearance of the pistol is so well known that the weapon hardly needs description here.

About 1857, those for the United States cavalry were furnished with a detachable butt-piece fastened to the butt of the pistol by a screw, so that the arm could be fired from the shoulder; the weapon, with this addition, was termed the pistol-carbine. It was soon entirely superseded by Colt's and other revolving pistols. See Revolver.

The dueling-pistol of the last century was a finished weapon, having a long, slim barrel, and fired by a hair trigger. The stock and barrel were generally inlaid with silver. Much pride and pleasure were found in their possession and curious modifications, — *saw*-handles and *cross*-handles, and so on. Rifling for pistols was not generally adopted until some time after it had been used in long-barreled guns.

The Derringer pistol, which has some celebrity, is short-barreled, of very large caliber, and has been compared to a pocket-howitzer. It is a very effective weapon at short range. The latest pattern of Derringer is a single-barreled breech-loader, weighs about 8 ounces, and carries a half-ounce ball.

Toy pistols have been made which project a buckshot with considerable force by the explosion of a percussion-cap. Toy pistols for firing an arrow by the force of a spring, or projecting a cork by the expansion of air which has been previously compressed in a chamber, are also common.

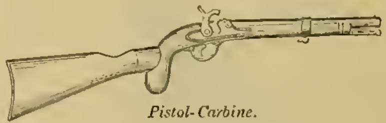
The earliest form of pistol was used by the English cavalry in 1544. The earliest form of revolving, cylindrical breech, whose chambers are brought consecutively in line with the barrel, is found in the English United Service Museum, and is supposed to date from the time of Charles I.

The Colt pistol, which has attained the highest celebrity, was introduced from the United States into England in 1853. See Revolver.

The English cavalry-service pistol has a length of 13¾ inches; barrel, 8 inches; weight, 40 ounces; caliber, .577 inches; rifling, 5 grooves, having one turn in four feet.

Pis′tol–car′bine. (*Fire-arms.*) A horseman's pistol provided with a removable butt-piece, which may be secured to its stock by a spring-catch, or detached, so that the weapon may be fired either from the hand or the shoulder.

Fig. 3756



Pistol-Carbine.

Pis′tol–pipe. (*Metal.*) The tuyere of a hot-blast furnace.

Pis′tol–rout′er. A kind of carpenter's plane. A router with a handle like a pistol-stock.

Pis′ton. A device so fitted as to occupy the sectional area of a tube and be capable of reciprocation by pressure on either of its sides. It may be of any shape corresponding accurately to the bore of the tube; but the cylindrical form is almost exclusively employed for both, as in the common pump and the steam-engine. One of its sides is fitted to a rod, to which it either imparts reciprocatory motion, as in the steam-engine, or by which it is itself reciprocated, as in the pump. In the former case, it has no opening leading from one side to the other, and is termed *solid*, though generally not really so; but in the latter, an aperture controlled by a valve permits the passage of the fluid from one side to the other during its downward movement. A distinction is, however, made in pumps; the *solid* piston being known as a *plunger*, the *hollow* piston as a *bucket*. The piston usually requires *packing* to cause it to fit closely within its cylinder, and at the same time allow its free backward and forward motion. For this purpose, its ends are usually formed by two connected disks, or have a deep annular groove between them for receiving the packing material, which may be hempen cord wound around it, or other somewhat expansible substance, which will not wear too rapidly nor cause excessive friction. In modern practice, metallic rings, cut through at one side, so that their expansion may compensate for any wear, are largely employed in the steam-engine. The simple form of piston required for the pump will be more fully explained under the head PUMP, this article being more particularly descriptive of the various kinds used in the steam-engine.

The earliest known use of a piston in a cylinder is found in some of the ancient blowing-machines of the native metallurgists of Asia and Africa. This was much earlier than the air-pumps of Ctesibus, 150 B. C. See "Spiritalia Heronis."

It is believed that Papin's pistons were of wood, and that Cartwright was the first to use a metallic piston.

One of Cartwright's valves was in the piston, and was tripped by the contact of the valve-stem with the end of the cylinder.

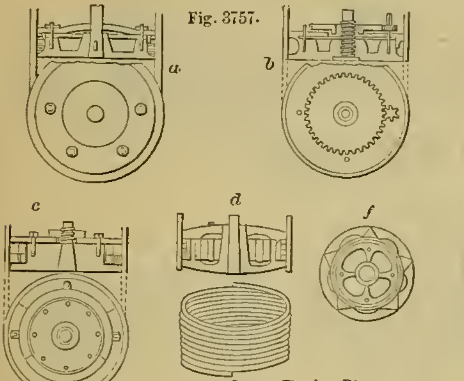
James Watt found the piston imperfectly fitted in a roughly bored cylinder. The principal packing was a body of water on the upper surface.

He patented the lubricant, 1769, preferring mutton tallow, but hemp and tallow had long been used. To this he sometimes added plumbago-dust. A common piston till a comparatively late date was a double cone of wood banded with leather strips.

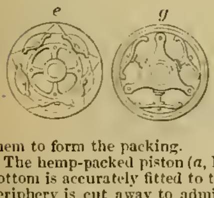
This was superseded by a metallic piston, turned to fit neatly in the cylinder, and having a circular plate on each side clamping two leathers, cupped and chamfered off to an angle of 45°.

The piston for the atmospheric engine was a plate of cast-iron, about ½ inch less in diameter than the cylinder, and 1½ inch in thickness, with a rim about 4 inches from the edge. Beyond this a flat ring is fitted and the parts are screwed together, after hemp and tallow have been inserted between them to form the packing.

Fig. 3757.



Steam-Engine Pistons.



The hemp-packed piston (*a*, Fig 3757) is in common use. The bottom is accurately fitted to the cylinder, and a portion of the periphery is cut away to admit of a gasket of unspun hemp or soft rope to be wound evenly around it, to form the packing. This is compressed by means of a plate and screws, so as to expand it against the inside surface of the cylinder, making a steam-tight joint.

The piston-rod is attached by an enlarged head, screw-nut, and key to the bottom of the cylinder, which has a central boss to strengthen it at that point. The piston is lubricated by melted tallow or oil introduced into the cylinder by a funnel and a pipe with a double stop-cock.

Wolf's piston (*b*) was so arranged as to be tightened without removing the cylinder cover. A screw-thread is cut on the cylinder-rod, which is also surrounded by a toothed wheel engaging a pinion on a vertical rod passing through the cylinder cover. By turning this, the screw-thread is caused to draw the two piston-heads together, tightening the packing.

Cartwright's piston (*c*) resembled the wedge metallic piston in construction. The pieces of which it is formed having a determined curvature, and being too stiff to yield readily, it did not well adapt itself to inequalities in the cylinder, if the latter had not been accurately bored.

Brass rings as a substitute for the hempen packing in pistons was invented by Murdock and Aiken of Glasgow, in 1813.

The wedge metallic piston (*e*) is formed by rings cut into a number of parts, pressed upon the cylinder by wedges, which are kept in their places by springs

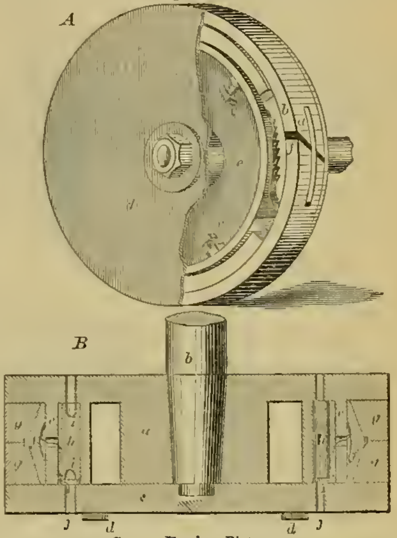
Jessop's piston (*d*) has an expanding coil of metal of spiral form surrounding the piston-body between the two piston-heads, filled in with hemp packing, which assists the outward pressure of the coil and helps to prevent the passage of steam.

The spring metallic piston (*f*) has wedges inserted behind the metallic rings, forming its perimeter, which bear against springs that force the rings outward into contact with the surface of the cylinder.

In *g* the wedges are dispensed with, the springs bearing directly against the metallic rings.

In Askwith's packing arrangement (*A*, Fig. 3758), a divided ring is inclosed between the piston-heads *d e*; a recess is formed at the point where its two ends nearly meet, into which a pivoted partition-piece *a* shuts, so as to prevent the passage of steam through the cut *f*; on the interior is a toothed rack *b*, in which a spring engages, to maintain the expansion of the ring, which is regulated by set screws *c c*, working through the flange *g* on the piston-head; a small quantity of steam is admitted between this flange and the ring, so that the piston is both steam and metal packed.

Fig. 3758.



Steam-Engine Pistons.

In Jacob's (*B*), the packing is effected by steam entering through the apertures *i j*, alternately above and below the plug *h*, which acts as a valve, and passes to the back of the ring *f*, the wedge-shaped face of which, under the influence of the steam-pressure, serves to force outward and apart the outer segmental rings *g g*, causing them to act equally against the interior surface of the cylinder, forming an effectual packing.

The following may be cited as the distinguishing features of pistons. They principally concern the lapping of rings, which are forced out by various means.

Screws alone.
Springs alone, supported.
Springs alone, unsupported.
Springs and wedges.
Springs and screws.
Wedges and screws.
Wedge, rack, and spring.
Cone and axial screw.
Springs on outside with wedges.
Steam admitted through apertures beneath rings.
Steam admitted through face of packing.
Steam admitted through valves.
Flexible outside disks.
Pistons with grooves for wire or jute.

Fig. 3759 shows a number of steam-pistons with peculiar modes of packing.

a a′ is Askwith's, 1867, in which the divided portion is covered by a break-joint plate held to its seat by a spring. The outer ring is set out by screws projecting from the inner ring. *a′* shows a dowel-plate.

b is Brown's, 1859, which has metallic springs, thrusting outwardly the elastic break-joint rings, and seated upon a supporting boss.

c is Fairbanks's, 1872, having a corrugated expanding spring, screwed fast to the packing-ring at its midlength.

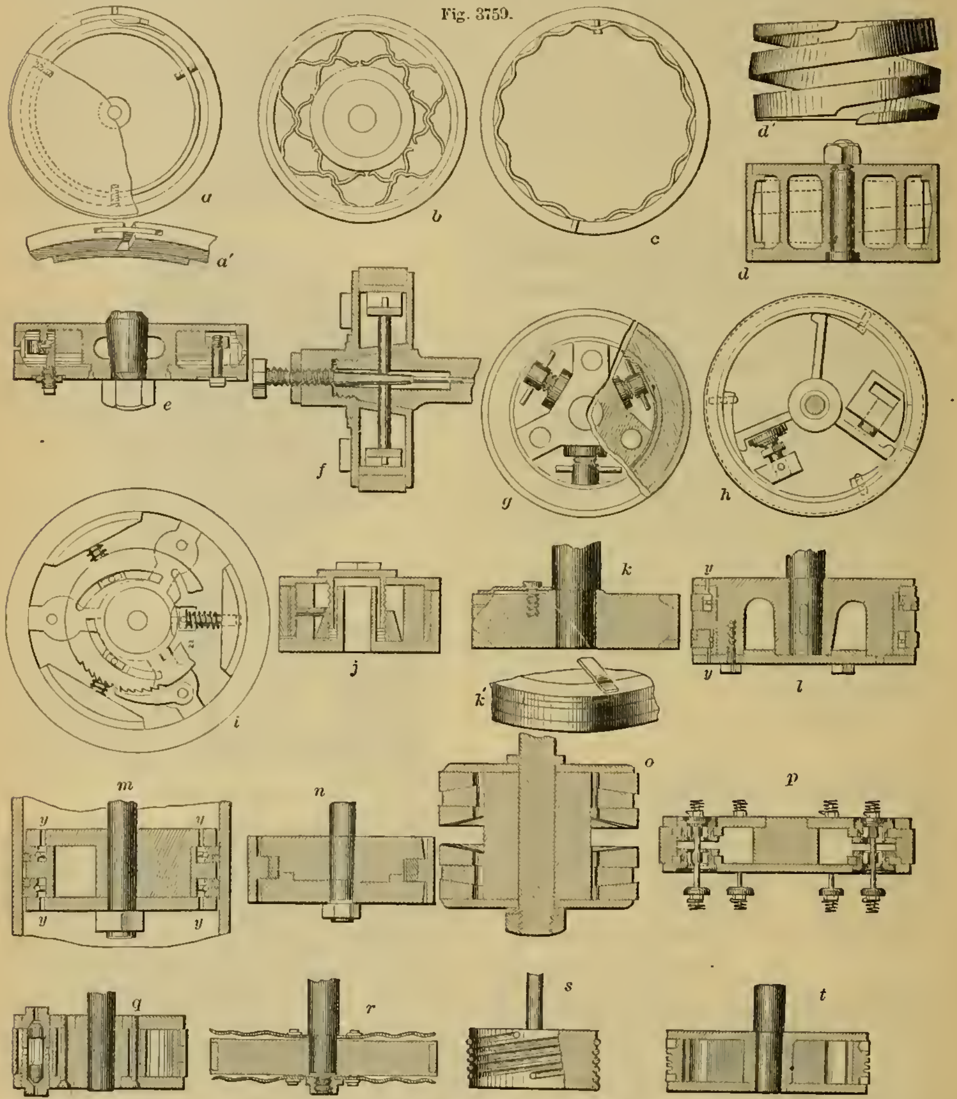
d d′ is Lowe's, 1866, which has a beveled spiral spring, inclosed between a head and follower, and expanding the rings. *d′* shows the detached ring expanded laterally and vertically.

e, Bower and Qualter's piston, 1866, has springs driven against the rings by the force of wedges at the back. The wedges are set up by screws.

f, Hoagland's, 1857. By turning the axial screw the conical shaft is driven against the radial bars, which drive against the springs and expand the circumferential ring.

g is Blake's piston, 1871, a part of which is shown with the cover removed. It has screws which force a body of soft vulcanite or metallic springs against the outer rings of the piston. The screws are turned by bars.

Fig. 3759.



Steam-Pistons, with different Modes of Packing.

h is the Huss piston, 1871, combining wedges and screws. By turning the screws, the radial bars projecting from the central boss are forced against the wedges on the inside of the expanding ring.

i is Allen's piston, 1873. It has wedges and springs, and a rack to hold it to its set. The portion of the wedge-plate at *z* is broken away to expose the rod and the spring which bears against the segment which distends the packing-ring. The rotation of the wedge-plate acts upon each of the three.

j is Carey's piston, 1873, which has an axial screw and a conical nut, the latter pushing against the stems of the followers to force outwardly the peripheral piston-ring.

k k′ are Adams's piston, 1868, in which the piston-rings are wedge-shaped at their overlapping portions, and are driven outwardly by the lateral pressure of a wedge actuated by springs on the face of the piston.

l is Buchanan's piston, 1865, in which the piston-rings are expanded by steam admitted behind them, through apertures on each face leading to the groove in which the rings work. These openings are at three points of the circle, and show at *y y* in the figure.

m is the Dunbar piston, 1860; and is somewhat similar to the last stated.

n, the Hunt piston, 1867, has a T-shaped packing-ring, whose stem is packed in its groove, and which is expanded by steam below its extended flanges.

o is the Smith piston, 1867. Steam is admitted through a central groove in the packing, and passes behind the rings.

p, Witty's valve, 1869, in which steam is admitted through valve-ways to the space behind the ring. The contact of the valve-stem with the end of the cylinder actuates the valve.

q is Hedden's valve, 1863, in which steam is admitted by valves in the piston into the space behind the expansible ring.

r is Cabell's piston, 1866. It has flexible outside disks, whose peripheries move in contact with the surface of the cylinder.

s is Cameron's, 1866. It has a coil of wire in a spiral groove around the piston

t is Clark's, 1865. It has a grooved periphery for wire or jute.

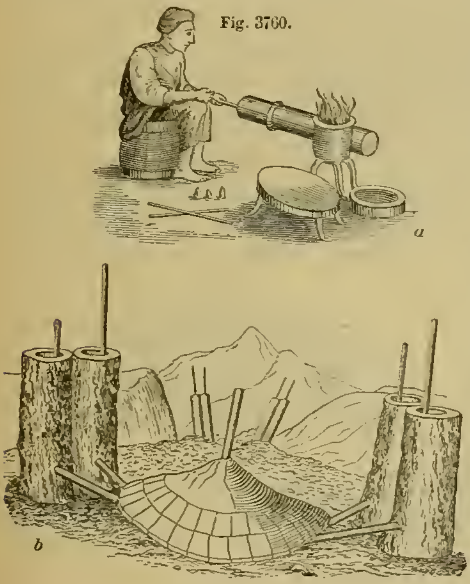
Gale's patent, July 21, 1857, has a piston with circumferential grooves occupied by steam and water of condensation, which act as a packing. The same feature is found also in the stuffing-box, which is grooved interiorly.

The dimensions and evaporative capacity of the steam-generator for a given duty are determined by the number of cubic feet of water required to propel a piston of a given area a given number of feet per hour.

Say, for instance, that to overcome the resistance of the machinery to be moved a steam pressure of 20 pounds per square inch on a piston having an area of 5 square feet will be required. Assuming the required speed of the piston to be 200 feet per minute to give the necessary velocity to the machinery, the calculation stands thus: The speed of 200 feet per minute is 12,000 feet per hour; the quantity of steam at 20 pounds' pressure to the square inch is, therefore, 12,000 × 5 (the area of the piston) = 60,000 cubic feet of steam per hour. Steam at 20 pounds' pressure to the square inch bears the proportion to water of 1,281 to 1. Therefore, 60,000 ÷ 1,281 = 47, nearly, which represents 47 cubic feet of water evaporated per hour; say, equal to 47-horse power.

Pis′ton-bel′lows. In Fig. 3760, *a* represents a portable, single-acting Chinese bellows. Air is admitted to the tube through an inwardly opening valve, when the piston is drawn backward and is forced out by its forward movement through a valve at the side opening outwardly.

Fig. 3760.



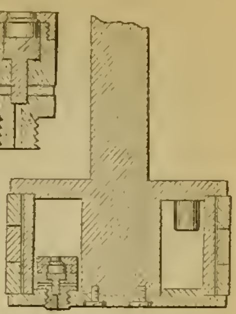
Piston-Bellows.

b is a piston-bellows, formed by boring out the trunks of trees, used by the natives of Madagascar for smelting and forging iron. The air-induction valve would appear to be in the piston. The operator sits on and between two of the tubes, working a piston with each hand. The furnace, seen between the two pairs of bellows, is merely a hole roughly lined with stone and plastered with clay.

Pis′ton Blow′ing-ma-chine′. That form of blowing-machine in which the air is driven from a cylinder by a reciprocating piston. See page 305.

Pis′ton-head. That portion which fits into and reciprocates in the cylinder. The *head* is distinct from the rod. A somewhat unnecessary distinction. See PISTON.

Fig. 3761.

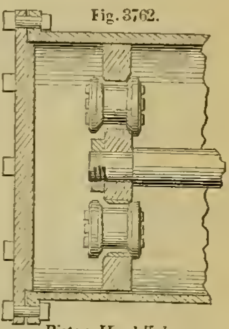


Piston-Head.

In the example, the hollow head has a self-acting valve, by which steam is admitted to the piston for the expansion of the packing-ring. The areas of the ends of the valve vary in proportion to the desired difference of pressure between the steam on the outside and that on the inside of the piston.

Pis′ton-head Valve. A valve in a piston to admit steam, either to the interior, to expand the packing-ring, as in Fig. 3761, or, as in the example (Fig. 3762), in which it acts to change the steam. As the piston reaches the end of its stroke, the valves in the piston-head are opened by contact with the cylinder-head, and admit steam from behind the piston to that space about to receive the incoming steam.

Fig. 3762.



Piston-Head Valve.

Pis′ton-pack′ing. A material for preventing the leakage of steam between the piston-head and the cylinder in which it works. For mechanical devices, see PISTON.

Among the materials and modes of piston packing may be enumerated the following:—

The first list is from English patents, and gives the number and year of the patent

5,032 of 1824. The piston is padded with linen or woolen material, placed smoothly on both sides of the piston, with a thin piece of paper between. A circle of metal is placed on each side of the padding and screwed together.

7,437 of 1837. Rings of cloth diminishing in diameter toward the center and coated on both sides with a solution of india-rubber.

7,800 of 1838 Grooves around the piston filled with an alloy of zinc, tin, and regulus of antimony.

9,411 of 1842. Cork between two plates screwed together. Around the edge of the piston and the cork is a thin band of brass, which forms the rubbing surface of the piston.

13,682 of 1851. Thin metallic rings laid one upon another, and backed by canvas impregnated with a composition of fat, graphite, sulphur, and alum.

41 of 1852. Cuttings of india-rubber burned and mixed with charcoal, graphite, lead, and lampblack.

384 of 1852. Tuck's patent. Rolls or folds of canvas coated with india-rubber, and inclosing strands of india-rubber.

1,025 of 1854. Spun yarn saturated with solution of india-rubber.

1,865 of 1854. Core of india-rubber within a roll of canvas, coated with solution of india-rubber.

2,617 of 1860 Leather band covered by vulcanized rubber and another band. Sometimes a covering of wire-gauze.

2,415 of 1863 Wire and woolen threads, interwoven, placed over canvas treated with grease, graphite, sulphur, and alum.

3,148 of 1863. Esparto grass steeped in caustic soda; then boiled in solution of carbonate of soda; dried, oiled, and opened for spinning.

19 of 1865. Web formed in braiding-machine, having elastic india-rubber core: passed between smoothing-rollers and then through lubricant.

555 of 1868. Interior of hemp, jute, etc., covered with cotton duck.

1,120 of 1868. Paper, cut to size, is treated with powdered soapstone and graphite, then spread on cloth or rubber, rolled up into a cylindrical form and dried; then saturated with hot tallow, cooled, drained, and cut into rings.

602 of 1871. Cotton, woolen, or flax flocks or waste, subjected to pressure in molds.

897 of 1871. Asbestus strengthened by cord.

2,515 of 1871. Strips of canvas, etc., wound upon a rod, from end to end, so that each thickness overlaps the preceding one, cemented together. Rope thus formed filled with tallow.

549 of 1872. Elastic band of wire and asbestus interwoven.

613 of 1872. Strips of cork inclosed in fabric. Brass gauze as interior lining.

995 of 1872. Fabric treated with paraffine, india-rubber, lead, zinc, graphite, sawdust, and quicksilver.

3,126 of 1872. Rubber tube with soft rope within

The following are United States patents. The figures give the numbers and years of the patents: —

34,283 of 1862. Layers of flax, asbestus, and wool, placed alternately in a tube full of water, through the bottom of which steam passes. After being pulped in this they are compressed in molds.

36,987 of 1862. A core of cork with a loose braiding cover; over this twine with cotton sliver wound about it. The whole steeped in hot water and tallow.

44,475 of 1864. Pulverized soapstone and asbestus mixed with cotton.

45,261 of 1864. Packing-yarn saturated with a mixture of pulverized charcoal, molasses, and tallow; then covered with canvas sewed on.

47,119 of 1865. A tube of fabric, sewed or braided, filled with sawdust, soapstone, graphite, whiting, zinc paint, white lead, resin, flaxseed meal, etc. Yarn may be saturated with this before braiding. Metallic thread braided cover.

63,285 of 1867. Strands of cotton saturated with powdered soapstone, or other lubricant, and covered with yarn.

64,688 of 1867. Harl or roving of hemp covered with braided material or fabric.

64,995 of 1867. Strands of jute or yarn passed through powdered soapstone; twisted into a rope; passed through melted paraffine; covered in a braiding-machine; then through paraffine.

73,454 of 1868 Wire or vegetable fiber, braided one over the other, with lubricants between.

77,275 of 1868. Lubricant of stearine, powdered soapstone, etc., is introduced into packing while being twisted or braided

77,902 of 1868. Yarn run from reels through a vat of oil, wax, and powdered soapstone, and twisted into rope.

101,425 of 1870. Core of asbestus, with canvas cover coated with rubber, vulcanized or otherwise. Pulverized asbestus spread on the canvas cover, or the latter may be of pulpy asbestus and a fibrous or glutinous material

102,958 of 1870. Pulp of rags and paraffine.

108,284 of 1870. Sliver or hempen rope impregnated with a vehicle of melted paraffine, with graphite, burnt hair, etc.

108,285 of 1870. A layer of fiber on a plate saturated with a mixture of melted paraffine or tallow and soapstone or graphite, compressed into sheets.

108,286 of 1870. Felt impregnated with a mixture of graphite, soapstone, and burnt hair, while in a vessel of paraffine.

108,722 of 1870. Material coated with rubber is punctured, and graphite or other lubricant forced therein.

108,931 of 1870. Graphite mixed with comminuted leather and paraffine.

109,239 of 1870. Loose yarn run into slivers, twisted and combined with melted paraffine, graphite, soapstone, etc.

110,582 of 1870. Rubber, graphite, and soapstone combined.

110,583 of 1870. Sponge impregnated with graphite and glycerine.

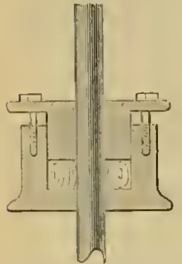
110,584 of 1870. Hair or wool felted with graphite, asbestus, etc., consolidated by action of water.

131,645 of 1872. Long fibers of wool and asbestus covered with metallic or fibrous material with lubricants between.

Somewhat similar materials are used for the pistons of pumps, though the common device is a leathern disk a trifle larger than the diameter of the bowl.

Pis'ton-rod. The round rod which connects the piston with the cross-head or crank of the steam-engine, as the case may be: or the pump-handle with the plunger or bucket.

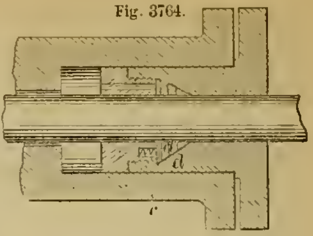
Fig. 3763.



Piston-Rod and Stuffing-Box.

The piston-rod passes through a steam-tight collar, known as a *stuffing-box*, as in the example, in which cork is compressed by the gland.

Fig. 3764.



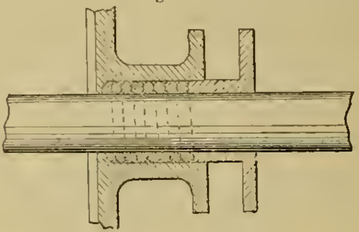
Piston-Rod Packing.

Pis'ton-rod Pack'ing. A material or device around the piston-rod to prevent leakage of steam from the cylinder.

In the example, the packing is pinched between the conical gland *d* and the perforated collar *c*, through which steam is admitted to the packing.

In Fig. 3765, the strands of hemp are wound on wire, and form annular sections or a coil around the piston-rod in the stuffing-box.

Fig. 3765.



Piston-Rod and Stuffing-Box.

Pis'ton-spring. A coil in the circumferential groove of a piston to expand against the cylinder and form a packing.

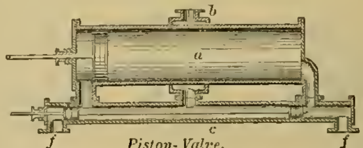
A spring inside a piston-head to expand the rim against the cylinder. See PISTON.

Pis'ton-valve. A valve consisting of a circular disk, which reciprocates in a cylindrical chamber. It is sometimes preferred to the slide-valve, as it is readily packed and its friction is less.

a is the cylinder; *b*, the steam-pipe, having a belt around the cylinder by which the steam reaches the valve-chamber *c*. The valves are on a single rod, and *f f* are the eduction passages

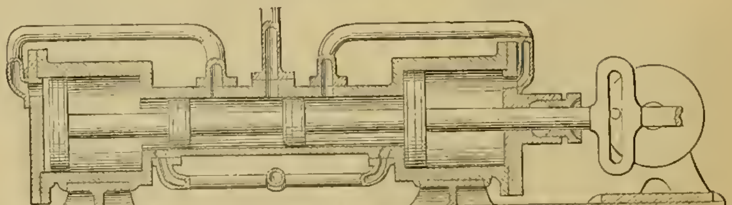
In Fig. 3767, the two piston-valves are on the stem of the piston, and govern the induction and eduction ports, through

Fig. 3766.



Piston-Valve.

Fig. 3767.



Steam-Engine and Pis'on-Valve.

which steam is admitted to be conducted from the respective cylinders.

Pit. 1. The shaft of a mine.

a. Pumping-pit; a shaft in which the pumps and hydraulic machinery work.

b. Working-pit; a shaft in which the mineral is hoisted and the supplies and workmen lowered.

c. Engine-pit; the shaft in which the engine works.

2. (*Founding.*) A cavity or hollow scooped in the floor to receive cast-metal.

3. A vat in tanning, bleaching, dyeing, or in washing alum earth, etc.

4. A sunken place in which charcoal is piled for burning.

Pitch. 1. (*Machinery.*) *a.* The distance between the threads of a screw measured on a line parallel to the axis. The *depth* is the radial measurement.

b. The distance between the centers of two adjacent teeth in a cog-wheel, measured on the *pitch-line*, which is concentric with the axis of revolution and at such a distance from the base of the teeth as to have an equal rate of motion with a similar line in the cog-wheel with which it engages.

c. The *pitch* of a rivet is the distance apart from center to center. It is four diameters in seams and butts of plates, and eight diameters in angle irons and bars. See Rivet.

d. The distance between the stays of marine and other steam boilers. In marine boilers it is usually from 12 to 18 inches.

2. (*Carpentry.*) The inclination of a roof. This is expressed, —

a. In angles, as 30°, 45°, etc.

b. In parts of the span, as one half, one quarter; indicating that the elevation of the comb is one half or one quarter of the span. When the hight is half the breadth the angle of the slopes is a right angle.

c. In the proportion which the rafters bear to the span.

The *common* pitch, so called, has a rafter three quarters the length of the span.

The *Gothic* has a *full* or *whole* pitch, the rafters being the length of the span, making an equilateral triangle.

The *Greek* has a pitch $\frac{1}{9}$ to $\frac{1}{7}$ of the span, giving an angle of 12° to 16°.

The *Roman* has a pitch from $\frac{1}{5}$ to $\frac{2}{9}$ of the span, giving an angle of 23° to 24°.

The *Elizabethan* has rafters longer than the span.

3. (*Architecture.*) The *rise* or versed sine of an arch.

4. (*Mining.*) A lode or portion of a lode let out to men to work by the piece or by a percentage of the product.

5. (*Saws.*) The pitch of a saw is the *rake* or inclination of the face of a tooth. The *space* is the distance between the points of the teeth. The *rake* is a forward slant of the *face*, not common, but found in some saws.

6. (*Planes.*) The slant of a plane-bit in its stock. The pitch is regulated by the angle of the *bed*. The spokeshave has an angle of from 25° to 30°. The *common pitch* of a bench-plane is 45°, and is used for pine and other soft woods. *York* pitch of 50° for bench-planes working in hard and stringy woods; mahogany, for instance. *Middle pitch*, 55°, for molding-planes and smoothing-planes for mahogany and similar woods. *Half pitch*, 60°, for molding-planes in wood difficult to work. As the pitch becomes steeper, it becomes a scraping action. Pitch of scraping and metal planes is 80° to vertical.

In the miter-plane the chamfer of the bit is set upward; the flat side rests on a bed of 25°, the angle of the bit is 35°, so that the cutting-edge has an elevation of 60°.

7. (*Water-wheel.*) In overshot water-wheels, the *bucket-pitch* is a circular line passing through the *elbows* of the buckets. The elbow is the junction of the *floor* and the *arm*, which form the *bucket*. See Bucket.

8. (*Paddle-wheel.*) The *pitch* of the paddles is the distance between them, measured on the circle which passes through their centers. It is commonly from 1.6 to double their depth.

9. (*Propeller.*) The pitch of a propeller-screw is the length, measured along the axis, of a complete turn.

A *gaining-pitch* is one in which the pitch gradually increases from the *leading* to the *following* edge.

10. (*Music.*) The acuteness or gravity, hight or depth, of any particular sound in the compass or range of notes comprehended by any voice or instrument. A musical sound is produced by a series of vibrations recurring at precisely equal intervals; the greater the number of vibrations in a given time, the more acute or higher the pitch.

The standard or concert pitch has long been a vexed question, although now pretty well settled For a long series of years prior to 1839 it had been gradually rising, much to the inconvenience of public singers. The C tuning fork in use in 1699 made 489 vibrations in a second, while in 1859 the number of vibrations had increased to 538. In England, in 1842, Mr. Hullah, as a public instructor, and under the sanction of the Committee of Council on Education, fixed a standard of 512, which has an especial convenience, as being a power of 2. In France, in 1858, the Imperial Government fixed it at 522. It was on all sides agreed that the then existing opera-pitch of 546 was too high and painful to soprano singers. Sir John Herschel — a high authority — strongly recommended 512; but instrumental performers stated that, while they could lower the pitch to 528, even at that some of them would be compelled to get new instruments. The Committee of the Society of Arts therefore fixed the standard at 528.

Pitch-back Wheel. (*Hydraulic Engineering.*) A kind of water-wheel, in which the water is turned at an angle with its direction in the flume before descending into the buckets.

Pitch-block. A cushioned seat of a concave hemispherical form, in which sheet-metal ware is held while being chased. See Chasing-tool.

Pitch-chain. Vaucanson's chain. One composed of metallic plates bolted or riveted together, to work in the teeth of wheels.

Pitch-cir′cle. (*Gearing.*) The circle of contact of a cog-wheel which meshes with a corresponding cog-wheel or rack.

Pitched Fas-cine′. A fagot of dry twigs, covered over with incendiary composition, and used to set fire to buildings or to light up works. It is made in the same way as common fascines, except leaving a cylindrical space in the axis, is bound with strong wire, and is first coated with a composition of twenty pitch and one tallow, and, when hardened, a second coat of equal parts of pitch and resin is given the fascine, which is afterward primed at each end with rock-fire.

Pitched Work. (*Masonry.*) Work in rubble or undressed stones which are not thrown in indiscriminately (*pierre perdue*), or laid regularly (*coursed work*), but in which the blocks are *pitched* or tossed into place with a certain degree of regularity, so as to bind one another in place. It is used in the facing or upper courses of breakwaters, the slopes of jetties, and on similar maritime constructions.

Pitch′es. The guide-pins which direct the floor-cloth printer in placing the blocks on the canvas so that the respective dots of color will fall into the right places in the pattern.

They answer as the register-points in chromo-lithographic printing, in which the paper is placed successively on stones with different-colored inks; the points penetrating the paper preserve the *register*.

A sheet of paper on the *tympan* of a printing-press acts as a guide in placing the paper thereon in printing, so that the matter shall occupy the right place on the page. Where the printing is in more than one color, the *tympan-sheet* acts as a register.

Pitch'fork. A husbandman's fork of two or three tines for pitching hay, straw, or sheaves, or of four tines for manure.

Pitch'ing. (*Hydraulic Engineering.*) A facing of dry stone laid upon a bank, to prevent the wear by waves or currents.

Pitch'ing-piece. (*Carpentry.*) The piece against which rest the upper ends of the *carriage-pieces, notched boards,* or *rough-strings,* supporting the steps of a stairs. An *apron-piece.*

Pitch'ing-tool. 1. (*Watchmaking.*) A tool used in placing wheels between the plates of a watch.

2. (*Mining.*) A kind of pick used in commencing a hole.

Pitch-line. (*Gearing.*) The circle described by the extremity of the primitive radius.

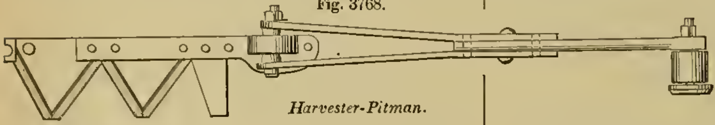
Pitch-pipe. (*Music.*) A flute or free-reed pipe tuned to a given pitch, and used by choristers as a tuning-fork to give the required elevation of the voice. The reed-pipe has a given note. The flute-pipe may have a piston and a range of adjustment.

Pitch-wheels. (*Gearing.*) Toothed wheels in machinery or in a train working together.

Pit-coal. Fossil coal. Stone coal.

Pit-cock. A cock to discharge air from a water-pipe. See also PET-COCK.

Fig. 3768.



Harvester-Pitman.

Pit-kiln. An *oven* for coking coals; in contradistinction to a *mound.*

Pit'man. (*Machinery.*) The rod which connects a rotary with a reciprocating object, as that which couples a crank with a saw-gate, or a steam-piston with its crank-shaft. So called from the lower man of a pair who worked in a pit at the lower end of the saw.

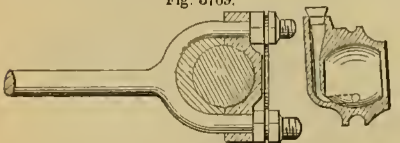
The word has now a local application to the man in charge of the drainage-pumps in a pit or shaft.

The more general use of the word refers to a bar proceeding from a crank or wrist, such as the rod connecting the cutter-bar of a harvester with the wrist on the crank-wheel.

Pit'man-box. The stirrup and brasses which embrace the wrist of the driving-wheel.

In the example, the driving-wrist is formed with a ball and flange, on which is fitted a cap having an oil reservoir to lubricate the joint, and apertures to receive the forked end of the pitman.

Fig. 3769.

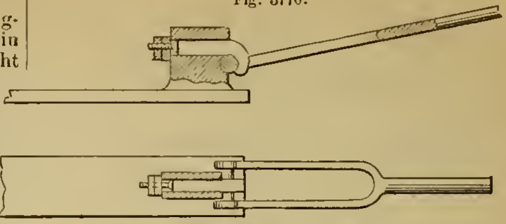


Pitman-Box.

Pit'man-coup'ling. A means of connecting a pitman to the object which it drives.

In the example, the bolt is secured to the forks of the pitman, and is held snugly in its semi-cylindrical socket by an adjustable hook-bolt.

Fig. 3770.

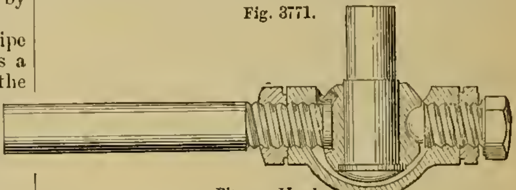


Pitman-Coupling for Harvesters.

Pit'man-head. The block or enlargement at the end of a pitman, at which point its connection is made to the object by which it is driven or which it drives.

The means are usually a strap, gib, and key, but in certain machinery, as in harvesters, another arrangement is preferred, as in Fig. 3770, or in the example, in which the wrist revolves in the divided box, which is supported on a screw at the end of the pitman, and a pivot from the opposite side of the oil-cup; a determinate freedom of motion is allowed in a plane coincident with its points of suspension and also transverse thereto.

Fig. 3771.



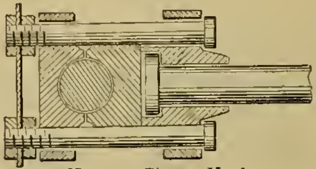
Pitman-Head.

Fig. 3772 is another form in which the head of the pitman is connected by swivel-pieces to the parts holding the boxes of the wrist to secure freedom of motion.

In Fig. 3773, the chilled-box pitman-head has an internal screw to receive the threaded end of the pitman, which is secured by a jam-nut.

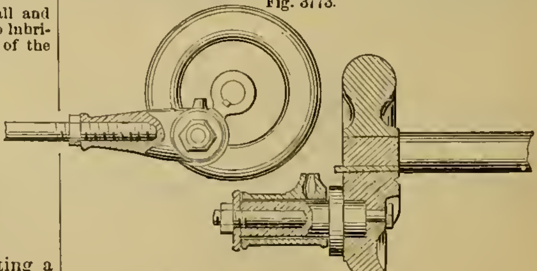
Pi-tot's' Tube. A current-meter. It is a tube open at both ends and bent at right angles. The longer leg is graduated and held vertically while the

Fig. 3772

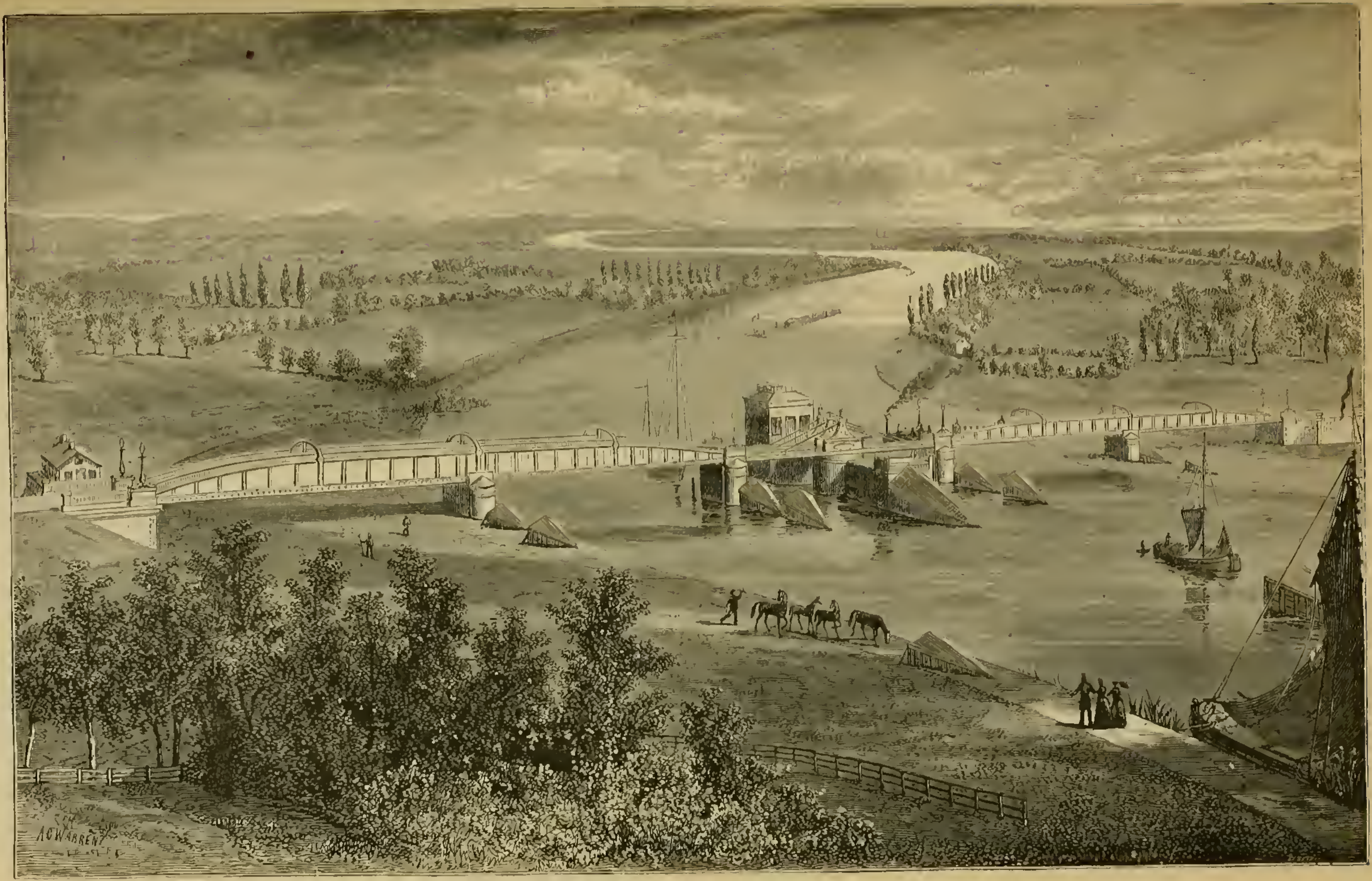


Harvester Pitman-Head.

Fig. 3773.



Wrist-Wheel, Wrist, and Pitman-Head.



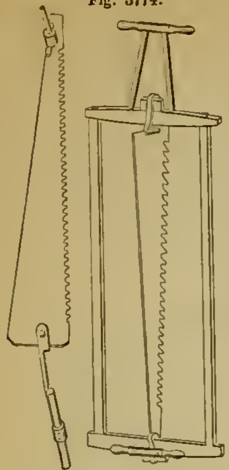
PIVOT BRIDGE OF THE AMSTERDAM, UTRECHT, AND COLOGNE RAILWAY.

OVER THE YSSEL, NEAR WESTERVOORT, HOLLAND.

PLATE XLI

See page 1721

Fig. 3774.



Pit-Saw.

lower end is plunged in the water, the mouth pointing up stream. The rising of the water in the tube, above the level of the outside, is the measure of the force, that is, speed of the current. See CURRENT-METER.

Pit-saw. A saw operated by two men, one of whom stands on the log and the other beneath it. The place of the latter is frequently in a pit, and thence the name.

Pit-work. The pumping and lifting apparatus of a mine-shaft.

Piv'ot. 1. (*Machinery.*) A short shaft or pintle on which a body oscillates or revolves.

A bearing-pin of a small shaft.

2. (*Watchmaking.*) A journal at the end of an arbor. The workman uses special tools, known as the pivot-*drill*, pivot-*broach*, pivot-*file*.

Piv'ot-bolt. (*Ordnance.*) The axis of horizontal oscillation. A traversing platform passing through the pivot transom and the front sleeper of the platform.

Piv'ot-bridge. One form of swing-bridge, which moves on a vertical pivot beneath its midlength.

Fig 3775 shows a number of forms of drawbridges.

a is a swinging span made up of panels of trusses.

b is a span on the Bollmau principle across the Mississippi at Quincy, Illinois.

c is a pivot-bridge of the New York Central Railway on the Linville principle.

d is a swinging bridge on the Linville principle; it is one span of several across the Missouri River.

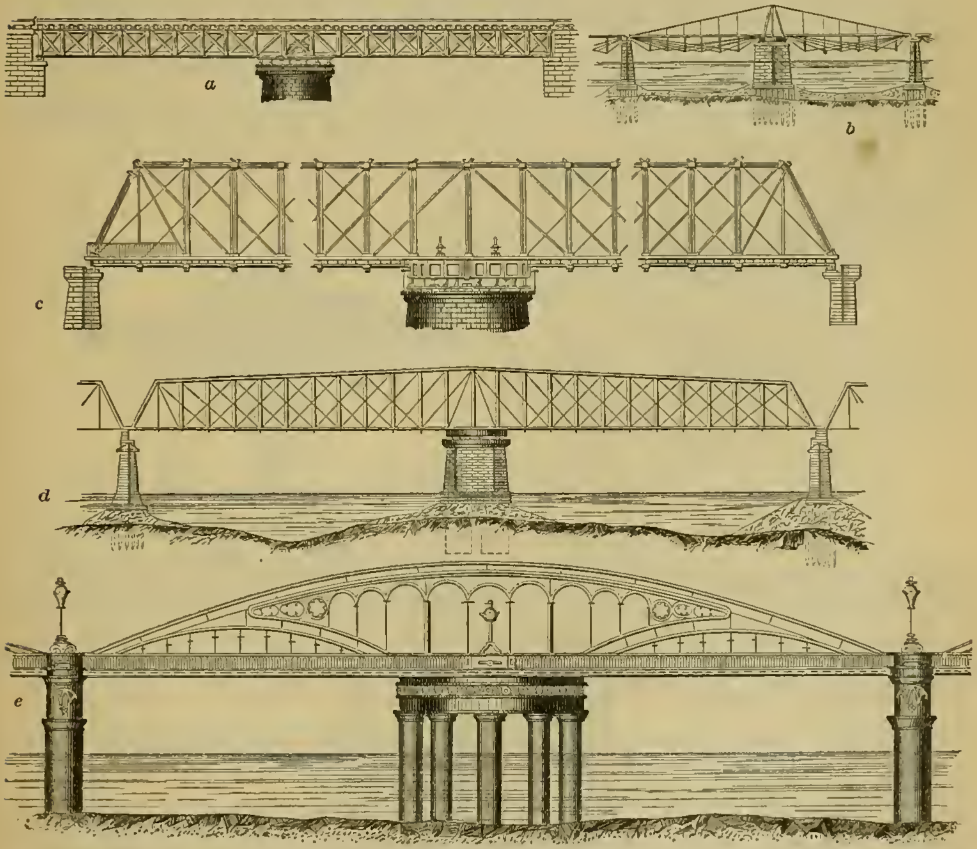
e is a bridge on the bowstring principle across the Harlem River, New York.

Plate XLI. is a view of the Swing Bridge of the Amsterdam, Utrecht, and Cologne Railway, over the Yssel near Westervoort, in Holland. It shows the swinging span, gatekeeper's house, land spans for carrying off water at spring floods, ice-breakers in the stream and on the lowlands. In the distance are the dunes of the coast.

Piv'ot-broach. (*Watchmaking.*) A fine broach or tool for opening the pivot-holes of watches.

Piv'ot-drill. (*Watchmaking.*) A bow-drill used in making the pivot-holes in plates of watches.

Fig. 3775



Pivot-Bridges.

Piv'ot-file. (*Watchmaking.*) A fine file used in dressing pivots on the arbors of watches.

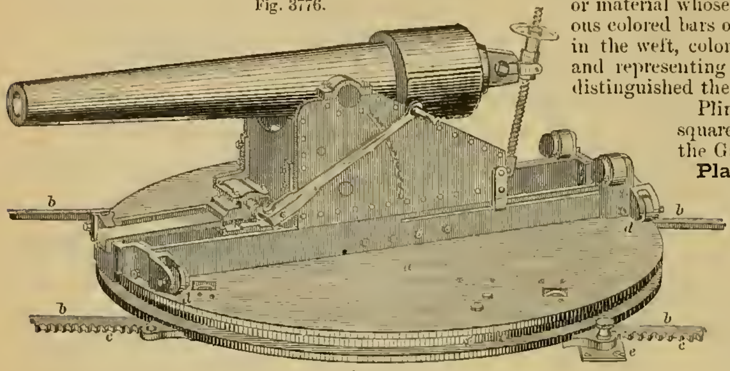
Piv'ot-gear'ing. (*Gearing.*) Cog-wheels so arranged that the axis of the driver may be shifted, to allow the machine — a threshing-machine, for instance — to be set in any direction from the power.

Piv′ot-gun. A gun mounted on a carriage which may be revolved so as to sweep all points of the compass. Usually employed on shipboard, but sometimes in fortifications.

Fig. 3776 shows a Parrott gun mounted on a pivot-carriage adapted to be shifted from side to side of a vessel, so that one battery may answer for both broadsides. The carriage is in use on the thirty gunboats built for the Spanish government in New York, about 1870, and has since been adapted for other vessels. It was invented by Ericsson.

The platform *a* runs on tracks *b b* across the deck of the vessel, and may be propelled by a cog-wheel gearing in the rack *c* on one of the tracks. The carriage proper is pivoted in the center of the platform, and rests on wheels *d d*. When in firing position the platform is fastened to the deck by pins, one of which is shown at *e*.

Fig. 3776.

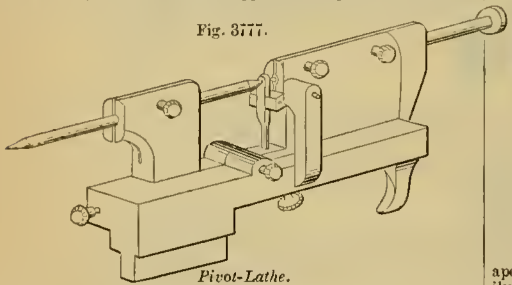


Pivot-Gun.

Piv′ot-lathe. A small lathe used by watchmakers for turning the pivots on the ends of arbors for watch-movements.

In the example, the staff on which the pivot is to be turned is sustained in a laterally adjustable rest, with an axial support in the rear; the head which supports the spindle of the cutting-tool is adjustable laterally; the shank of the burnisher is socketed in a transversely adjustable rest.

Fig. 3777.



Pivot-Lathe.

Piv′ot-tooth. (*Dental.*) An artificial crown attached to the root of a natural tooth by a dowel-pin of wood or metal occupying the nerve-canal, which is enlarged by a *broach* for that purpose.

Piv′ot-tran′som. (*Ordnance.*) The front member of the chassis.

Pix. (*Coining.*) A box in which are placed samples of coin for assay. *Pyx.* See COINING; REMEDY.

Place-brick. A name given in England to the imperfectly burned bricks at the outer part of a kiln or clamp. They are inferior in hardness and durability. Called also *pecking-brick*, *sandal-brick*, *samel-brick*.

Pla-cen′ta-for′ceps. (*Surgical.*) A forceps for grasping and extracting the afterbirth.

Pla-cen′ta-hook. (*Surgical.*) A small, round pointed hook with ebony handle, used in obstetrics, to extract the afterbirth.

Place-of-arms. (*Fortification.*) Enlargements in the salient and reëntering angles of the *covered-way*, and serving for the occupation of the troops who defend it. See BASTION.

Plaid. (*Fabric.*) Goods of any quality or material whose pattern consists of various colored bars or stripes in the warp and in the weft, colored in the wool or thread, and representing the Scotch tartans which distinguished the clans.

Pliny states that to divide by squares in weaving came from the Gauls.

Plain-back. (*Weaving.*) *a.* The ground on which the *nap* or *pile* is raised.

b. Bombazette.

Plain Cloth. (*Fabric.*) Not twilled.

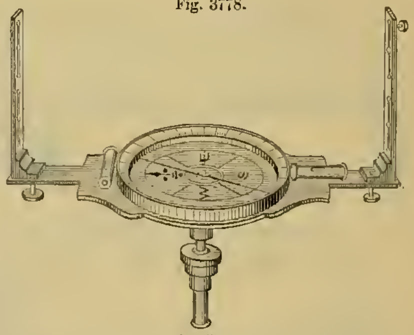
Plain-com′pass. A simple form of the surveyor's instrument. It has a needle about six inches long, a graduated circle, main plate, levels and sights, and is placed upon the brass head of the *Jacob-staff.*

The compass-circle is divided to half-degrees on its upper surface, the whole degree marks being also cut down on the inside circumference, and is figured from 0 to 90 on each side of the center or "line of zeros."

The sights, or standards, have fine slits cut through nearly their whole length, terminated at intervals by large circular apertures through which the object sighted upon is more readily found.

The right and left hand edges of the sights have respectively an eye-piece, and a series of divisions, by which angles of elevation and depression, for a range of about twenty degrees each way, can be taken with considerable accuracy. This arrangement is termed a *tangent-scale*, the divided edges of the north sight being tangents to segments of circles having their centers at the eye-pieces and their points of contact with the tangent lines at the zero divisions of the scale.

Fig. 3778.



Plain-Compass.

Plain-gauze. (*Weaving.*) Worked without flowers.

Plain-mold′ing. (*Joinery.*) Molding of which the surfaces are plane figures.

Plait. 1. Braid.

2. A flat fold in a garment, as on a shirt-bosom.

3. Straw-plait is made in various ways, and after a variety of patterns, known by the name of the place whence it is brought, as *Leghorn*, *Tuscan*, *Dunstable*; or by the number of strands, as *seven*, *double-seven*; or by other characteristics, as *split*, *vandyke*, *open*, etc.

The straws are carefully selected, cut into equal lengths, bleached by exposure to sulphur fumes, split lengthwise, and plaited together, according to the taste and the market.

The Leghorn, for instance, is a 13 plait, 6 straws being turned to the left and 7 to the right, so as to cross each other at right angles; the outer one of the seven is turned down, under two, over two, and under two; the outer straw on the other side, which now has seven, is next turned down, passing below, above, and below, in the same manner.

Straw is split by a wire which has a series of sharp edges equal in number to the number of splits into which it is desired to divide the straw. The slips are softened in water to render them pliable in plaiting. The plait is flattened between wooden rollers.

4. (*Nautical.*) Strands of rope-yarn twisted into *foxes*, or braided into *sennit.*

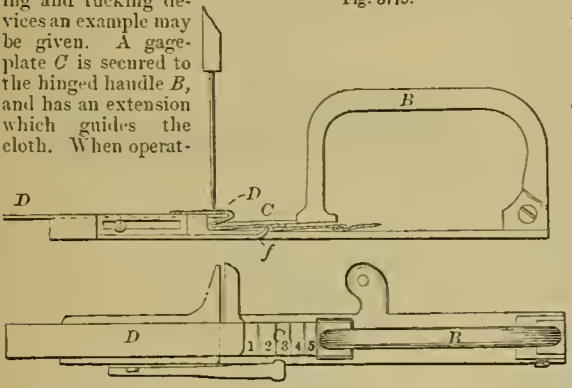
Plait'ed Rope. A flat rope made by plaiting instead of twisting. *Sennit.*

Plait'ing. 1. (*Hat-making.*) The interweaving of the felted hairs, forming a hat-body by means of pressure, motion, moisture, and heat. Also called HARDENING (which see).

2. Interweaving of strands to form a flat rope or braid.

Plait'ing-at-tach'ment for Sew'ing-ma-chines'. A plait is a flattened gather or fold. Of the numerous plaiting and tucking devices an example may be given. A gage-plate *C* is secured to the hinged handle *B*, and has an extension which guides the cloth. When operating, the gage-plate rests upon the cloth and pushes it against a shoulder, above which the folding-plate *D* is secured. An adjustable guide *f* causes the tuck which is just formed to be fed in a line parallel to the plait which is being stitched.

Fig. 3779.



St. John's Tucker.

Plan. A map or representation of a building or machine on a given plane. A horizontal section at a specified level.

1. In architectural drawing, the term is applied either to a *ground plan*, the *orthography*, or to a horizontal section at a given hight, say one of floors or stories.

In the *geometrical* plan, the parts are represented in their natural proportions.

In the *perspective* plan, the lines follow the rules of perspective, reducing the sizes of more distant parts.

Other views are *elevations, end* or *side,* and *sections;* also called *raised plans.*

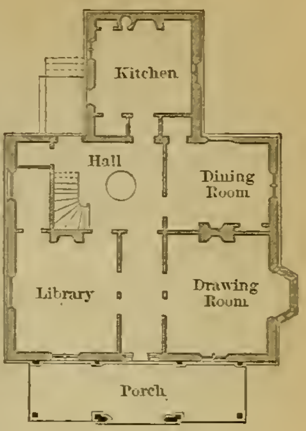
2. In shipbuilding, the term *plan* is of more general import, and we have —

a. The *shear-plan*, giving the lines of horizontal sections at different hights, as well as the bow and buttock lines, which represent the boundaries of vertical sections in planes parallel to the vertical longitudinal section. The shear-plan is practically a side elevation or longitudinal view.

b. The *half-breadth plan* is practically a top view of one half of the vessel, divided vertically and longitudinally in the line of its keel. It is a *plan* in the more restricted sense.

c. The *body-plan* is an end elevation, showing the *water-lines, buttock and bow* lines, *diagonal* lines, etc. See LINE.

Fig. 3780.



Plan of a Cottage.

Plan'ceer. (*Architecture.*) A SOFFIT (which see).

Planch. An iron shoe for mules.

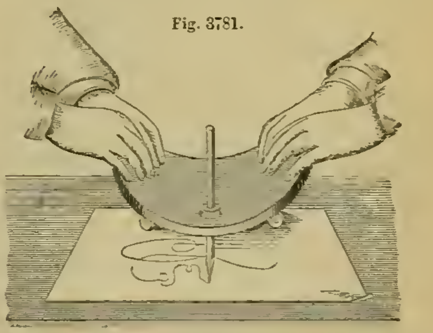
Plan'chet. (*Coining.*) A flat disk of metal. A round disk of metal weighed and tested is a planchet ready for coining.

The strips of plate from which planchets have been removed are called *scissel.*

Plan-chette'. 1. A heart-shaped piece of board mounted on thin supports, two of which are casters, and one a pencil which makes marks as the board is pushed under the hands of the person or persons whose fingers rest upon it. The exact cause of its motions is not clearly understood, as a portion seems to be involuntary on the part of the performers.

Planchette belongs to the family of so-called "spirit-manifestations," table-tippings, etc. These and similar phenomena have not been satisfactorily explained; and thus far they seem productive of more harm than good, where accepted as genuine manifestations of disembodied spirits.

Fig. 3781.



Planchette.

In principle it is as old as the hills. The Chinese know all about it. When they would consult a god, they set before the image a platter of sand, and two men grasp one leg each of a V-shaped piece of wood, the point of which rests on the sand. The spirit of the god is supposed to descend and move the marker, and the marks it makes in the sand are translated into an oracular answer!

While the pursuit of such knowledge has been the destruction of the religious faith of thousands, and while the pursuit of the exact and speculative sciences has, in many cases, crowded out all belief in the supernatural, it is a comfort to some of us to read the testimony of the great physicist Faraday: "I have never seen anything incompatible between these things of man which can be known by the spirit of man which is within him and those higher things concerning his future which he cannot know by that spirit."

2. A circumferentor.

Plane. 1. (*Woodworking.*) A carpenter's cutting and surface-smoothing tool, of which there are many varieties, called from some peculiarity of construction or purpose.

A tool having a bit-iron set in a flat-soled stock, and used for smoothing surfaces by taking thin shavings therefrom.

The *bit* is known as the *iron*.

The *iron* is fastened in the *stock* by the *wedge*, which holds it to the slanting surface known as the *bed*. The *abutment* is the shoulder, between which and the plane-bit the wedge is driven.

The bottom of the *stock* is the *sole*.

The *toat* is the handle.

"The shavings of fir, when briskly *planed*, always curl up in circles like the tendrils of the vine." — PLINY.

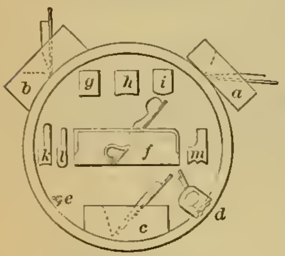
The plane of the Romans was known as *runcina*.

The Japanese planes are small, with single irons, — no handles. The planes are shorter, lighter, and the wood shallower than ours, being generally not more than an inch deep. To plane a piece of wood, they lay it on the ground, squat on their hams, hold it fast with their toes, and work the plane by drawing it with both hands toward them.

Some of their tools appear to be mere children's toys; for instance, they have a smoothing-plane two and one half inches long, one inch broad, and half an inch thick

In Fig. 3782, *a* shows a flat solid plane applied to a curved exterior surface; the rounding can, however, be effected more speedily and conveniently by the concave plane *b*. The compass-plane *c* is adapted for curved interior surfaces, and may be used for forming curves having a greater radius than its sole. *d* is a plane for the hand-rails of staircases; *e*, spokeshave; *f*, bench-plane; *g*, section of stock of bench-plane; *h*, *i*, *k*, *l*, *m*, sections of molding-planes.

Fig 3782.



Planes (*Diagram showing the Kinds*).

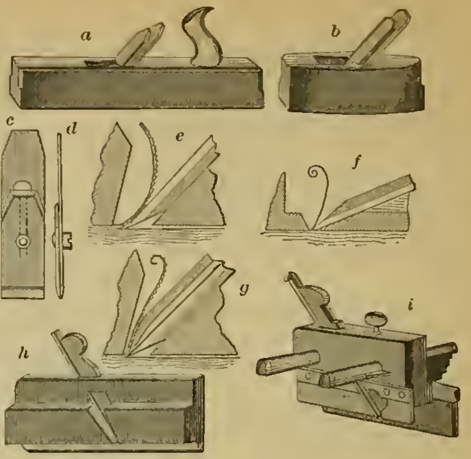
In Fig. 3783, *a* is a jack-plane; *b*, smoothing-plane; *c*, *d*, double plane-iron, the shorter is termed the *break-iron*. *e* illustrates the action of a plane in which the mouth has become much worn; the shavings are comparatively unbroken, and the iron, splitting the fibers, does not give a smooth surface. *f*, mouth of *miter-plow*, of small aperture, faced with metal and effecting a comparatively smooth cut; this object is better effected by the double plane-iron, as shown at *g*; *h*, fillister; *i*, plow.

In Smith and Carpenter's plane (*A*, Fig. 3784), the stock is stiffened by an upper metallic frame; the plane-iron *a* is held between the wedge *b* and curved branch *c*, and is adjusted by a thumbscrew *d*.

Evans's plane-stock *B* consists of a metallic piece *a*, in which the bit is secured by a lever *b* provided with a thumbscrew; curved arms *c c*, to which the flexible sole *d* is attached, work in slots at the ends of the stock; the sole may thus be adjusted to any desired curve within certain limits, the arms being secured by the screws *e e*.

The stock of Buckel's plane *C* is made in two parts, pivoted together at *a* through metallic guide-plates on each side. A spring *b* is interposed between the two parts at front, their distance apart being regulated by the screw *c*. The plane-iron is fixed in the upper part, and is caused to protrude more or less from the mouth, according to the downward pressure exerted by the hand; the depth of cut may thus be varied at each stroke, and the drag of the bit as the plane is drawn back is prevented

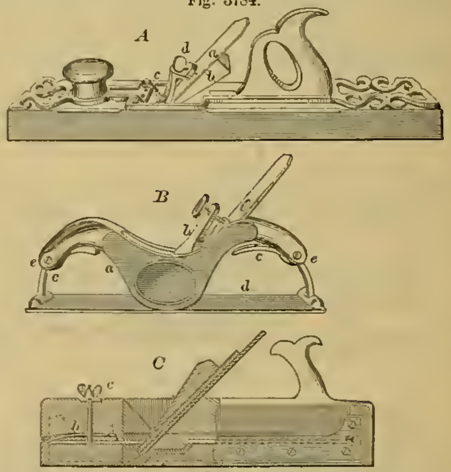
Fig. 3783.



Planes.

An American plane, patented in 1832, has a thumbscrew on the top iron, which moves two lateral pins fitting in grooves in the sides of the plane. The plane-bit being adjusted to the required position, rotation of the thumbscrew tilts the top plate, which bears against the bit and holds it in place without a wedge.

Fig. 3784.



Planes.

The following are the dimensions of some of the more common varieties of planes: —

	Length in Inches.	Width in Inches.	Width of Irons.
Modeling-plane	1 - 5	¼ - 2	3/16 - 1½
Smoothing-plane	6½ - 8	2⅝ - 3⅛	1¾ - 2⅓
Rabbet-plane	9½	⅜ - 2	⅜ - 2
Jack-plane	12 - 17	2½ - 3	2 - 2¼
Panel-plane	14½	3½	2½
Trying-plane	20 - 22	3¼ - 3⅜	2⅜ - 2⅓
Long-plane	24 - 26	3⅝	2⅝
Jointer-plane	28 - 30	3¾	2¾
Cooper's jointer-plane	60 - 72	5 - 5¼	3½ - 3¾

The angle of the bit varies with the work; the harder the wood the steeper the pitch.

Common pitch is 45°, and *half-pitch* is 60°. There are other pitches between the two. See PITCH.

See under the following heads: —

Angle-plane.
Astragal-plane.
Badger-plane.
Banding-plane.
Bead-plane.
Bench-plane.
Border-plane.
Break-iron.
Capping-plane.
Carpenter's plane.
Compass-plane.
Concave-plane.
Cooper's plane.
Core-box plane.
Cornice-plane.
Counter-check.
Covetta.
Cutting-plane.
Cutting-thrust.
Dovetail.
Dovetail box-plane.
Edge-plane.
Fillet-plane.
Fillister.
Fluting-plane.
Fore-plane.
Forkstaff-plane.
Grooving-plane.
Hand-rail plane.
Hollows and rounds.
Hollow-sash plane.
Howel.
Ice-plane.
In-shave.
Jack-plane.
Joiner's plane.
Jointer.
Jointing-plane.
Lamb's-tongue.
Long-plane.
Matching-plane.
Metal-plane.
Miter-plane.
Moleling-plane.
Molding-plane.
Ogee-plane.
Overshave.
Ovolo-plane.
Panel-plane.
Panel-plow.
Pistol-router.
Plane-guide.
Plane-iron.
Plane-table.
Plow.
Quarter-round.
Quirking-plane.
Rabbet-plane.
Reed-plane.
Reglet.
Rounding-plane.
Round-nose plane.
Router.
Sash-fillister.
Sash-plane.
Scaleboard-plane.
Scraping-plane.
Shooting-plane.
Side-fillister.
Side-plane.
Side-rabbet plane.
Side-round plane.
Side-snipe
Single and three reed planes.
Skew-plane.
Skew-rabbet plane.
Slat-plane.
Slitting-plane.
Smoothing-plane.
Snipe-bill plane.
Splint-plane.
Spokeshave.
Spout-plane.
Square-rabbet plane.
Stock-shave.
Sun-plane.
Table plane.
Tonguing-plane.
Toothing-plane.
Try-plane.
Whisk.
Witchet.

2. A straight surface; a "true plane" is a gage or test of flatness. The "true" planes exhibited by Whitworth at the Paris Exposition were polished metallic surfaces of 100 inches area. These were prepared in triplets, to avoid the error which may occur, as, when ground together, one might become convex and the other concave, but a third could not possibly fit both unless they were all correct. The error is said not to have exceeded the $\frac{1}{1000000}$th of an inch. One slides over the other as freely as upon ice, until, by pressure, the film of air is removed, and then the adherence is so strong that one is readily lifted by the other. See PLANE-SURFACE.

3. (*Fortification.*) *Plane of defilade;* a plane passing through the crest of a work parallel to the plane of site.

Plane of site; the general level of the work, horizontal or inclined.

Plane-ash'lar. (*Masonry.*) Ashlar with smooth-worked face.

Plane-bit. The cutter of a plane; generally termed the *plane-iron.* The cutting-edges of plane-irons are generally a right line, but, for some purposes, they are made with rectangular or curved grooves. They are set in the stock at various angles with the sole, 45° being termed *common pitch:* this is employed in bench-planes for soft woods; 50°, *York pitch,* for mahogany and hard woods; 55°, *middle pitch,* is used in molding-planes for soft woods, and smoothing-planes for mahogany and hard woods; 60°, *half pitch,* in molding-planes for hard woods. The iron rests on the *bed,* and is held between this and the abutment by a wedge which adjusts its projection beyond the mouth. In metal-workers' planes the iron is set at an angle of 70° or 80°; it is adjusted by a vertical screw, and an end screw and block is substituted for the wedge; its face is frequently grooved, giving a greater penetration, the smoothing being afterward effected by a plane with a narrow bit.

Double irons are generally employed in the better class of planes; the upper, called the *break-iron,* does not cut, but breaks the shaving, allowing the lower bit to effect a smooth-cutting action without splitting the wood.

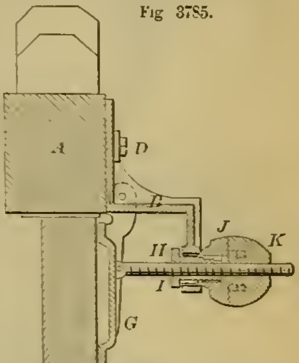
The *scraping-plane,* having its bit perpendicular or nearly so, is also employed on hard wood and ivory; with its edges serrated, such a plane is used by cabinet-makers for roughing veneers and the surfaces to which they are glued.

The width of plane-irons varies according to kind.

Modeling-planes	$\frac{3}{16}$ – 1½	inches.
Smoothing-planes	1¾ – 2⅜	"
Rabbet-planes	⅜ – 2	"
Jack-planes	2 – 2¼	"
Panel-planes	2½	"
Trying-planes	2⅜ – 2¾	"
Long-planes	2⅝	"
Jointer-planes	2¾	"
Cooper's jointer-planes	3½ – 3¾	"

Plane-guide. (*Joinery.*) An adjustable attachment used in beveling the edges or ends of plank. Woodville's (Fig. 3785) is secured to the stock *A* by screws *D,* passing through slots in the plate *B* hinged to the plate *G,* which rests on the face of the board; the desired inclination is given to the sole of the plane by the screw *H* working through the threaded nut *I,* and held by the jam-nut *J K.*

Fig 3785.

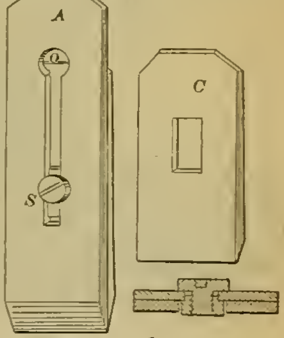


Plane-Guide.

Plane-i'ron. The cutting-iron inserted in a plane-stock and fastened by a wedge. Names indicate structure or function, as —

Double plane-iron.
Break-iron.
Top plane-iron.
Round-nose plane-iron.
Toothed plane-iron.
Smoothing plane-iron.
See PLANE; PLANE-BIT.

Fig. 3786



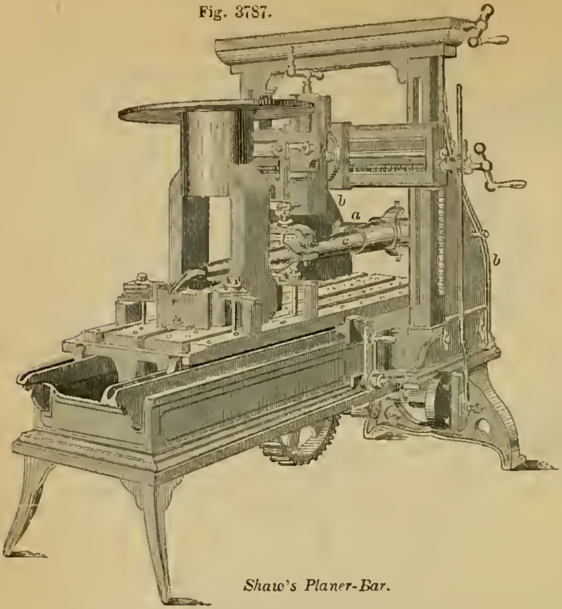
Plane-Iron.

A, plane-iron. *C,* cap.
S, coupling-screw; a slot.

Plan'er. (*Printing.*) A wooden block used to even the face of a form of type before printing; the top usually covered with leather to deaden the blow of the mallet.

Plan'er-bar. A device attached to a planer for the purpose of effecting in part the work of a slotting or shaping machine. Shaw's (Fig. 3787) consists of a transverse cylinder *a* journaled in the standards *b b*; the bar *c* is pivoted to *a* at *d,* forming a universal joint, and allowing the tool *e* to be presented in any direction, within certain limits, to the work on the bed beneath. At *f* is a pivoted box, which is fastened by a pin to the tool-post and carriage, in the feed-motion of which the tool *c* consequently participates. The illustra-

Fig. 3787.

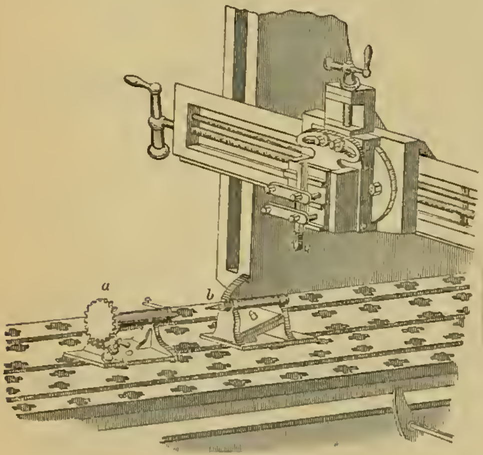


Shaw's Planer-Bar.

tion shows the tool operating on the interior of a large casting.

Plan'er-cen'ters. Devices similar to lathe-centers for supporting small work on the bed of a planing-machine. One of the two (*a b*, Fig. 3788) is provided with a worm and worm-wheel, by which the work may be rotated, so as to present each face in succession to the cutter *c*; the other has an inclined plane, by which the slope of the work is regulated so as to give a taper, if required.

Fig. 3788.



Planer-Centers.

Plane-stock. (*Joinery.*) The body of the plane in which the iron is fitted. See Plane.

The *sole* or *face* is the flat lower surface.

The *iron* is the cutting piece.

The *wedge* holds the iron upon the slanting portion, called the *bed.*

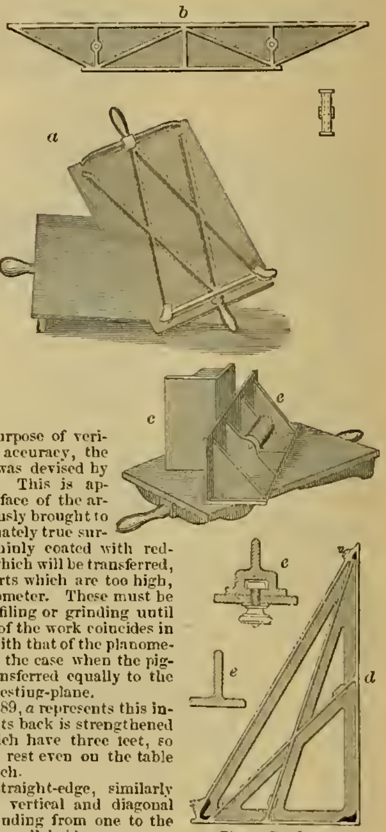
The plane-iron projects through the *mouth,* through which also pass the shavings.

A *horn* is a projecting piece at the fore end.

A *handle* or *toat* is at the rear end, to push by.

Plane-sur'face. Plane-surfaces are produced by the planing-machine, by the file, and by grinding, using an abradant.

Fig. 3789.



Plane-Surfaces.

For the purpose of verifying their accuracy, the *planometer* was devised by Whitworth. This is applied to the face of the article, previously brought to an approximately true surface, and thinly coated with red-lead in oil, which will be transferred, in those parts which are too high, to the planometer. These must be reduced by filing or grinding until the surface of the work coincides in every part with that of the planometer; this is the case when the pigment is transferred equally to the face of the testing-plane.

In Fig. 3789, *a* represents this instrument. Its back is strengthened by ribs, which have three feet, so that it may rest even on the table or work-bench.

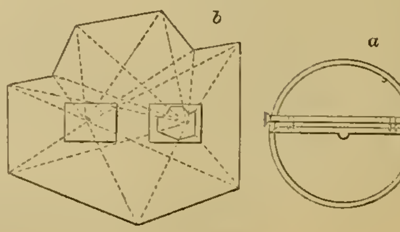
b is a straight-edge, similarly stiffened by vertical and diagonal flanges extending from one to the other of its parallel sides.

c c are angle-plates, made to form a true right angle at the edges and ends, so that by placing the work on a surface-plate, its external angles may be tested.

d is a square with wide faces, and having braces set at angles of 60° and 45°, respectively. The stops *e e* may be set so as to project beyond the square, and be applied to the edge of the work, or turned out of the way, leaving the side of the square flat. A *planometer*.

Plane-ta'ble. An ancient instrument for taking angles in mapping. The round table *a* is adapted to receive sheets of paper, and has a marginal, graduated circle. Over the center of the table an alidade

Fig. 3790.



Plane-Table.

is pivoted, one side of the alidade intersecting the center and reaching to the marginal graduations. The telescope being directed in turn to the different objects to be observed, a line is drawn on the table which represents the direction to the said objects from this station. Another station is then selected, and the distance between the two carefully measured. The telescope is then pointed to the same objects in turn from the new station, and the lines of direction marked on another sheet of paper. The two triangulations being placed on a plotting-table at the proper distance between stations, on the required scale, the lines of direction from each station are prolonged, and their intersections give the angles, as in figure *b*, which is supposed to be a fort whose angles are all distinguishable objects, and whose sides are straight lines between the said angles.

Würdemann's plane-table is a geodetical instrument consisting of two main parts: (1.) The motion works on a tripod, including leveling-screws and a horizontal movement, with clamp and tangent, above which is fastened down the drawing-board, which receives the paper. (2.) On this is placed the alidade, consisting of a broad metallic ruler with level, an upright column, near the middle, carrying above a telescope on a horizontal axis, so as to have a vertical movement of about 30° each way from the horizontal position. The telescope itself is accurately adjusted parallel to the ruler's edge. A vertical divided arc of 30° each way, with vernier reading to minutes, is commonly added for determining altitudes. The plane-table is used altogether for details of surveys, such as roads, shore lines, borders of forest, houses, etc. It differs from all other instruments in the results of the work, that it produces immediately a detail map in the field, whilst going over the ground, measuring distances, and triangulating within the limits of the sheet on the board according to the scale of reduction required. A telemeter rod or chain is used in connection with it.

Plan'et-a'ri-um. A machine for exhibiting the relative motions of the planets and their positions in respect to the sun and one another, sometimes rather absurdly called an *orrery*.

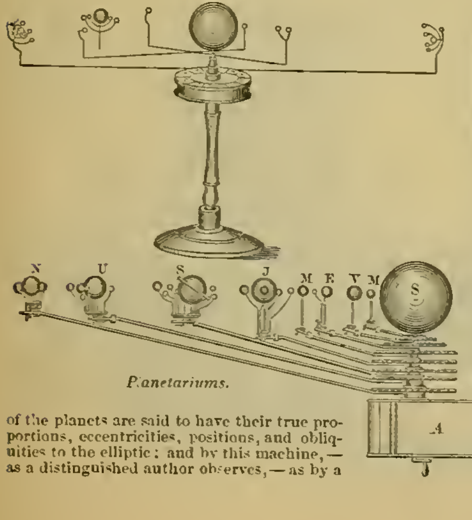
A planetarium made by Graham, the renowned mechanician and watchmaker, came into the possession of the Earl of Orrery and obtained celebrity. It received its name from Steele, who wrote a description of it.

The first recorded *planetarium* was made by Archimedes, about 200 B. C. It must have been constructed after the geocentric system, which then obtained, — the earth in the center, and so on.

A *planetarium* constructed at Florence in the fifteenth century is described in a letter from Angelo Politiano to his friend Francesca Casa. It illustrated the Ptolemaic system, the received theory of the time.

The planetarium of Huyghens, preserved in the University of Leyden, showed the revolution of the primary planets about the sun, and that of the moon round the earth, performed in the exact times actually occupied in those motions. The orbits of the planets are said to have their true proportions, eccentricities, positions, and obliquities to the elliptic: and by this machine, — as a distinguished author observes, — as by a perpetual ephemeris, the situations, conjunctions, and oppositions of the planets for any time may be accurately determined.

Fig. 3791.



Planetariums.

We read of a *planetarium* by Watson, in 1689, and another constructed by Rowley, 1700, from the plans of Graham. This was the one referred to above as having come into the possession of the Earl of Orrery, and is similar to the upper one in the accompanying figure.

Sir John Herschel says: "As to getting correct notions on the magnitudes and distances of the planets by drawing circles on paper, or, still worse, from those very childish toys called orreries, it is out of the question."

With great deference to the distinguished astronomer, we must insist upon the use of orreries, not for showing magnitudes and distances, but for exhibiting the relational positions and explaining celestial phenomena.

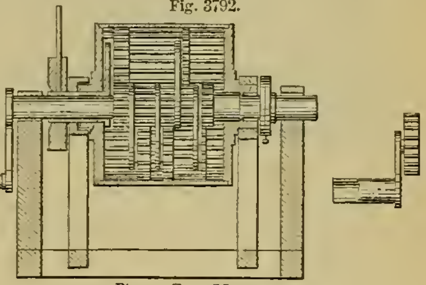
Dr. Desaguliers described a complete *planetarium* in his "Course of Experimental Philosophy," published in 1734.

A very complete apparatus of the kind was a planetarium shown in London in 1791, and purchased by the English government in 1793, to be sent out with Lord Macartney on his embassy to China, as a present to the emperor of the Celestial Flowery Land. It was said to have been ample and scrupulously correct. Whether the English and French mashed it when they sacked Pekin, about seventy years afterward, we do not know

In the lower planetarium (Fig. 3791), the globe representing the sun is supported on a central shaft, around which are arranged a series of sleeves, corresponding in number to the planets of the solar system. The shaft supporting the sun is caused to rotate in a time relatively corresponding to the diurnal revolution of that luminary, and the sleeves which carry the tubes supporting the planets are also revolved in times proportionate to their revolutions around the sun by wheels meshing with gears on a shaft within the case *A*, and provided with an exterior crank by which it is turned. The diurnal revolutions of the planets are caused by bevel-gearing on the sleeves and on rods within the tubular arms above mentioned, which rods also carry on their ends gears for causing the revolution of the satellites around their primaries.

Plan'et-gear. (*Gearing.*) That in which one or more cog-wheels besides rotating on their axes revolve around the wheel with which they mesh. In the example, which is a mechanical movement for gaining speed for the cutter-bar of a harvester, the inclosing cylindrical case is fixed and has an inside gear. A planet-wheel on an arm turning with the axial shaft engages the inside gear, and also a spur-wheel upon a sleeve turning loosely on the axial shaft. The latter sleeve has an arm carrying a planet-wheel. This device may be multiplied to any extent to convert power into speed.

Fig. 3792.

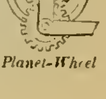


Planet-Gear Movement.

Plane-tile. A flat tile, about 6½ × 10½ inches and ⅝ thick. It weighs from 2 to 2½ pounds. It is fastened by two oak-pins, which pass through holes made in the tiles in the molding. Tiles are laid to a 6½-inch gage; 740 cover 1 square, *i. e.* 10 × 10 = 100 square feet. A *crown*-tile.

Plan'et-wheel. The exterior revolving wheel of the "sun and planet" motion, invented by James Watt. So called from its rotation around another gear-wheel, which is termed the *sun-gear*. The axis of the planet-gear is preserved concentric with the axis of the central or sun wheel by means of an arm. The planet-wheel sometimes gears with an internally cogged

Fig. 3793.



Planet-Wheel

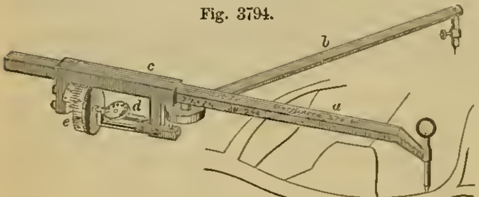
wheel, and may be driven by the latter, rolling around inside the larger gear-wheel instead of outside. (See Epicycloidal Wheel; Sun and Planet Motion.) The action may be inverted, the larger wheel driving the smaller instead of being driven by it.

Pla-nim′e-ter. An instrument for ascertaining the contents of irregular plane figures.

More than thirty years ago, Oppikoffer, of Berne, invented an instrument of this description, which seemed to fulfill all the requirements of the case; but its cost and the practical difficulties attending its use prevented its general adoption.

More recently, Amsler Laffon of Schoffhausen devised a simpler and much less costly instrument of the kind, which was exhibited at the Paris Exposition of 1867. The principle of each is nearly the same, the area being measured by a roller of given surface, the number of revolutions of which are indicated by a disk.

Fig. 3794.



Planimeter.

Amsler's polar planimeter has a sliding arm *a* and a pivoted arm *b*, the former having a pin for penetrating the paper, and the latter a tracing-point. The arm *a* is graduated to indicate acres, square inches, and square feet. In use, the needle-point is pressed into the paper into a point either within or without the figure; the arm *a* is adjusted by sliding in or out until the mark for acres, inches, or feet, as may be required, corresponds with a mark on the box *c*; the tracing-point is moved along the outlines of the figure until the point is reached at which it was started. If the stationary needle-point were placed without the figure, the readings of the counting-wheel *d* and index-roller *e*, subtracted from their readings at the commencement of the operation and multiplied by the indication to which the slide was set, give the area; if the stationary point be without the figure, a number opposite the indication on the slide is added to the final readings on the wheels *d e*, and the former reading subtracted therefrom; the difference is then multiplied, as before.

Other planimeters have been constructed by General Morin and by Mr. Sang. Sometimes called a platometer.

Plan′ing-ma-chine′. 1. (*Wood.*) A machine for truing up and facing boards or the sides of timbers. When it also works the edges, it is known also as an *edger;* when the edges are respectively tongued and grooved, they are known as *matched*, are said to be *matched up;* when the stuff is molded or dressed to ornamental shape, the machine is known as a Molding-machine (which see).

Planing-machines for wood-working are of three general kinds, and will be mentioned in the order of their invention, not of their usefulness.

a. The *reciprocating* planing-machine was invented by General Bentham in 1791, its action being based upon that of an ordinary plane. It had a large plane or stock with inclined bits (plane-irons) which reciprocated on ways, planing down to a thickness the board which lay upon the bed beneath, the board being moved forward after each reciprocation of the plane, in order to expose a fresh surface to be worked. The plane-iron was the whole width of the board, and slips on the bed determined the depth of penetration. The plane was moved to and fro by a crank; it was held down to its work by weights, and was lifted above its work during the back stroke, to save the dulling of the cutter.

The *scaleboard plane* is of this character, and is used in cutting from boards or balks the wide chips used in making some descriptions of boxes, for veneer, and for other purposes. It has a plane-iron the width of the board, and the protrusion of the iron from the sole of the plane determines the thickness of the scale.

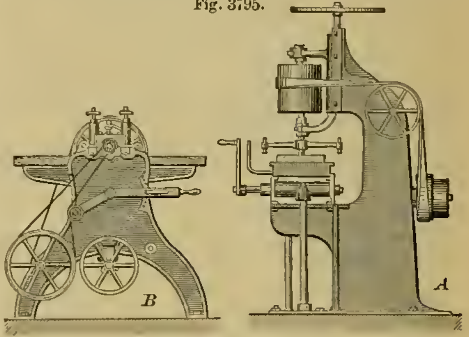
General Samuel Bentham's name is preëminent in the history of machines for working wood. See Wood-working Machines.

This plan has been again and again tried, but has not succeeded. It was probably the feature of Hatton's planing-machine, English patent, 1776.

It appears that subsequently General Bentham (brother of Jeremy) made molding-machines with rotary cutters, and also planing-machines to dress both sides at once.

b. The *transverse* planing-machine was invented and patented by Bramah, in 1802. It has a horizontal roughing-wheel armed with gouges, followed by plane-irons for finishing. It is known also by the name of the *Daniels planing-machine.*

Fig. 3795.

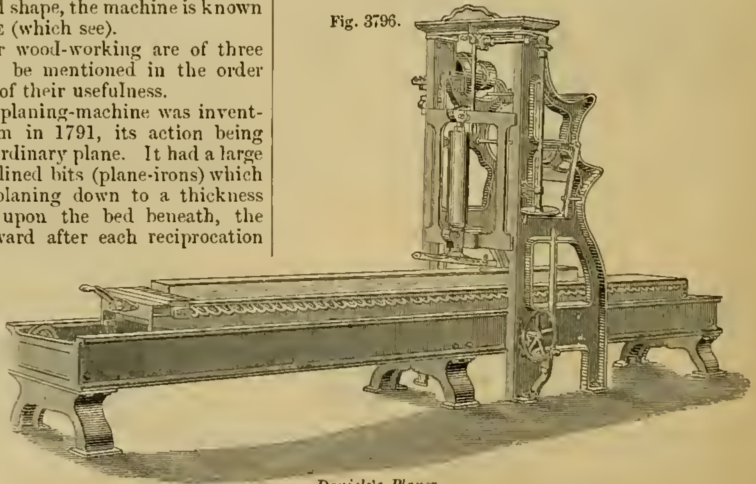


Transverse Planer.

A, Fig. 3795, is a view of a machine of this kind by Richards of Philadelphia. As shown, it is especially adapted for pattern and car shops; is wholly of metal, including the carriage, which is planed true, moves on anti-friction rollers, and is provided with end and side clamps that will hold pieces 15 inches wide, 6 inches thick, and 6 or more feet in length, or as small as 1 inch square. See also Transverse Planer.

The clamps and all the adjustments are so arranged as to be instantly changed for pieces of various sizes. The feeding movement is performed by hand. This admits of a rapid manipulation of the machine, modifies the feed to suit the work, and allows the operator to feel the action of the cutters. The driv-

Fig. 3796.



Daniels's Planer.

ing-pulleys can be arranged so that the machine will stand either parallel with or transverse to the line-shaft; a counter-shaft being required in the first case. The cutter-head is of wrought-iron, the spindle of steel, and the bearings of brass. The framing, being open on the front, gives easy access to the cutters, and admits pieces of any width. The operator is protected by an iron shield in front of the cutters.

In Bramah's machine, as used in the gun-carriage department of Woolwich Arsenal, England, the boards passed beneath a disk-wheel which rotated on a vertical spindle, and had 28 gouges and 2 plane-irons on its lower face. The lumber traversed on either of two beds, one on each side of the spindle, the feed being by means of a continuous chain which passed over pulleys at the ends of the tracks. The cutter-wheel was large, and revolved 90 times in a minute.

Fig. 3796 is a view of the Daniels planing-machine, made by Fay & Co., Cincinnati, Ohio. Instead of the wheel with 28 gouges and 2 double-irons of the original Bramah, it has a pair of arms, each carrying a cutter. The timber to be dressed is dogged to a sliding carriage, the feed being automatic and adjustable as to rate. The cutter is driven by a band upon the roller on the vertical shaft of the cutter; this portion of the machine being in a gate, which has a vertical adjustment in the standards of the frame, so as to determine the level on which the cutter shall work.

c. The *cylinder planing-machine.* This is now the usual machine. It has cutters on a drum rotating on a horizontal axis over the board which passes beneath. The cutter-drum is the width of the board, and may be repeated underneath and at the edges, so as to plane top, bottom, and edges simultaneously. In some cases, the board travels on its edge.

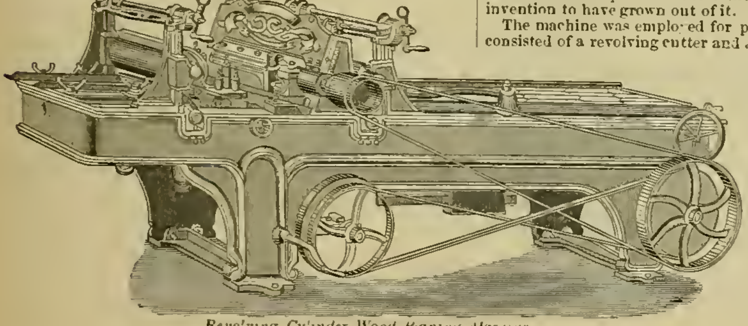
An early form of this was Muir's planing-machine for facing flooring-boards. It had rotary cutters above and below, two oblique fixed cutters to smooth the faces, two cutters to make the sides parallel, and two others to make the rabbets which form a tongue.

The Woodworth planing-machine, patented in 1828 and twice extended, became an odious monopoly, and did much to discredit the patent system. It claimed the combination of cutting-cylinders and feeding-rolls. Cutting-cylinders were used by Bentham thirty-five years before, and rollers for feeding lumber to circular saws were described in Hammond's English patent, 1811.

Richards's roller-feeding planing-machine (*B*, Fig. 3795) is a small machine of the cylinder class, adapted for preparing lumber for pattern-makers and others. As shown, it is constructed to plane from ¼ to 5 inches thick and 20 inches wide; has a wrought-iron cutting-cylinder, wrought-iron feeding-rollers, and cylinder-bearings of brass.

The planing-machine (Fig. 3797) may be taken as an example of its class. It has an iron frame, will plane 24 inches wide, and match up to 12 inches. It has a three-knife steel-lipped cylinder for facing, and triple-sided gun-metal matcher-heads. It planes up to 4 inches thick.

Fig. 3797.



Revolving-Cylinder Wood-Planing Machine.

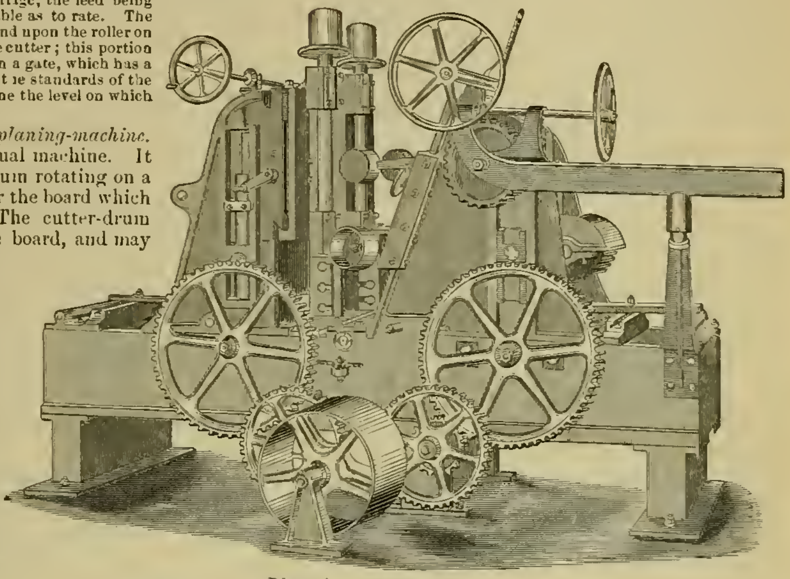
This form of planing-machine, with peculiarly shaped cutters, constitutes a MOLDING-MACHINE (which see).

The *outside* molding-machine is one in which the head overhangs the bearing.

The *inside* molding-machine has its cutter-head between bearings.

Fig. 3798 is a view of Richards's planing-machine for dressing to shape and dimensions, timbers for cars, machines, bridges, etc. It planes true and out of wind three sides at a time, the working side being previously dressed to lie upon the carriage of the machine. It has a cross cylinder-cutter for the top, and two vertical cutters for the sides, with in and out adjustment for the latter and up and down adjustment for the former so as to dress to any size within the dimensions for which it is constructed.

Fig. 3798.



Dimension Planing-Machine.

2. (*Metal-working.*) A machine in which a metallic object dogged to a traversing-table is moved against a relatively fixed cutter. In practice, the cutter is adjusted in a stock, and is usually fed automatically between strokes.

The earliest machine for planing metal was invented by Joseph Moxon, and described and illustrated at pages 208 and 215 in "Mechanick Exercises, or the Doctrine of Handy Works," published in London, 1694. The metal-planing machine was subsequent to the lathe, and would appear by this invention to have grown out of it.

The machine was employed for planing brass moldings, and consisted of a revolving cutter and an adjustable guide or table, along which the bar or brass to be planed was drawn by the operator. The machine appears to have been entirely successful for the purpose intended. This was the original *milling-machine*.

As in the case of so many important inventions, however, but little progress was made for a while, and the original invention and inventor were almost forgotten, when, nearly a century after Moxon, the necessities of the times caused the revival of the invention to be made with special reference to iron. In the year 1751, the engineer of the Marly Water-Works on the Seine, France, contrived and put in execution a machine for planing out the wrought-iron pump-barrels employed in that work. (See page 454, plate 45, in Buchanan's "Practical Essays," published 1841.) This is believed to have been the first instance in which iron was reduced to a plane surface without chipping or filing.

The present metal-planing machine is an application of the slide-rest, which was invented by General Sir Samuel Bentham and described in his patent of 1793.

The planing-machine dispensed, to a great extent, with chipping and filing, and is at the bottom of all successful fitting of machinery. It is next in importance to the lathe, and has, since its invention, about 1814, been much modified and improved. Its use has effected a complete change in the manufacture of tools and machinery of every class, and has made possible the construction of many works which could hardly otherwise have been attempted.

In its invention we find credits to Clements of London, who was a workman in Bramah's shop; to Fox of Derby, and to Roberts and Rennie of Manchester. Bramah, it appears, employed, in 1811, the revolving cutter to plane iron, thus adapting to metal the form found best adapted to wood-working, and which survives in our *milling-machines*, now so much and deservedly esteemed. Clement, previous to 1820, made a planing-machine for planing the sides of looms and the triangular bars of lathes. The bed moved on rollers, and the tools cut both ways. Much of the work for Babbage's calculating-machine was planed on Clement's machines. Fox made a planing-machine, in 1821, to plane the cast and wrought iron bars used in lace-machines. It planed 10 feet 6 inches, 22 inches in width, on an object not above 12 inches high. Rennie, in 1820, it appears, had a planing-machine with a movable bed urged by an endless screw and rack and with a revolving tool.

The first machines were moved by a chain winding on a drum; rack and pinion, and eventually the screw arrangement, were substituted.

The metal-planing machine of Joseph Clement of London is illustrated and described on page 157 *et seq.*, Vol. XLIX., "Report of Society of Arts" for the year 1832. The inventor, in his communication to the society, says that he aimed to do with this machine for straight surfaces all that the lathe was made to do for round surfaces. The paring or cutting tool and the stuff to be operated upon were held respectively, as in the lathe, at fixed relative distances from each other, entirely independent of any mouth-piece, such as employed in the plane proper or carpenter's plane. This great invention included the reciprocating bed, guided and moved horizontally and automatically with a greater or less stroke. It included two cutters, capable of being directed forward and backward and at different elevations, so as to cut at both forward and backward strokes of the bed.

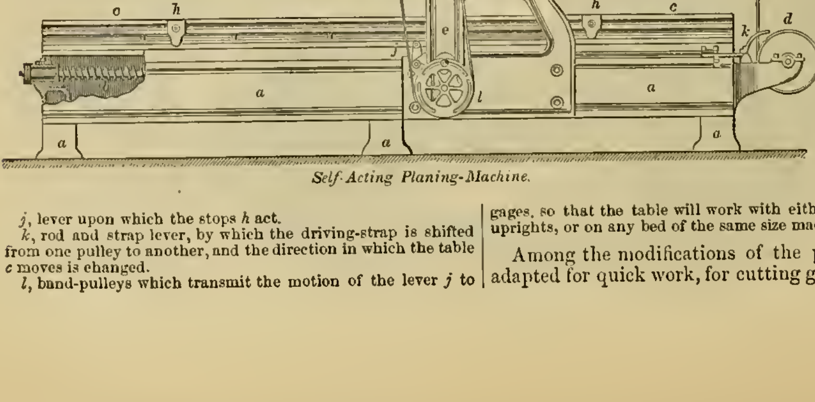
The cutter or cutters were fixed in a slide-head, and by suitable guides, screws, and mechanical connection with the bed, were shifted automatically at the end of every stroke, and could be fed downward at will, so as to make a deeper or shallower cut.

The cutters could be canted to one or other side to any angle whatever, so as to plane either the right or left side of the stuff. In a word, it was the planing-machine of our day. Clement was a worthy pupil of the illustrious Joseph Bramah.

Fig. 3799 is a side elevation of a self-acting planing-machine for horizontal, vertical, and angular planing.

a, bed and standards.
b, guide-screw.
c, the table, having a nut (not shown) taking into the guide-screw, by which it is moved along the bed.
d, the driving-apparatus, which, by being at the end of the bed, is out of the workman's way.
e, uprights.
f, cross-slide.
g, reversing-tool to plane both ways.
h h, two stops, which can be fixed at any distance apart, according to the desired traverse of the table.

Fig. 3799.



Self-Acting Planing-Machine.

j, lever upon which the stops *h* act.
k, rod and strap lever, by which the driving-strap is shifted from one pulley to another, and the direction in which the table *c* moves is changed.
l, band-pulleys which transmit the motion of the lever *j* to the reversing-tool at the same time as the strap is shifted, and the tool is thus made to turn at each end of the work. The band-pulleys also impart self-acting motions to the tool in the transverse, vertical, and angular directions, as required.

The reciprocation of the supplementary tool-frame at right angles to the motion of the table gives the transverse cut. The angular cut is given by the combination of the motions, transverse and longitudinal.

The same general arrangement of machine with a fixed tool, to plane only one way, and the driving-apparatus *d*, constructed to give to the table a quick return-motion, is sometimes made. The tables of machines which do not plane above two feet long are moved by a crank.

Planing-machines were farther improved by the use of two tool-boxes on the cross-slide, and by the application of slide-rests or tool-boxes fixed upon the uprights, self-acting vertically, for planing articles at right angles to the tools on the cross-slide.

The necessities of the manufacture of wrought-iron and steel ordnance, and the revolution they have caused in the construction of vessels of war, have called into requisition a great many alterations and adaptations of the present machines, as well as many entirely new ones. The planing-machine especially has been called upon to plane the edges of armor-plates to different curves, shapes, or angles. In most cases, this has been accomplished by a pattern bar of iron or steel, placed on edge in a small chuck fixed upon the surface of the table, adjustable by set-screws, and shaped to the form to which it is required to plane the edge of the plate: as the table travels, this bar, which runs between two circular rollers attached to the under side of the cross-slide, moves the tool sideways, according to the amount of curve in the shaper or guide-bar, the tool-box being disconnected for this purpose from the screw in the cross-slide.

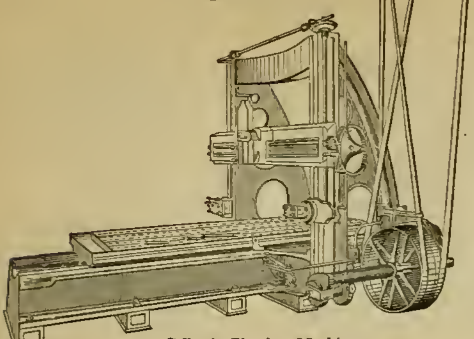
Fletcher's duplex planing-machine (English) is arranged with double beds and double tables, each table having a separate set of gearing, with starting, stopping, and feed motion. There are two tool-boxes on the cross-slide, each of which is independently self-acting, so as to work with its own table. Thus, the two tables may be used separately as two smaller machines working independently of each other, and capable of planing different lengths of work at the same time; or, when planing a large article, the two tables, gearing and motion, may be coupled, so as to form one large machine, — an arrangement rendering the machine capable of doing a variety of work. Also, one table may be fixed stationary as a bed-plate to bolt awkwardly shaped or long pieces of work upon, while they are planed by a slide-rest fixed upon the other table. When used as one machine, both sets of straps and gearing are in operation, and are reversed by the stops of one table only, so as to ensure the straps moving at the same time.

This machine is capable of planing articles 10 feet wide and 10 feet high. The racks on the under side of the tables are 3 inches pitch, with stepped teeth; the wheel working into the rack is 3 feet 9 inches diameter at the pitch-line, and is driven by a smaller pinion. By this arrangement a steadier motion is obtained; and also the pulleys and driving-gear can be placed entirely behind the face of the uprights, so as to leave the front of the machine perfectly clear, that the straps may not be in the way when putting the work on and off. The pulleys, being below the ground-line, may be driven by a horizontal underground shaft at the back of the machine, and no straps will then be visible. Machines of this description are made with beds 40 feet long, to plane work up to 14 feet in width.

Fig. 3800 is a perspective view of Sellers's self-acting planing-machine for horizontal, vertical, and angular planing of any required length, with spiral-gear driving-motion; positive geared feeds, self-acting in all directions, with tool-lifter operating at all angles, and improved belt-shifter. This machine stands parallel with the overhead driving-shaft; the bed and table are fitted to uniform gages, so that the table will work with either end toward the uprights, or on any bed of the same size machine.

Among the modifications of the planing-machine adapted for quick work, for cutting grooves and what

Fig. 3800.



Sellers's Planing-Machine.

not, may be cited the *jack*, *jim-crow*, *key-groove machine*, *milling-machine*, *planer-bar*, *shaping-machine*, *slotting-machine*.

The *jack* is a small machine, and is named from its quick, handy ways and its compact form.

The *jim-crow* is the improvement of Joseph Whitworth upon the Clement planing-machine. It has a reversing-tool to plane during both motions of the bed, and is named from its peculiar motion, being adapted to "wheel about and turn about, and do just so." The table is moved endways by a quick-threaded screw, which allows the driving motion to be placed at the end. Whitworth's English patent is No. 6850, of December 11, 1835.

The *key-grooving machine* is a modification invented by Robert Roberts of Manchester. It has a strong mortise-chisel, which is reciprocated vertically by an eccentric, while the wheel to be slotted is laid horizontally on a slide, and traversed toward the cutter until the slot has attained the depth required.

The *milling-machine* is one in which the work is dogged to a table and fed toward a revolving cutter, which has a serrated face which cuts away the metal. See MILLING-MACHINE.

The *planer-bar* is a form in which the tool is on the end of a bar, which penetrates the interior of an object, and thus is enabled to reach deep-seated places. See SHAPER-BAR. See also Fig. 3787.

The *shaping-machine* is one in which the object is chucked on an axis or mandrel, the tool traversed above the work in a line parallel with the axis of the mandrel; the latter, being slightly rotated between each stroke, constitutes the feed, and the result is a circular shape attained by straight cuts. See SHAPING-MACHINE.

The *slotting-machine* — or *paring-machine*, as it is sometimes called in England — is a substitute for the file in hollowing out objects, and thus resembles the *key-grooving* machine; but the slotting-machine has two horizontal slides at right angles to each other and a circular adjustment or turn-plate, all three used in shifting the position of the work below the vertically reciprocating cutter, and all three having devices for mechanically *feeding the cut*, as it is called, or for moving the slides between each stroke.

The *crank*-planer is a shaping-machine for metal, in which the tool-stock is reciprocated by pitman attachment to a wrist on a crank.

Plan'ish-er. A thin flat-ended tool, used by turners for smoothing brass-work.

Plan'ish-ing. An operation in which sheet-metal is condensed, smoothed, and toughened upon a smooth anvil by the blows of a smooth-faced hammer. Copper plates for engravers are thus treated to condense the metal, which is otherwise too spongy for the purpose. Burnishing has a similar effect. Planishing is also employed upon silver for table-ware and in many other instances.

Plan'ish-ing-ham'mer. A planishing-hammer has smooth, very slightly convex faces, and is used upon sheet-metal in connection with a bright, steel-faced anvil. Its action is to condense and toughen the metal, and frequently to bring it into form, as in copper kettles, pans, etc. The face of the hammer is rounded more or less, according to the radius of the concavity of the vessel under treatment.

Heavy hammers of this description have a counterbalance suspension arrangement, to relieve the exertion of raising them after each blow, or are driven by machinery.

Plan'ish-ing-roll'ers. The second pair of rollers in preparing coining-metal. They are made of case-hardened iron and polished. The metal, which was run hot through the *breaking-down* rolls, is passed cold between the *planishing-rollers*, which bring the strips to a given thickness.

Plan'ish-ing-stake. (*Coppersmithing.*) A bench stake or small anvil for holding the plate when under the action of a planishing-hammer.

Plan'i-sphere. The representation upon a plane of the circles of the zodiac.

The zodiac represented on the ceiling of the temple of Dendera was discovered in 1799 by the French savans, during their researches under Napoleon's orders. A periodical work of 1801 thus describes this work in connection with a similar work at the base of a peristyle at Esne: —

"That at Esne indicates the solstice in the sign of Virgo, and that of Dendera, which is of later date, shows the sun in Leo. The intention of the founders of these monuments was certainly to represent the present state of the heavens when these were constructed. A comparison of these two zodiacs, which may now be instituted, throws back to the most remote antiquity the construction of these temples, and proves in a striking manner the knowledge which the ancient Egyptians possessed of that astronomical phenomenon, the precession of the equinoxes." — *London Monthly Magazine.*

Modern attempts to bring the matter within the present range of written history cite the era of the Ptolemies as the date of the projected zodiac.

A smaller planisphere of the same temple, Dendera, was removed to Paris in 1821.

Visconti judged from the position of the signs that the zodiac in the ceiling of the pronaos of Dendera was constructed between A. D. 12 and A. D 132, — a conclusion fortified by the reading of the name of Tiberius. It is not certain that the planisphere in another apartment is so modern.

Plank. 1. A board more than nine inches in width.

2. The board of a petard.

3. The frame of a printing-press on which the carriage slides.

4. The timbers which cover the *ribs* of a vessel and form the *skin*. Also those of the *deck*.

5. To unite slivers of wool in forming *roving*.

6. To harden by felting; said of hat-bodies after forming. They are *planked* or *hardened* to give them solidity, thickness, and strength.

Plank-hook. A pole with an iron hook at the end, with which quarrymen, miners, and others shift their *runs* or wheeling-planks, as occasion requires.

Plank'ing. 1. (*Shipbuilding.*) The *skin* or wooden covering of plank on the exterior and interior surfaces of the ribs and on the beams.

A line of planking is a *strake*, and is named from its position; as, *garboard*-strake, *bilge*-strake, *side*-strake, *shear*-strake, etc.

When the seam between two planks is straight, it is said to be *fair-edged*; when it is sloped, it is called *anchor-stock* or *top and butt*, according to the character of the sloping.

Wales are strakes of thicker plank. The term is used in shipbuilding, and also in *piling*. See PILE, page 1700.

2. (*Spinning.*) The splicing together of slivers of long-stapled wool. See BREAKING-MACHINE.

3. (*Steam.*) The *lagging* or *clothing* of a steam-cylinder. *Cleading.*

Plank'ing-clamp. (*Shipwrighting.*) An implement for bending a strake against the ribs of a vessel and holding it till secured by bolts or treenails.

In Fig. 3801 the chain-hooks catch against the ribs and afford a hold for the planking-clamp to strain against.

Fig. 3802 consists of a strain-bar with a knee, in which works a screw for pressing up the plank. Two hooks pass in the opposite direction from the strain-bar, and are adjustable thereon and take hold of the timber and hold so that the screw will force the plank up to its place.

Fig. 3301.

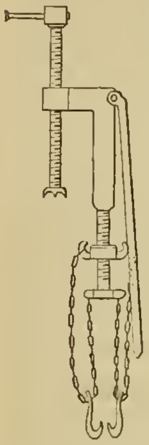
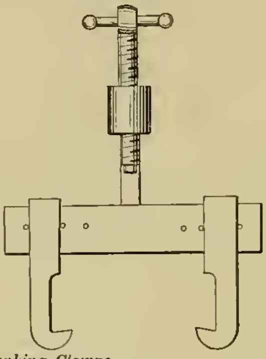
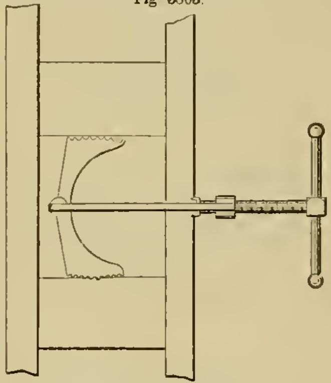


Fig. 3802



Planking-Clamps.

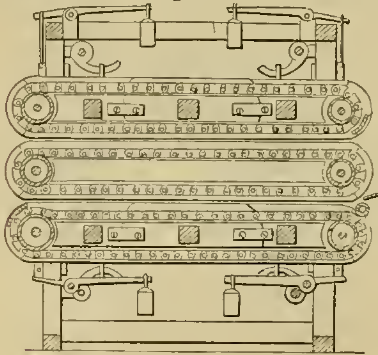
Fig 3803.



Toggle Clamping-Frame.

The clamping-frame (Fig 3803) has toggle-levers whose serrated segmental ends engage the ribs or joists, the screw acting on the plank.

Fig. 3804.



Machine for Sizing and Planking Hat-Bodies.

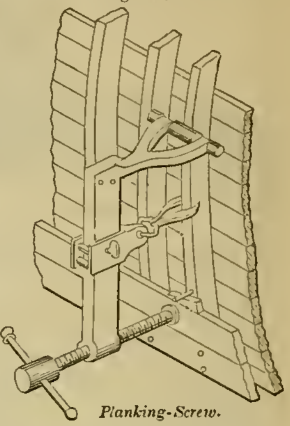
Plank'ing-ma-chine'. A machine in which hat-bodies, after being formed, are rubbed, pressed, and steamed to give them strength and body.

In the example, the intermediate belt of lags is the working-apron; the upper and under aprons may have a different velocity or merely act as beds. A shell at the exit of the upper apron aids in discharging the work In the arrangement for returning the work to continue the operation, a roller and board keep the felt clear of the lower apron till it is caught by the apron above. Steam is introduced between the aprons, the upper and under ones of which are counterweighted and vertically adjustable. See HARDENING.

Plank'ing-screw. An implement for straining planks against the ribs of vessels.

In the example, the fulcrum-point of the lever is dogged to the rib, and while one end is propped against the rib the other has a clamping-screw which brings in the plank to the shape of the frame. The lever slips in the clevis and the prop upon the rib to adjust the screw in the required position.

Fig. 3805.



Planking-Screw.

Plank-re-vet'ment. (*Fortification.*) Board lining of an embrasure or covering of a rampart.

Plank-road. A road of transverse planking or puncheons laid on longitudinal sleepers or string-pieces. A *plank-way.*

One mode of forming such a road is as follows: Two ditches are dug 16 feet apart, the earth being thrown on to the included strip. One half of the track is left as an earthen surface sloping toward the ditch on that side, the other is planked. Imbedded in the ground are laid longitudinal sleepers, 4½ feet apart. Each sleeper is from 12 to 20 feet long, 12 inches broad, and 4 inches deep. The sleepers are supported at the joints by scantling beneath. The planks are 8 feet long and 3 inches thick.

Plank-sheer. (*Shipbuilding.*) A plank resting on the heads of the top timbers of the frames or ribs. The *gunwale.*

Pla'no-con'cave Lens. A lens, one of whose sides is a plane and the other is curved inwardly. See LENS.

Pla'no-con'vex Lens. A lens one of whose sides is a plane and the other is curved outwardly.

The *doublet* and *triplet* are combinations of plano-convex lenses. See LENS; DOUBLET; TRIPLET.

Pla-nom'e-ter. A trial or plane surface on which articles are tested for straightness and level. It affords a standard gage for plane surfaces. (See PLANE.) An approved form consists of a cast-iron plate stiffened on the back by transverse and longitudinal ribs. The latter, two in number, converge to a point at one end, so that in use it always rests on three points of support. It is provided with a handle at each end. See PLANE-SURFACE.

Plant. A set of tools, machinery, apparatus, and fixtures as used in a particular business, *e. g.* the tools, benches, vises, lathes, planers, etc., of a machinist; the forge (including bellows), anvil, hammers, tongs, etc., of a blacksmith. That which is necessary to the conduct of the mechanical business, whatever it may be. The more complete the assortment of tools, the better their quality; and the more numerous they are, the more valuable is the *plant.*

The rolling stock of a railway.

The vats, tubs, stills, coolers, etc., of a brewery or distillery.

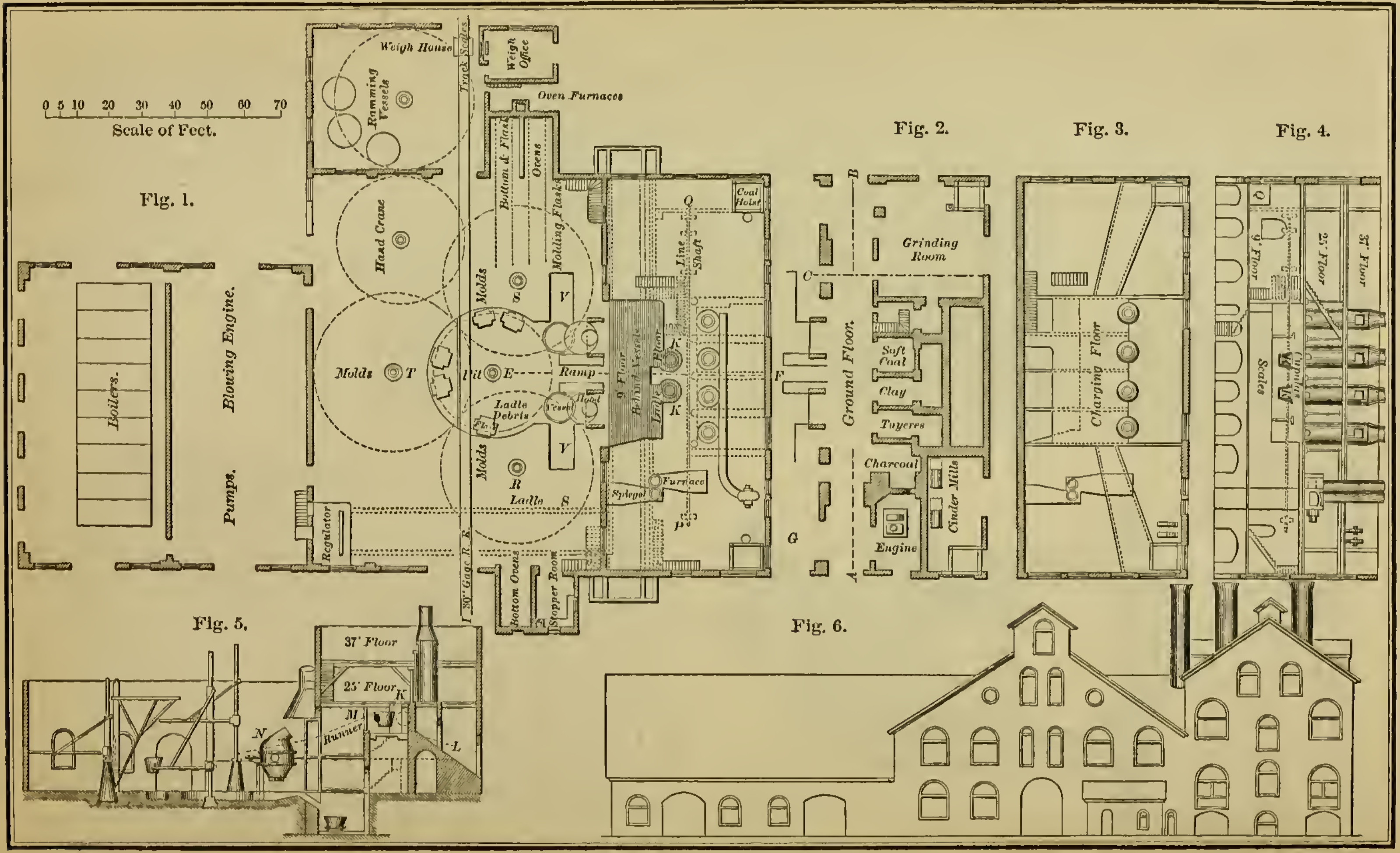


PLATE XLII.

AMERICAN FIVE-TON BESSEMER PLANT.

(*Product 80 tons per 24 hours.*)

See page 1734.

According to a report recently published in Germany, the working plant of Krupp's steel works at Essen was, during the last year, 514 melting, annealing, and cementing furnaces, 169 forges, 249 welding, puddling, and reheating furnaces, 245 coke-ovens, 120 miscellaneous ovens or kilns, 256 steam-engines (collectively of 8,377 horse-power), 340 lathes, 119 planing-machines, 65 shaping-machines, 144 boring-machines, 120 unclassed machines, and 90 grindstones There were also 56 steam-hammers, one of which weighs 30 tons. The number of workmen employed were 7,100, and 70,000 tons of steel were turned out. The Bessemer convertors, of which there are several at work, are not enumerated in this list

Plate XLII. illustrates the Bessemer works of the North Chicago Rolling-Mill Company, from which those of other large American works do not essentially differ.

Fig. 1 is a ground plan of the converting-engine and boiler-houses, and of the 25-foot floor of the cupola building.

Fig 2 is a ground plan and Fig. 3 a plan of the 37-foot or cupola charging-floor.

Fig. 4 is a section at *A B*, Fig. 2, showing the cupolas and their ladles in elevation.

Fig 5 is a section at *E F*, Fig. 1, showing a side elevation of the cranes, convertors, cupolas, etc.

Fig. 6 is an end elevation of the buildings

The ground-floor of the works, contrary to the English practice, is all on the same level, is accessible from all sides, and the engine and boiler houses are at the side of the converting building, leaving the ends open for the through passages *A B I J*.

The hoist for coal, etc., and that for iron are at opposite ends of the cupola building, — an arrangement which allows more room in the yard than if they were placed side by side.

A hydraulic cylinder, whose stroke is equal to one half the distance traversed by the hoist, is most convenient and durable.

The pig-iron and coal for the charges are carried on light four-wheeled iron wagons, easily managed by one man. These possess the advantage over those of larger size, of being less liable to interfere with each other upon the charging-ground, and also afford greater facilities for the intimate intermixture of the different qualities of pig-metal, of which six or more kinds are thoroughly mixed in each wagon before charging.

In this country, cupolas are used instead of reverberatory furnaces, and this practice is being introduced abroad. The cupola is cheaper to construct and maintain, affords greater heat, melting the metal more rapidly, and melts 5 to 6 pounds of metal to the pound of coal. It also occupies much less room and requires a less costly building than the reverberatory furnace.

In order to adapt the ordinary foundry cupola to the Bessemer process it was found necessary to increase the depth from the tuyeres to the tap from one foot to three or four feet, to double the sectional area of the tuyeres, and to reduce the projection of the boshes.

The dimensions of the cupolas are about as follows: hight, 14 feet; interior diameter of elliptical cupola, 6′ 5″ by 3′ 5″; the aggregate sectional area of the tuyeres, six in number, is 200 square inches. Circular cupolas having the same sectional area are sometimes employed.

The charge consists, first, of 5,400 pounds of coal, over which are placed from 3 to 3¾ tons of pig-iron; this is succeeded by 1,400 pounds of coal, over which is charged the same amount of metal. These alternate charges of coal and metal are continued until the cupola is filled, a small quantity of limestone being added as a flux. The cupola is kept filled to the charging-door for from 8 to 10 hours. It will hold 5 tons during the first few charges; but as the hearth becomes filled with slag, the capacity is decreased, and more frequent tapping is required They are capable of melting 100 tons of iron in 9 hours. The molten iron is tapped from the cupola into ladles *K*, having a capacity of 12 tons each. The objects of interposing ladles between the cupolas and convertors, instead of tapping directly into the latter, are, (1.) that the gray iron charges may be accurately weighed, so that the amount of spiegeleisen to be added may be definitely ascertained; (2.) the convenience of holding the metal until the vessels are ready to receive it. Pressure-blowers have been usually employed for the cupolas, but of late the Sturtevant fan-blower has been successfully introduced at the Troy works.

The cupola dump *L*, Fig 5, is situated conveniently to the cinder-mill, Fig 2, where the cinders are ground, so that the *shot-iron* may be saved and remelted.

The cupola charging-floor is over the ladles, thus permitting the width of the building to be reduced. The molten metal is conveyed from the cupolas to the convertors by means of the ladles *K* and runners *M*. These deposit it in a trough having branches by which it is conducted to either convertor. The spiegeleisen furnaces are shown in plan Fig. 1, and in cross section Fig 4.

Reverberatory furnaces are preferred for melting spiegeleisen, as the charges may be kept hot longer. Cupolas are, however, used in some works. The engine which drives the blower is placed beneath the charging-floor of the building, to economize space. This engine also drives the cinder-mills. At the opposite end of the converting building a space is left for grinding and mixing the refractory material for lining vessels, etc.

In the converting department of all American works the vessels are placed side by side and raised above the general level. A platform extends around the convertors, by means of which all parts of the vessels are easily accessible. A passage *Q* on the same level affords access to the coal-hoist. This arrangement also allows greater swing to the cranes, the side ingot-cranes *R* and *S* commanding the vessels, the pit, and all the floor room over which they swing. The central ingot-crane *T* commands the pit and a large floor space, and all the cranes swing over the railroad *I J*. The ingots are removed by cars as fast as produced, and taken to the weighing-house at the end *J* of the road.

The cupola building has bins for holding the materials, as coal, etc., required for current use. Where, as in England, everything in the melting department is on different levels, the buildings are necessarily large, the distance between the bins and the places where their contents are to be used great, and the operations interfere with each other, whereas in a high building with several floors the operations are simplified and the materials more conveniently stored. Thorough ventilation is secured by lantern roofs and windows on every side.

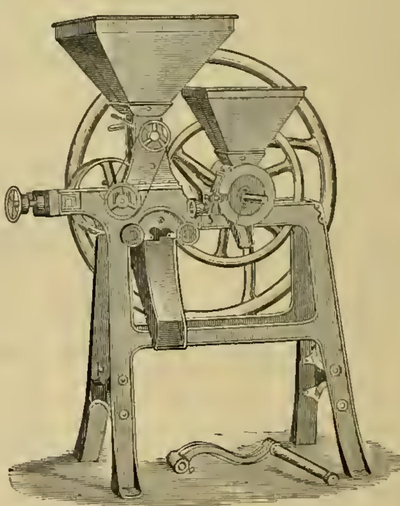
The hight of the cupola building, allowing free ventilation on all sides, is an important feature. The gangway *A B*, Fig. 2, is convenient for ventilation, also for reaching all sides of the vessels, as well as for transportation. Underneath this, in the newer works, is an underground passage (Fig. 5) which communicates with the cellar under the grinding-mill and the coal-hoist. This serves for removing waste material The water and blast pipes leading from the regulator are secured to the walls of this passage; an indispensable precaution in a cold climate.

Until recently, only eight heats per day could be made with the five-ton convertors, owing to the difficulty of replacing the bottoms of the converting vessels when the tuyeres were worn too short. This difficulty has been overcome by Mr. Alexander L Holley, the consulting engineer of the principal Bessemer steel works of the United States. Since Mr. Holley's improvements but two or three hours time is required to replace a bottom. This has doubled the production, from 16 to 25 five-ton heats now being made in a day of 24 hours. The quantity of metal usually charged into the convertor at each heat is from 12,000 to 12,500 pounds, to which from 5 to 8 per cent of spiegeleisen is added at the close of the operation.

The steel is cast into ingots which are afterward rolled into blooms. In a few American works, however, they are hammered into blooms. See BESSEMER PROCESS; CONVERTOR.

Plan-ta'tion-mill. A crushing-mill for oats, linseed, etc., adapted to plantation use. It has two hoppers *a b* with separate delivery-spouts, so that two different kinds of seeds may be ground at once, or seed of the same kind may be ground to two different degrees of fineness. The mill may be driven by horse or hand power.

Fig. 3806.



Plantation-Mill.

Plant'er. See CORN-PLANTER; COTTON-SEED PLANTER; POTATO-PLANTER, etc. See list under AGRICULTURAL IMPLEMENTS.

The following table is useful for calculating the number of seeds, plants, shrubs, trees, or what not, to an acre of ground at given distances apart.

Hills in an Area of an Acre.

Feet Apart.	No.	Feet Apart.	No.	Feet Apart.	No.	Feet Apart.	No.
1	43,560	5	1,742	9	538	16	171
1½	19,360	5½	1,440	9½	482	17	151
2	10,890	6	1,210	10	435	18	135
2½	6,939	6½	1,031	10½	331	20	108
3	4,840	7	889	12	302	25	69
3½	3,556	7½	775	13	258	30	48
4	2,722	8	680	14	223	35	35
4½	2,151	8½	692	15	193	40	27

Plaq′uage-style. A mode of calico-printing. See Padding.

Plash. To interweave branches, as for gabions, dikes, weirs, hurdles, etc.

Plasm. A mold or matrix.

Plas′ter. 1. (*Plastering.*) *a.* A composition of lime, sand, and water, with or without hair as a bond, and used to cover walls and ceilings.

b. Calcined gypsum or sulphate of lime, used, when mixed with water, for finishing walls, for molds, ornaments, casts, luting, cement, etc.

It is also the basis for stucco and scagliola or artificial marble.

The hydrated sulphate of lime is calcined at a heat of about 300° Fah., and parting with 20 per cent of water falls into a white powder. While it decrepitates it does not decompose, like limestone, but is greedily absorbent of water, and by combination therewith becomes again solid.

Calcined with alum it forms *Keene's cement*, which solidifies more slowly than the common plaster of Paris, but is harder when set. See Cement.

Reburnt with borax and other substances, it produces other and fine cements. See Cement.

The mortars used for *inside plastering* are termed *coarse*, *fine*, *gage* or *hard finish*, and *stucco*.

Exterior plaster or stucco: 1 volume of cement powder to 2 volumes of dry sand.

In India, to the water for mixing the plaster is added 1 pound of sugar or molasses to 8 imperial gallons of water, for the first coat; and for the second or finishing, 1 pound of sugar to 2 gallons water.

Turkish plaster or hydraulic cement: 100 pounds fresh lime reduced to powder, 10 quarts linseed-oil, and 1 to 2 ounces cotton. Manipulate the lime, gradually mixing the oil and cotton, in a wooden vessel, until the mixture becomes of the consistency of bread-dough.

Dry, and when required for use mix with linseed-oil to the consistency of paste, and then lay on in coats. Water-pipes of clay or metal, joined or coated with it, resist the effect of humidity for very long periods.

The names of plaster coatings are as follows: —

First coat of two-coat plastering: *laying*, when executed on lath; *rendering*, when executed on brick.

First coat of three-coat plastering: *pricking-up*, when executed on lath; *roughing-in*, when executed on brick.

Second coat: *set*, in two-coat plastering; *floating*, in three-coat plastering.

Third or *finishing* coat: *stucco*, when for painting; *setting*, when for papering.

Or, as follows: —

Lath, laid, and set: lath with two coats of plaster.

Lath, laid, set, and colored: the addition of coloring to the former.

Lath, pricked-up, floated, and set: three-coat work.

Lath, floated, and set fair: same as the last.

Roughed-in, floated, and set: three-coat work on brick walls.

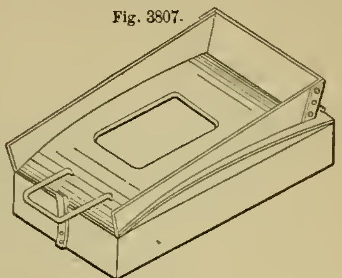
The Greeks used a very durable mortar for stucco and plastering. Their walls and floors are yet hard and white, and retain their polish in instances where they have not been mutilated.

The Romans plastered their cisterns and reservoirs with a mixture of pure lime and pounded brick, which hardened into a mortar resembling breccia, which has nodules of red matter in a white matrix. This was beaten to render it plastic, and it was then *floated* on to the walls by sandstone trowels, which were rubbed over the surface to smooth it. Over this was laid a coat of fine plaster covered by one of red-lead and oil.

2. (*Medicinal.*) Plasters are spread by placing the material upon the wash-leather or paper, on which is laid a mask which determines the margin when the material is flattened by the hot spatula. One form of the device has a pair of masks which move over each other so as to expose an opening of any required size and proportions.

Fig. 3807 has a shield hinged to a block which has a concave upper surface. The leather is clamped between the shield and bed, and is exposed at the opening in the former.

Fig. 3807.



Plaster-Spreader.

Perkins's patent, January 15, 1830, has a pair of rollers, between which the leather is run, flattening down the plaster upon it.

Blisters were made by Hippocrates, 400 B C Cantharides are commonly found in Spain, and their use is ascribed to Aretæus of Cappadocia, 50 B. C.

Sticking-plaster is made as follows: Two solutions are first made: one, an ounce of isinglass in eight ounces of hot water; and the other, of two drachms of gum benzoin in two ounces of rectified spirits. These solutions are to be strained and mixed. Several coats of this mixture, kept fluid by a gentle heat, are then to be applied with a camel's-hair brush to a piece of silk stretched on a frame, each coat being allowed to dry before the next is applied. A layer of a solution composed of one ounce of Chian turpentine in two ounces of tincture of benzoin is then to be applied to the other side of the silk and allowed to dry.

Plas′ter-cast. A copy of an object obtained by pouring plaster of Paris (sulphate of lime calcined and pulverized) mixed with water into a mold which forms a copy of the object in reverse.

While the art of modeling in clay was attributed by the ancients to Dibutades the Corinthian, about 985 B. C., that of taking plaster casts is attributed by Theophrastus and Pliny (A. D. 70) to Lysistratus of Sicyon, a brother of the celebrated sculptor Lysippus. He first took plaster casts, and from these obtained a second cast in wax. The plastic nature of the latter enabled him to rectify imperfections and form an enduring, life-like copy. The names of Rhæcus and Theodorus of Samos are also noted in this connection.

After being neglected for centuries, the art was revived by Verocchio (1422–88) and by others; the immediate incentive being to obtain copies of the specimens of ancient art which were being disinterred and discovered. The sovereigns of France also took this means to add to the artistic interest and beauty of their capitals and art museums.

In making plaster casts the gypsum is mixed with water, the proportion of the latter depending on the purpose to which it is intended to be applied. The more fluid the mixture is, the more easily and perfectly will it enter the finest lines of the mold; but such casts, when dry, are more porous and therefore more tender than those in which a smaller quantity of water has been used. Much also depends on properly mixing the ingredients; the water must never be poured on the powder, but the powder must be shaken into the water, and the best way of doing this is to take up the powder between the fingers and thumb, and then allow it to drop gradually into the water, taking care that it does not run into lumps, and that every particle becomes thoroughly soaked. Proceed in this way till the powder comes to the level of the water, and then stop if a thin plaster is wanted; but, if a stronger one is required, keep adding powder till it stands about a tenth of an inch above the water When the whole of the gypsum has been put in, allow the ingredients to remain undisturbed for a few seconds, and then stir up the mixture cautiously and gently with a spatula, and as soon as it begins sensibly to thicken pour it into the mold The great error that amateurs fall into in this part of the process arises from want of patience; they put the powder into the water too hastily, generally employing too much of it, and keep incessantly stirring it till it thickens; the consequence of which is, that it contains air-bubbles, is hard in some places and soft in others, and is not capable of being perfectly united to a succeeding layer of plaster. Good plaster, when mixed with the proper quantity of water, should be of the consistence of cream, and will set or become solid in about ten minutes, but cannot safely be removed from the mold till about half an hour afterward.

If a mold is to be made of a simple object, it is evident that it must be formed in at least two parts, that we may be able to extract the cast, or allow the mold to *deliver*, as it is called; and in the case of any regular geometrical figure two parts only are necessary. The same may be said of any figure whatever which has no recesses or projections whose sides do not overlay any portion of the mold in the direction in which it is necessary to withdraw the latter. Should any of them do so, it will be necessary to construct the mold of a greater number of parts, so that each separate part may be removed in the direction of the wider part of the opening formed by the object and the projection. A great part of the art of the molder consists in forming these *safe* molds, as they are called, in as few pieces as possible. Nevertheless, in intricate pieces of statuary it is said as many as 700 or more separate pieces are required.

Deeble's mode of obtaining casts of leaves is to lay the leaf face upward on a bed of fine-grained, moist sand, and cover it by means of a camel's-hair brush with a mixture of wax and Burgundy pitch made fluid by heat. The leaf, being then removed from the sand and dipped in cold water, is readily withdrawn from the wax mold, which is then placed in sand, as the leaf was, and covered with a thin plaster laid on with a brush and forced into all the interstices of the mold; more plaster is then poured on, which, in setting, evolves sufficient heat to render the wax pliable and allow it to be removed from the cast.

Mr. Fox's method of forming an elastic mold in two pieces capable of delivering undercut surfaces is, after oiling the body to be molded, to cover it completely with a thick mixture of warm melted glue with a little treacle. The glue, when cold, is cut into two parts, and may be removed without difficulty from the object. They are then oiled internally and bound together, and the cavity being filled in the usual way with plaster, affords a perfect cast.

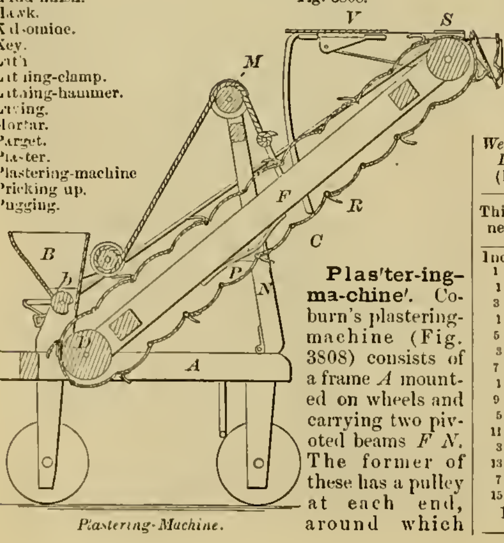
Luster may be imparted to plaster casts by dipping them repeatedly in a hot, saturated solution of alum. The surface of the cast is thereby hardened, and a certain amount of translucency obtained.

Another mode is to dry it, then coat with melted white wax and warm at a fire to effect the absorption of the wax.

Plas'ter-ers' Tools and Work. See —

Angle-bead.
Angle float.
Angle-staff.
Bastard-stucco.
Batten.
Boss
Coarse stuff.
Coat.
Darby.
Dots.
Dubbing out.
Fine stuff.
Finishing-coat.
First-coat.
Float.
Floating.
Gage stuff.
Grounds.
Hand-finish.
Hawk.
Kalsomine.
Key.
Lath
Lathing-clamp.
Lathing-hammer.
Laying.
Mortar.
Parget.
Plaster.
Plastering-machine
Pricking up.
Pugging.
Rendering.
Rough-cast.
Roughing-in.
Rule.
Scagliola.
Screed.
Screen.
Second coat.
Set.
Setting.
Shave-hook.
Staff-angle.
Stucco.
Three-coat work.
Trowel.
Troweled
Two-coat work.

Fig. 3808.



Plastering-Machine.

Plas'ter-ing-ma-chine'. Coburn's plastering-machine (Fig. 3808) consists of a frame *A* mounted on wheels and carrying two pivoted beams *F N*. The former of these has a pulley at each end, around which passes an endless band carrying a series of trowels *R*. Mortar is placed in the hopper *B*, and by turning a crank the endless band is set in motion, and at the same time the grooved roller *b* is rotated, supplying each trowel with mortar as it passes under the hopper. The trowels are successively carried forward, and their contents successively applied to the surface (a ceiling in the illustration) to be plastered. After giving its stroke each trowel is automatically tilted, and returns to receive a fresh supply from the hopper. *V* is a gage for smoothing and regulating the thickness of plaster, the surplus of which is carried off by a slide. The machine is pushed forward as the work advances, the beam *F* being raised or lowered to suit the work by a rope passing over a pulley *M* on the beam *N*.

Plas'ter-mill. One for grinding gypsum or lime for mortar. See MORTAR-MILL.

Plas'ter-spat'u-la. A piece of steel about 3 inches long by 1 wide and ⅛ thick, in a long handle. By its means plaster is *spread* on muslin or sheepskin. It is heated and used something like a flattening iron.

Plat. (*Nautical.*) A braid of *foxes*, used as in service for a cable in the hawse. A *fox* is a short rope made by twisting a few rope-yarns together. See PLAIT.

Plat-band. (*Architecture.*) *a.* A plain flat ashlar or a molding on a capital from which an arch springs. An *impost*.

b. A flat fascia, band, or string, whose projection is less than its breadth; the lintel of a door or window is sometimes so named.

Plate. 1. (*Carpentry.*) *a.* A beam on a wall or elsewhere to support other portions of a structure. A *capping-piece*.

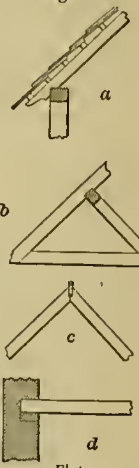
a, *rafter*-plate.
b, *purlin*-plate.
c, *crown*-plate.
d, *wall*-plate.

2. (*Nautical.*) *a.* An iron band or bar: as the *back-stay* plate connecting the dead-eye of the back-stay to the after channel; *futtock*-plates; *channel*-plates, etc.

b. A sheet of metal forming a portion of a strake on a ship's side.

3. A thick sheet of metal for forming a portion of a boiler or similarly constructed object.

Fig. 3809.



Plates.

Weight of a Square Foot of Cast and Wrought Iron, Copper, Lead, Brass, and Zinc, from 1/16 to 1 Inch in Thickness. (HASWELL.)

Thickness.	Cast-Iron.	Wrought-Iron.	Copper.	Lead.	Brass.	Zinc.
Inch.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1/16	2.346	2.517	2.89	3.691	2.675	2.34
1/8	4.693	5.035	5.781	7.382	5.35	4.68
3/16	7.039	7.552	8.672	11.074	8.025	7.02
1/4	9.386	10.07	11.562	14.765	10.7	9.36
5/16	11.733	12.588	14.453	18.456	13.375	11.7
3/8	14.079	15.106	17.344	22.148	16.05	14.04
7/16	16.426	17.623	20.234	25.839	18.725	16.34
1/2	18.773	20.141	23.125	29.53	21.4	18.72
9/16	21.119	22.659	26.016	33.222	24.075	
5/8	23.466	25.176	28.906	36.913	26.75	
11/16	25.812	27.694	31.797	40.604	29.425	
3/4	28.159	30.211	34.688	44.296	32.1	
13/16	30.505	32.729	37.578	47.987		
7/8	32.852	35.247	40.469	51.678		
15/16	35.199	37.764	43.359	55.37		
1	37.545	40.282	46.25	59.061		

NOTE. The wrought-iron is that of hard-rolled Pennsylvania plates, and the copper that of hard-rolled plates from the works of Messrs. Phelps, Dodge, & Co., Conn.

4. (*Steam-engine.*) To *plate* a *port* is to close it by the *land* or unperforated portion of the plate of a slide-valve.

5. (*Horology.*) One of the parallel sheets of metal in a watch or clock into which the principal wheels are pivoted.

6. (*Dentistry.*) The portion which fits to the mouth and holds the teeth of a denture. It is of gold, silver, aluminum, or vulcanite.

7. (*Metallurgy.*) A flat metallic piece in a furnace, usually a part of the bed or bosh.

8. (*Hat-making.*) A *plate-hat* is one of which only the outer layer is fur.

9. (*Printing.*) A page of type, stereotype, or electrotype, for printing.

10. (*Engraving.*) *a.* The metallic surface in which an engraving is cut. Hence the names *plate-engraving*, *copperplate*, etc.

b. An impression from such an engraved plate.

11. A piece of metal to be attached to an object; as a *name*-plate to a trunk, a *door*-plate, a *coffin*-plate, a *finger*-plate, to keep the stain of fingers from a door, etc.

12. A piece of service of silver, gold, or their imitations.

The Roman *patera* or *patella* (a plate, dish, or saucer) was of metal or earthenware, often highly ornamented, and sometimes with a handle. In the latter condition it looked like and was occasionally used as our griddle.

The *patina* seems to have been deeper, like a bowl, and sometimes had a cover. A large bowl was *crater*; the ladle, *cyathus*; a drinking cup, *poculum*. See Smith's "Dictionary of Greek and Roman Antiquities," *Patera*; *Patina*.

13. A small, shallow vessel for table service; one at a time for each guest, in contradistinction to the dish which holds the viand from which a guest is helped.

Pepys complains that at the Lord Mayor's dinner, London, 1663, the major part of the guests had "no napkins nor change of trenchers, and drank out of earthen pitchers" and ate from "wooden dishes."

Pewter and wood were the ordinary ware for many centuries. Afterward, common earthenware. Imported ware from China give the fillip to some persons of ingenuity and taste, the principal one of whom was Wedgewood. See POTTERY; PORCELAIN.

Plate-bend'ing Ma-chine'. A machine for bending plates of metal to any required curve for boilers, water-wheel buckets, etc. Those for forming regular curves comprise three rolls, two of which are driven by gearing, and the third, generally the upper one, runs free.

In the illustration, *a b* are the driven rolls, rotated in either direction by the gears *c d*. The bearings of the free roll *e* are raised or lowered by turning the hand-wheel *f*, which, by means of the gear-wheels *g*, rotates the shaft *h*, having a worm at each end gearing with worm-wheels *i*, which turn screws supporting the bearings of the roll *e*. By varying the distance between the upper and lower rolls, a greater or less curvature is given to the plate, the curvature being greater in proportion to their nearness together.

Fig. 3810.

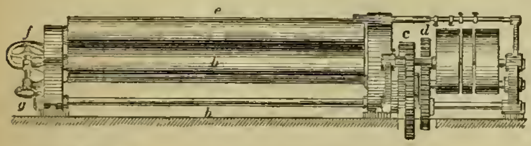
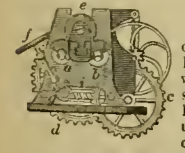


Plate-Bending Machine.



In some machines of this kind the upper roller is provided with separate adjustments at each end, so that, by raising one end more than the other, plates may be bent to a conical shape, or by altering the relative hight of its bearings, their surfaces may be made of an elliptic, parabolic, or other non-circular curve.

For bending the thick and irregularly curved plates required for armor-plating a powerful form of press is employed. The upper and lower beds have each a series of parallel longitudinal bars, adjustable by screws, so that a special curve may be given to each plate. The bars of the two beds are adjusted so as to correspond, and the plate, flat, as it comes from the forge or rolling-mill, is placed between them, and the movable bed, usually the lower, is caused to approach the other by screw or hydraulic pressure. See ARMOR-PLATING; ROLLING-MILL.

Plate-brass. Rolled brass. *Latten.*

Plate-en-grav'ing. A mode of engraving as distinct from the *relief* engraving on wood. The lines are cut into the plate, are filled with ink, and the surface is wiped clean and polished; soft paper is laid on the plate, and both are run through a roller-press. See COPPERPLATE-ENGRAVING, pages 618, 619.

Engraved plates are multiplied by the electro-plating process.

1. A *reverse* of the plate is obtained by deposition of copper in the bath. This mold is in cameo, and from this as many intaglio copies of the original may be obtained as may be desired.

2. An impression of the plate is taken on thin paper with an ink of gum-dammar, oxide of iron, and essence of turpentine. This is transferred to a copper plate; the paper is removed by washing, and the cameo thus obtained is placed in the bath for the deposition of an intaglio for the printer.

Plate-glass. Plates of glass covered with tin-foil, for mirrors, were made in Venice during the sixteenth century, but the invention of casting glass to form plates is due to Abraham Thevart. In the year 1688, plates 84 × 50 inches were cast by his process at St. Gobin, in Picardy.

A plate-glass manufactory on a small scale was established at Lambeth in 1673, but the manufacture does not appear to have flourished in England until it was undertaken by the British Plate-Glass Company, chartered by act of Parliament in 1773. Their works at Ravenshead, Lancashire, are still in operation.

The ingredients and their proportions, employed in making plate-glass, are kept secret as far as possible by the manufacturers. The following is given as one of the formulas: Silica, 78 parts; potash, 2; soda, 13; lime, 5; alumina, 2.

The materials, in a comminuted form, are fused in crucibles or pots exposed to an intense heat in a furnace; the complete fusion requires about 20 hours. From the pots it is ladled into a cistern, the *cuvette*, which is also placed in a hot furnace, where it remains until the glass is fined and in proper condition to flow readily and equably. When this occurs, the cuvette is lifted out of the furnace by means of tongs and hoisted on to a carriage by which it is moved to the casting-table. It is now skimmed to remove impurities from its surface, and hoisted by a crane immediately over the casting-table. See CUVETTE, Fig. 1579; CASTING TABLE, Fig. 1181.

The casting-table is surrounded by side and end ledges, corresponding in depth to the thickness of the plate to be made, to prevent the escape of the liquefied glass which is poured upon it by tilting the cuvette. During the pouring a washer is drawn immediately in front of the glass to remove any dirt from the casting-slab, and when this has been covered to the requisite depth a heavy copper roller is passed over the surface of the glass, causing it to exhibit a beautifully iridescent play of colors: this roller flattens its upper surface, and causes any excess of the metal to be thrown off at the end of the table, where it is received in a trough of water.

A thick flange of the glass is turned up at the end of the plate, to which, when somewhat hardened, a rake-shaped iron is applied, by which it is forced into the annealing-oven or upon a carriage by which it is conveyed to the oven. As the plate is yet plastic, its under side takes an impression from the bricks of the oven, while its upper surface, though smooth, is uneven; it consequently requires to be ground and polished. After remaining in the oven about five days and being allowed to cool gradually, it is carefully examined to see if it will admit of being finished as a single plate, or whether it has flaws or knots which necessitate its being cut into smaller pieces. If the latter be the case, the defective portions are cut out and the remainder serves for plates of less size.

In either case the plates are imbedded in plaster of Paris upon stone tables about 8 × 15 feet in width and length; these are arranged in pairs, at about 10 feet distance apart.

Other plates of glass are cemented to the under surfaces of two swing-tables or runners, which, by means of a horizontal frame between each, are caused to traverse backward and forward, a circular motion being at the same time imparted by means of a vertical crank-shaft pivoted to the central and upper part of the table and actuated by bevel-gearing; four other cranks, one at each corner of the frame, serve to guide and limit its motion, causing its central point to describe a circle about four feet in diameter, so that different portions of the faces of the upper and lower glass plates are continually applied to each other. Sharp river sand sifted into two different sizes is used as an abradant; when the surface of the lower plate has been ground quite flat by the coarser sand, it is removed by careful washing and the finer sand is substituted for it; to this succeeds emery powder, a coarser and then a finer quality being applied, the glass being thoroughly washed previous to each change of material, so that none of the coarser particles previously used may remain to cause scratches on its surface. The plates are then inverted, and the same process is repeated on the other side. For this purpose the frame above described is suspended by chains which admit of its being raised from the face of the lower table. These machines do not permit the use of very fine emery, as their weight and velocity at such near proximity as they would necessarily be would tear the surface of the glass; the velocity is consequently reduced when the finer emery is employed, and a different machine, worked by hand-power, is used for the final smoothing, preparatory to the process of polishing. This is effected upon stone benches about two feet high, having plane upper surfaces which are covered with wet canvas. Upon this one of the larger plates is laid, the wetted surface of the canvas serving to retain it in place. A smaller plate is used as a grinder or runner; if this be of such size that a uniform pressure cannot be imparted to it by hand, leaden weights are distributed over its surface. Emery powders of gradually increasing fineness are applied with water, and the runner is traversed back and forth by hand with a semicircular stroke, its path being slightly changed at each stroke, while the runner itself is gradually turned around as on an axis during the progress of the work These combined movements serve to evenly distribute the emery and insure an equal amount of grinding both to the bed-plate and runner. Small plates are smoothed by young girls; for the larger sizes two women stand, one on each side of the bench, and by placing their outstretched hands on the runner give it a backward and forward movement of five or six feet.

About six sizes of carefully washed emery are used in smoothing, and between each change the plates and everything about the apparatus are carefully washed, including the hands of the operators The fine emery powder last employed imparts a very smooth surface to the plates, which are now ready for polishing. The polishing-machine has a bed mounted upon rollers, and traversed slowly back and forth sidewise by a rack and pinion beneath. Two carriages supported on wheels at each end, which run on rails at each end of the table, have a reciprocation of about two feet by means of two opposed cranks, so that one advances as the other recedes. They are placed about four feet apart, and to their under surfaces are attached rubbers having sockets in their upper part, into which bars with rounded ends on the under side of the carriage are fitted, allowing a certain freedom of motion independent each of the other; they measure 6 × 8 inches. are placed at distances of one foot apart, and their faces are covered with thick felt. By the reciprocating motion of the carriage and the transverse movement of the bed, they are caused to act on every part of the surface of the glass, a sufficient pressure being imparted to each by weights.

The powder generally employed in polishing is "Venetian pink," a substance containing a small proportion of oxide of iron mingled with earthy matter. It is used with water, which reduces the friction and prevents the glass from becoming heated Tripoli, crocus, and putty powders, when used with water, cut too actively to produce a high polish in this way; though they are employed dry for the last finish in hand polishing, the amount of surface acted on with the velocity and power of the machinery would render them liable to tear the face of the glass, beside exposing it to the contingency of being broken by the heat evolved.

Repolishing old plates which have been scratched is generally effected by hand, as the operation may be restricted to the scratched portion. The process is commenced with tripoli and finished with putty-powder or crocus. The rubber is attached to the end of a pole suspended from a spring, which affords the necessary pressure, and is pushed back and forth by a workman. This process is both tedious and laborious, and causes the surface to present a wavy and polished appearance much inferior to that of machine-polished glass.

Plate-hoist. A clamp or clutch by which a plate is lifted into position for attachment to the angle-irons forming the ribs or frames; or for getting the plates aboard for other parts of the work. It

Fig. 3811.

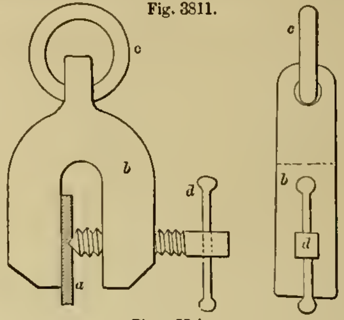


Plate-Hoist.

consists of a strong stirrup *b* and ring *c*, the latter being attached to the hook of the tackle. The plate *a* is clamped against one leg of the stirrup by the point of the set-screw *d*, which passes through the other leg.

Plate-hold'er. (*Photography.*) *a.* Also known as *dark-slide* or *slide.* That part of a photographic camera which is used to contain and transport the sensitized plate. It consists of a thin, flat, rectangular frame or box, square or nearly so, the dimensions of which enable it to take exactly the place of the ground-glass screen upon which the visible picture falls. The back of the plate-holder is provided with a door, which, when opened in the dark room, admits of the introduction or withdrawal of the collodionized plate. The front, that is, the side which faces the lens, has a thin sliding shutter, which serves to uncover the sensitive surface when the slide is in its place, so that it may receive the rays of light, the action of which forms the photographic image, exactly in the position occupied by the ground glass during the operation of focusing. By this contrivance the plate is taken to and from the camera in total darkness. *Inside frames* or *kits* are used within the plate-holder for making small negatives.

b. A pneumatic device used to hold the plate during development.

Plate-i'ron Gird'er. A girder made of wrought-iron plate, either rolled with flanges or built up of flat plates and angle-iron. See Girder. See also pages 1198, 1199.

Plate-leath'er. Wash-leather for rubbing and cleansing silver-plate and jewelry.

Plat'en. (*Printing.*) The slab which acts in concert with the bed to give the impression. See Printing-press.

Plate-of-wind. (*Music.*) In the construction of organ-pipes, a thin aperture whence a sheet of air issues, impinging upon the *lip* of the mouth and receiving a vibration which is imparted to the column of air in the pipe. See Pipe; Mouth-pipe.

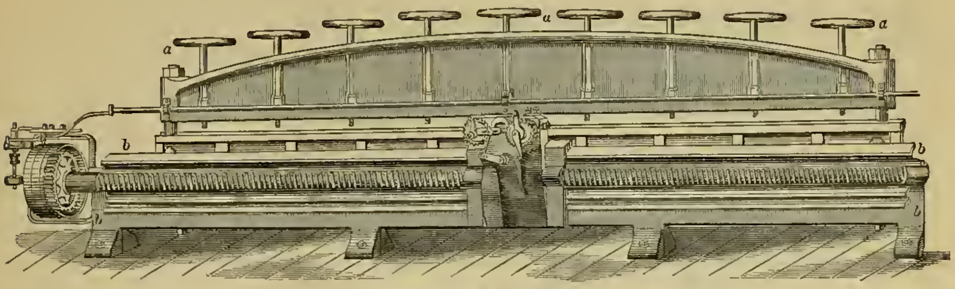
The word is sometimes applied to the issuing stream of air, which is flattened by the surfaces between which it passes, so as to impinge as a ribbon of air upon the edge of the lip.

Plate-pa'per. Paper for taking impressions of engraving. *Copperplate*-paper.

Plate-plan'ing Ma-chine'. A machine designed for planing true edges and bevels on plates for boilers and for iron ships.

In the machine illustrated, the plate is clamped upon a wooden bed, 14 feet long, by means of holding-down bolts *a a*, etc. The cutter-head is driven by a screw sliding on a pair of ways *b b*, one above the other. It is self-operating in feed, and has cutters which work each way. It bevels the edge and squares up a narrow calking surface. Ships' plates may be planed before or after bending. In the latter case the bed is curved to the form of the plate.

Fig. 3812.



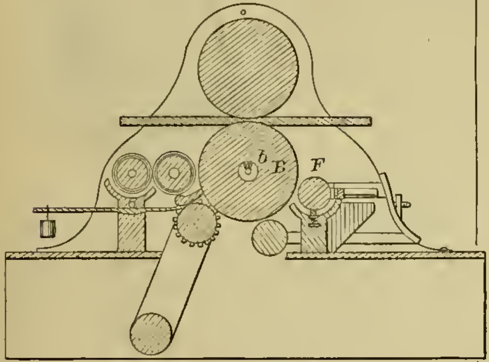
Sellers's Plate-Planing Machine.

Plate-pow′der. Rouge and prepared chalk or oxide of tin and rose-pink. Used in polishing silver-ware.

Plate-print′ing Ma-chine′. One for printing from plates or cylinders engraved in intaglio. Such plates have depressed lines made to contain ink, which is smeared all over the surface; the superfluity is wiped off, leaving the lines full; the surface is then polished and damped, absorbent paper being pressed against the plate during the passage between rollers. The ink leaves the lines and adheres to the paper.

Machines for this purpose have been made to operate upon plates, the inking rollers being succeeded by wipers and polishers, after which the plate, on its bed, passes beneath a D-roller and returns. The plate is kept hot by gas or oil lamps beneath the bed or by iron heaters; a blanket between the impression-roller and the back of the paper gives a spongy but severe pressure, which forces the paper partly into the lines of the plate, whence it withdraws the ink as the paper is subsequently lifted. See COPPERPLATE-PRINTING, page 619

Fig. 3813.



Cylindrical Plate-Printing Machine.

Another form of plate-printing press has the engraving on a roller *B* heated from the interior by a row of gas-jets *b*. The ink is applied by the roller on the left, which rotates in contact with the ink-distributing roller and the engraved cylinder on its respective sides. Beneath the inking-rollers is an ink-doctor, a knife edge which removes the greater portion of the superfluous ink. The cylinder then comes in contact with an independently revolving wiping brush-roller, then with a second wiper-roller, and next with a roller *F*, whose surface performs the duty performed in the hand-printing process by the palm of the hand, being surfaced with whiting for giving the final polish to the cylinder before it passes to the paper, which is pressed upon it by the roller above.

Plate-rack. A frame in which washed and rinsed dishes and plates are placed to drain.

Plate-rail. (*Railway Engineering.*) A flat rail.

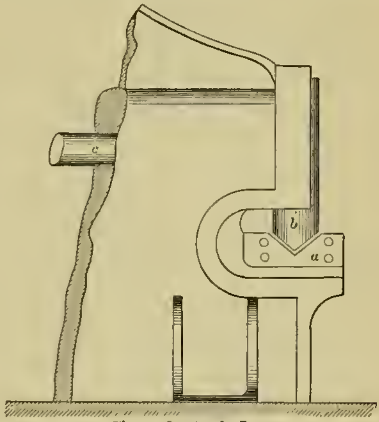
Plate-rail′way. A tramway in which the wheel-tracks are flat plates.

Plate-roll′er. A smooth roller for making sheet-iron.

Plate-shears. (*Metal-working.*) A shearing-machine for sheet-metal, such as boiler-plate. See SHEARING-MACHINE; BAR-SHEAR, etc.

A shears for cutting bent plates or angle-irons. The bed *a* and cutter *b* are adapted to the shape of the piece, so as to avoid bending or buckling, and the cutter is operated by a cam on the shaft *c* or equivalent.

Fig. 3814.



Shears for Angle-Iron.

Plate-warm′er. A small cupboard standing in front of a fire and holding plates to warm.

Plate-wheel. A wheel without arms. One in which the rim and hub are connected by a plate or web. Many car-wheels are made in this way. The wheels of watches are made so, and the plate is afterward filed away in portions so as to leave spokes in the form of a cross. This is called *crossing-out*. A special file is used for the purpose.

Plat′form. 1. (*Fortification.*) The floor on which the guns are placed. It is level transversely, and has a slight slope toward the embrasure. The chassis, when pivoted forward, traverses on a curved track at the rear. The gun runs in and out of battery on the chassis.

2. A landing-stage.

3. A raised walk alongside a railroad-track, to

assist in mounting to or dismounting from the cars.

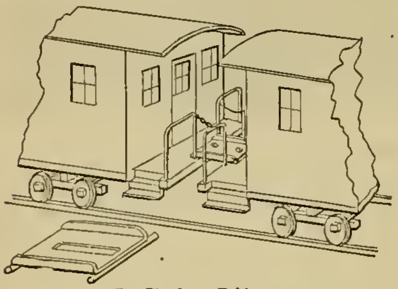
4. A floor supported by a scaffold.

5. The bench in a glass-furnace on which the pots are placed.

Plat′form-board. (*Ordnance.*) A side-board on an ammunition-carriage for forage. *Side-board; wing.*

Plat′form-bridge. (*Railway-cars.*) A gangway over the space between the platforms of adjacent cars in a train. It is a measure of safety, to prevent persons falling down between cars when in motion. In Fig. 3815 it is a gang-plank with arrangements to allow it to slip back and forth, but not slip off.

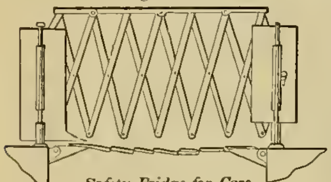
Fig. 3815.



Car-Platform Bridge.

In Fig. 3816, the floor and sides of the bridge which unite the platforms of adjacent cars are made on the expanding lattice or lazy-tongs principle; they are contractible, to be taken on board, or are swung in on pivots when the cars are detached.

Fig. 3816



Safety-Bridge for Cars.

Plat′form-car. (*Railway Engineering.*) An open car having no inclosing sides, or merely surrounded by low ledges; intended for carrying stone, pig-iron, and similar articles of freight.

Plat′form-car′riage. (*Ordnance.*) One for transporting mortars. *Platform-wagon.*

Plat′form-crane. 1. A crane on a movable truck.

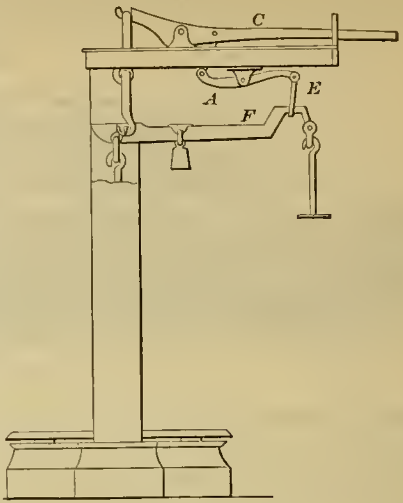
2. A crane on the *break* of a platform to land goods from wagons or cars.

Plat′form-scale. One with a flat scale on which the object to be weighed is placed.

There are *counter* platform-scales of a comparatively small size. Larger ones are wheeled about on the floor of a store or warehouse, being adapted for weighing boxes, barrels, sacks, and packages which are moved by trucks. A still larger form is the cattle or hay scale, on which the wagon and its load are weighed at once, and the *tare* afterward deducted. See SCALES.

The principle is readily understood from Fig. 3817. The knife-edge of the scale-beam *F* rests in an arm depending from the lever *C*; this and the beam are connected by the pivoted lever *A*, its connecting rod and loop *E*, so that the beam may be maintained in horizontal position, and its vibrations instantaneously checked during the process of weighing.

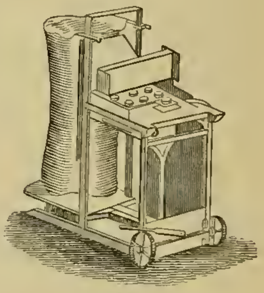
Fig. 3817.



Platform-Scale.

A favorite form of British platform-scales is upon the lever principle, but unlike the steelyard. A constant proportion as to length exists between the respective ends. A number of weights are employed, which represent from four to ten fold their amount on the platform, according to the proportion established. It is portable, and is the ordinary scale of the country for weighing coal or produce in bags.

Fig. 3818.



British Platform-Scales.

Pla-til′la. A white linen Silesian fabric.

Plat′i-na. Twisted silver wire.

An iron plate for glazing stuff.

A metal. See PLATINUM.

Plat′ing. The art of covering baser metals with a thin coat of silver or gold was practiced by the Orientals and Egyptians many centuries before Europeans excelled in ornamental metallurgy.

The process is now extensively applied to the cheaper metals, those which are more oxidizable being protected by those which are less so.

The process originally practiced, known as *French gilding*, consisted in applying silver leaf to articles of brass or steel; the union of the two metals was effected by heat and by rubbing with a burnisher. This lacked the desired permanency, and was supplanted by the method still generally employed where electro-magnetic agency is not resorted to. As practiced at Birmingham, Sheffield, and other places where work of this description is largely carried on, the process is essentially as follows: An ingot, composed of an alloy of copper and brass, is prepared by melting the alloy in graphite crucibles, and pouring into two-part cast-iron molds, greased on the interior to prevent adhesion, and having a high gate or mouth-piece to give the pressure requisite to insure solidity and uniformity. After withdrawal from the mold the ingot is dressed with the file on one or both sides, according as it is to be single or double plated. A plate of silver 1/40 the thickness of the ingot, and of slightly smaller dimensions, is then applied to its face, tied to it with wire, and a small quantity of a saturated solution of borax inserted around the edges. This salt melts at a low temperature, and excludes the air, which might otherwise oxidize the copper and prevent the union of the metals. The ingot is then transferred to the plating-furnace, and laid directly on the coke fire of the furnace, which has an iron door, provided with an aperture through which the interior may be viewed.

The operator watches at this hole, and when the proper soldering temperature is attained, which is known by the *riveting* or drawing together of the faces of the two metals, the ingot is instantly removed from the furnace; were it to remain a little longer an alloy would be formed, spoiling the plating. As it is, the metals are held in contact by the formation of a thin film of silver solder at their contacting surfaces. The ingot is then cleansed and drawn to the desired thickness between rolls.

In *plating copper wire* the silver is first formed into a tube one of the edges of which slightly overlaps the other. A red-hot copper cylinder fitting somewhat loosely is then inserted, and the two edges of the tube joined by rubbing with a steel burnisher. Its interior is then cleaned, and a copper rod on which it exactly fits is inserted; this is slightly longer than the tube, and is grooved at its ends, so that the ends of the tube by being pressed into these grooves may exclude the air: the compound rod is then heated red-hot, and the silver coating united to the copper by rubbing briskly lengthwise with the burnisher. The wire is then drawn to the required shape and thickness, being occasionally annealed during the process, and finally cleaned with dilute acid. Such wire is used for making bread-baskets and similar articles of utility or ornament.

Plated ware is formed by *raising* with the hand hammer, *spinning*, or on a large scale by stamping with counterpart dies or swages, and by punching.

Gilding, in which a thinner coating of the gold is applied to metallic or other surfaces, is effected chemically, as in Elkington's or more properly Bonnet's process, by dipping the metal into a solution containing gold; or mechanically, as in *destemper*, *oil*, and *leaf* gilding, by applying gold-leaf on a surface previously covered with size or similar adhesive matter. *Water*-gilding consists in the application of an amalgam of mercury and gold, from which the mercury is afterward expelled by heat. Various modifications of these processes employed in surfacing articles with gold and silver have received different technical names, as German gilding, Grecian gilding, and Japanese gilding; in the latter a fine powder is used, producing a "deadened" appearance. See GILDING.

Silvering brass or copper may be effected by dipping the article in nitric acid to clean the surface, and then rubbing the surface with a composition of —

Cream of tartar	100
Chloride of silver	10
Corrosive sublimate	1
	111

Then polish. Thermometer scales are thus silvered.

Articles made of an alloy of silver and copper may be blanched by dipping them into a solution of bisulphate of potash. The acid dissolves out the copper and leaves the silver isolated.

Silver may be *precipitated* on to a surface in a lustrous form by adding oil of cassia or cloves or a solution of grape sugar to a solution of certain salts of silver. Mix —

Aqua ammonia	30 grains
Nitrate of silver (crystals)	60 "
Spirits of wine	90 "
Water	90 "
	270 grains.

When the nitrate of silver is dissolved, filter, and add a solution of —

Grape sugar	15 grains
Spirits of wine	1½ ounces
Water	1½ "

Leave the article in the solution for a day or two.

Tin-plate, commonly known as sheet-tin, but, properly speaking, tinned iron-plate, is made by dipping the plate, previously scoured bright and *pickled* by immersion in dilute sulphuric acid, into a bath of molten tin covered with a mixture of oil and rosin. Tinned iron wire is prepared in a similar way. See TIN-PLATE.

In Mallett's process for *covering iron with zinc*, the plates, having been hammered and scoured to detach scale, are immersed in a "preparing bath," composed of equal parts of sal-ammoniac and muriate of zinc, from which they are transferred to the metallic bath, which is composed of 202 parts mercury to 1,292 parts zinc, by weight, with the addition of about 1 pound sodium or potassium to each ton of the compound. The affinity of this alloy for iron being very strong, care must be taken to avoid too long immersion, which would dissolve the iron.

Fig. 3819 is a machine for covering with a soft metal a strip of roofing-metal made up of several sections joined together. The ends of sheets or strips of metal are interlocked, and the connected sheets then passed between rollers to close the seams, and then through a bath of molten tin or other soft metal, which coats the surface and closes and covers the seams, so as to form continuous pieces of indefinite length without appreciable or pervious joints.

In *coating copper or brass vessels with tin*, they are first pickled with sulphuric acid diluted with about three times its bulk of water, then scrubbed with sand and water and washed dry. They are next sprinkled with dry powdered sal-ammoniac and slightly heated; a small quantity of melted block-tin is poured into the vessel, which is turned about until the inside is well covered, the excess being poured back into the melting-trough.

Iron is treated in a similar way, but requires more care, having less affinity for tin than copper If the vessel be greasy, it must be treated with strong muriatic acid. In old iron vessels, where the grease has penetrated the pores to a considerable depth, even this may fail to remove the grease.

An alloy of nickel, tin, and iron has also been employed for this purpose.

Plating German-silver table-ware with pure silver is effected by electro-magnetism. After removal from the coating-bath the articles are rubbed with a wire scratch-brush, and burnished with a steel burnisher wet with cream of tartar.

Græger's process of *covering iron and steel with copper* consists in first treating the object, previously well cleansed, with a solution of protochloride of tin and afterward with ammoniated solution of sulphate of copper; from the latter metallic copper is deposited, firmly adhering to the object, which may be afterward polished. Zinc and galvanized iron may be coated in the same way.

Gilbert's process of *coating hard metals with tin* or alloy consists in enveloping the metal to be coated, rolled into sheets of proper thickness, with a sheet of tin or alloy varying in thickness from .01 to .35 of that of the hard metal. The surface of the coating material is carefully rubbed smooth to prevent the formation of blisters or wrinkles, and the compound sheet is passed through polished rollers under a heavy pressure, by which considerable heat is generated, firmly uniting the surfaces of the two metals. The hard metal may also be tinned by immersion in a liquid consisting of one part by weight of nitrate or muriate of tin to about eighty parts of water; the time required varies from five to twenty minutes. See also ELECTRO PLATING; NICKEL-PLATING; GILDING; SILVERING; PLATINIZING; TIN-PLATE, etc. For list see METALLURGY.

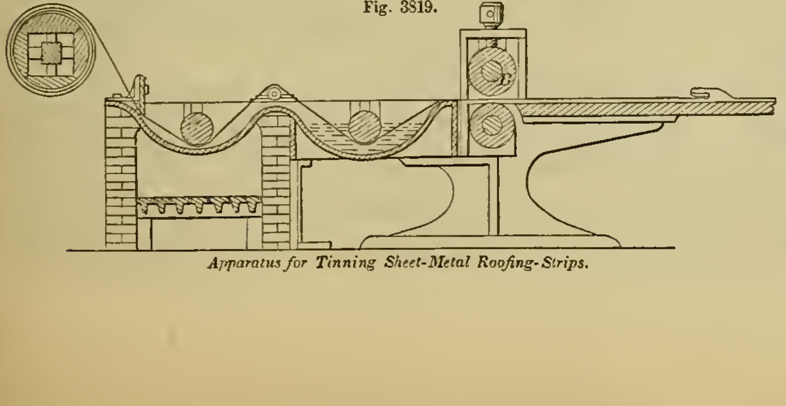
Plat'i-niz-ing. The deposition of a thin film of platinum on to plate-glass; this is transparent when regarded by transmitted light, but gives a reflection, as from a mirror, when viewed from the side which has the stronger light upon it. See LOOKING-GLASS.

Plat'i-num. A white, heavy, ductile metal, very difficult to fuse, and resisting the action of heat and air and most acids. Equivalent, 98.7; symbol, *Pt*; specific gravity, 21.5; fusible under the oxyhydrogen blowpipe. It is a grayish-white metal, moderately hard (between copper and iron), ductile; welds at a white heat; almost infusible. Alloys readily with many metals; is non-oxidizable.

It is used for burners, chemical vessels, and tools, setting artificial teeth, bushing for guns, points of lightning-rods, etc.

Plat'i-num-steel. Steel alloyed with $\frac{1}{100}$ part of platinum. It is said not to be quite so hard as *silver steel*, but tougher.

Fig. 3819.



Apparatus for Tinning Sheet-Metal Roofing-Strips.

Pla-tom'e-ter. An instrument for measuring areas on plans by mechanism. See PLANIMETER.

Platt. (*Mining.*) A cavity at the extremity of a level near a shaft, for collecting supplies of ore, which are placed in the *kibble* to be hoisted.

Plat'ten-ing Glass. The operation of forming glass into sheets or plates. In crown-glass this is effected by imparting a rapid whirling motion to the blown-out globe while still on the pontil. (See FLASHING.) Plate-glass is plattened by the roller, which forms it while still in a liquid state. The term is, however, specially applied to the operation of flatting cylinder-glass. In this case, the formed cylinder is cracked longitudinally by drawing a hot iron from end to end and dropping water on the heated line. A number of the cylinders are then introduced into a furnace, the cracked side uppermost, and when sufficiently softened each is taken up on an iron rod bent to a right angle and laid upon the flatting-stone, where it opens out and is smoothed down by an implement resembling a baker's peel, after which it is annealed. See GLASS; CYLINDER-GLASS; SHEET-GLASS.

Plat'ting. The top course of a brick stack or clamp.

Play. (*Machinery.*) *a.* A movement in a prescribed path; as the stroke of a piston, the oscillation of a pendulum.

b. Freedom of movement to a given extent to prevent binding. A certain looseness, as that of the arbors of watches between the plates, against which the shoulders abut. Known to watchmakers as *endshake.*

Pleat'ing. See PLAITING.

Plec'trum. (*Music.*) An ivory instrument whereby the strings of the lyre were anciently struck. It survived till a late day in the *quills* of the harpsichord and its congeners.

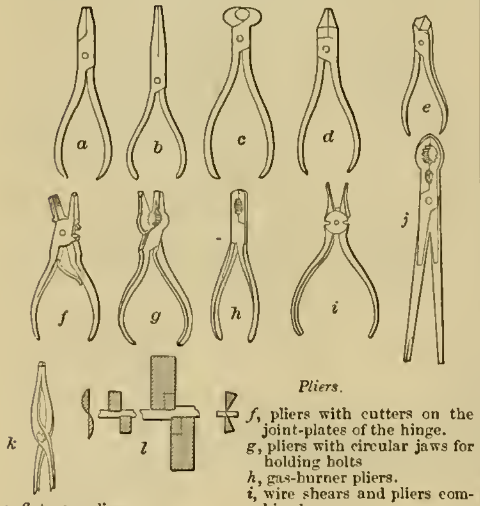
Pledg'et. 1. (*Surgical.*) A compress of lint flattened between the hands and laid over an ulcer or wound to exclude air, retain dressings, or absorb discharges. It differs from a tent in that the latter is a roll of lint introduced *into* a wound or ulcer to keep it from closing.

2. (*Nautical.*) A string of oakum used in calking.

Plensh'ing-nail. A large flooring-nail.

Plex-im'e-ter. A plate employed in auscultation, being placed in contact with the body to receive the blows of the hammer. See PERCUSSOR.

Fig. 3820.



Pliers.

a, flat-nose pliers
b, long flat-nose pliers.
c, cutting-pliers.
d, flat-nose pliers with wire-cutter on the side.
e, side-cutting pliers.
f, pliers with cutters on the joint-plates of the hinge.
g, pliers with circular jaws for holding bolts
h, gas-burner pliers.
i, wire shears and pliers combined
j, gas-pipe pliers.
k, long-nose pliers for blowpipe work
l, figures illustrating action of pliers.

Pleyt. (*Nautical.*) A kind of river craft. *Playte.* (ADMIRAL SMYTH.)

Pli'ant. A French folding seat or chair.

Pli'ers. A small pair of pinchers with long jaws, adapted to handle small articles, such as the parts of a watch or other fine machinery. It is also specially adapted for bending and shaping wire.

Pliers with peculiarly shaped or proportioned jaws are called *long-nosed* pliers, *round-nosed* pliers, *cutting*-pliers, etc.

For special purposes, as *fishing*-pliers, *bottling*-pliers, etc. See Fig. 3820.

Plinth. (*Architecture.*) *a.* A square set off at the base of a structure or edifice.

b. The lower course or courses which project beyond the general face of a wall, giving it a wider base.

The plinth of a column is a square slab above the base and below the *dado.* When it has an upper receding member, it is a *double-faced plinth.*

Ploc. A mixture of hair and tar for covering a ship's bottom.

Plomb-brut. Rough lead.

Plon'gée. (*Fortification.*) The declivity of the superior slope of the parapet.

Plon'ket. A coarse woolen fabric.

Plot. A ground plan. A *plat.*

Plot'ting-scale. A scale, usually 1½ inches by 1½ feet, used in plotting ground. It is of brass, ivory, silver, or boxwood.

Plow. 1. (*Agriculture.*) An implement for making a furrow in land, the object being to stir the soil, make a bed for seed, cover seed, hill up earth to crops, lay out lines for planting trees or shrubs, and for other purposes, according to construction.

Excepting in the sacred records of the period before the flood, history gives no account of a time when man was destitute of the *hoe* and the *plow.* The history of one of these is the history of the other, for they had a common origin. In the distant past they were all of wood, and differed little except in size. We may safely assume that the hand implement preceded that drawn by animals.

The original hoe was a forked limb (*a*, Fig. 3821). This, being shaped a little, and the *tusk* being pointed, formed a plow (*b*). Byron refers to the plowshare by this name in his account of the storming and sacking of Ismail on the Danube, where Suwarrow swears, —

> "That shortly plow or harrow
> Shall pass o'er what was Ismail, and its *tusk*
> Be unimpeded by the proudest Mosque."
> DON JUAN.

c d are other shaped limbs in which the lower piece is formed so that its sole may run on the ground and turn a furrow, and not merely scratch the soil. *e* is an ancient Etruscan plow from an urn. *f g* are Japanese plows in the Smithsonian Institution; they show two degrees of ingenuity in advance of the other examples

The images of Osiris are represented with a plow grasped in each hand, and a harrow slung over the shoulder by a cord. See HARROW

"Osiris taught the way and manner of tillage and good management of the fruits of the earth. Isis found out the way of cultivating wheat and barley, which before grew here and there in the fields, among the common herbs and grass, and the use of them was unknown." — DIODORUS SICULUS.

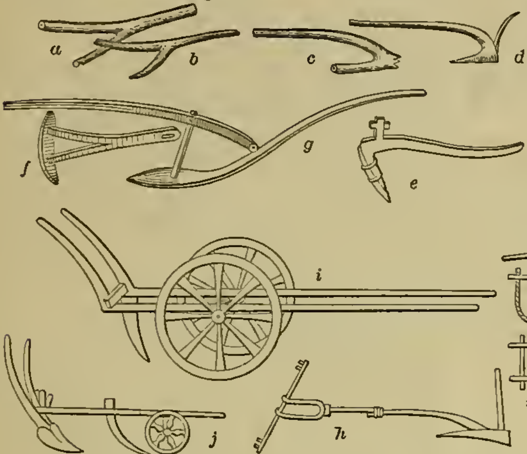
The early deifications were many of them of individuals who had opened up sources of agricultural prosperity. *Isis* was the Greek *Ceres; Osiris* became *Bacchus*, the *Father Liber* of the erudite Pliny

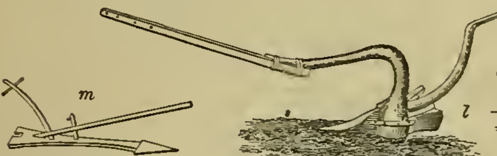
The great efficiency of the engineering works believed to have been executed by Sesostris, about 1800 B. C., indicates a great progress in the agriculture to which this scheme of irrigation was subservient. The alluvium of the valley of the Nile, however, never was plowed in the manner we consider essential to good husbandry on our soils.

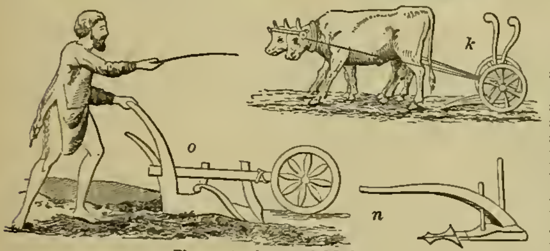
"Some of the Egyptians lightly run over the surface of the earth with a plow, after the water is fallen, and gain a mighty crop without any great cost or pains." — DIODORUS SICULUS (60 B. C.).

The paintings in the Memphis pyramids show plows with one and others with two handles. It cannot be said that they possess a mold-board; they rather resemble our shovel-plow, and by going over the ground a sufficient number of times would have put light alluvial soil in a fair state of tilth to a depth of five inches. In the rich valley of the Nile, which receives an annual deposit of silt, a plow of this kind would produce its maximum effect. Poor as they are, they are substantially similar to those used at the present day in the greater part of Europe, as may be seen by a comparison of the plows in Fig 3821. *h* is an ancient plow copied from Niebuhr, and is stated by him to be similar to the implement used to this day in Egypt and Arabia. With such tools, it was no wonder that Rome and Constantinople depended upon the alluvial valley of Egypt. *i j* are two wheeled-plows from Caylus's collection of Greek antiquities, and *k* is from an ancient Sicilian medal illustrated by Lasteyrie. *l* is a modern plow of Castile, and *m* is the plow now used in Sicily. It is hardly as good a one as that shown at *k*, which is a plow of the Greek occupation over 2,000 years since, before Syracuse fell under the attack of Marcellus, 212 B. C. It still lacks the mold-board. *n* shows the modern Roman plow, with a broad flat share. The diverging wings form a wedge which divides and turns over the soil to some extent The plowman stands on the rear portion of the sill-piece and holds on by the post, adding his weight to increase the depth of furrow.

Fig. 3821.







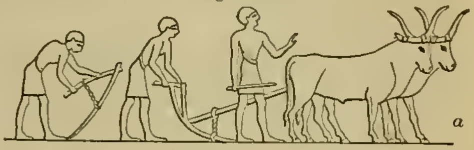
Plows, Ancient and Modern.

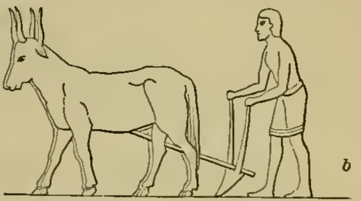
This, perhaps, is the pioneer of sulky plows and buggy plows, as we of the West call them. *o* is from Strutt's plates of ancient dresses, and indicates the appearance of the Anglo-Saxon plow and plowman of the eighth century.

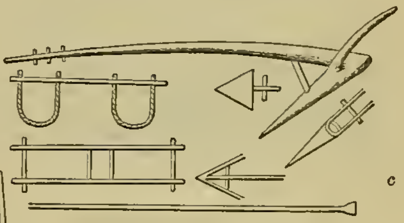
From the foregoing and those shown in the next figure, and a comparison of others for which we have no room here, it appears that the ancient Egyptian, Etruscan, Syrian, and Greek plows were equal to the modern plows of the South of France, part of Austria, Poland, Sweden, Spain, Turkey, Persia, Arabia, India, Ceylon, and China. The last thirty years may have worked a partial change, but not sufficient to invalidate the general truth of the statement. The ancient Etruscan plow, for instance, was probably as good an implement as the one now used by the peasantry of the Aroo, — the same territory.

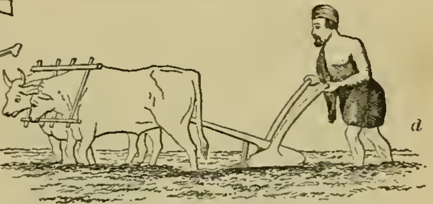
In Fig 3822, *a* is a group from Beni-Hassan, and of about the date of Osirtasen, who is considered by Wilkinson to be contemporary with Joseph; he who stored grain during the seven years when the Nile exceeded its usual hight; when Osiris came forth with more than wonted vigor and spread beyond the usual cultivated area. The group has three men; the oxen are yoked by the horns, — a mode which is occasionally seen, but not so commonly as the neck-yoke. The plowman is assisted by a driver, and is followed by a man with a hoe, who breaks the clods. In some cases the plowman had a whip or goad, and no driver. Cows were much employed in plowing; men and asses also. Horses. never.

Fig 3822.









Plows of Egypt and Syria.

Another form of the ancient Egyptian plow is shown at *b* in the accompanying cut. The presentation of the share is different, much like our shovel-plow, but instead of connecting the stilts to the beam and having a pair of handles proceeding therefrom, the man grasps a stilt in each hand Reins were not used in plowing in ancient Egypt, but are not uncommon in modern Egypt.

An illustration of the modern Syrian plow (*d*) is given to afford means of comparison. The share and mold-board in this more nearly resemble our form than do those of any other Eastern plow. The drawing is from Kitto. It is probable that his artist has improved on the original

Figure *c* gives views of two yokes and the details of the modern Syrian plow As before stated, it is rather of the shovel-plow order. The goad has a shovel at one end for clearing dirt from the share.

Osiris has the supremacy in all the deifications of ancient Egypt. Who he was that came to be so honored for his usefulness, that scores of centuries only added to his great fame, is now a matter of conjecture. He is represented with the instruments of tillage, and it is a reasonable supposition that he introduced great practical improvements in husbandry among this people of the Nile. As time rolled on, the name came to be transferred to the river itself, and Osiris the benefactor became a god, and the incarnation of the flood whose annual overflow was the life of the land. No flood, no food; let the Nile stay within his banks for a few years, and the granary of the ancient world becomes a desert. Abraham went down there to buy bread; Isaac started for the same place for the same purpose, but put up with Abimelech at Gerar; Jacob and his family were saved alive in Egypt during another drouth, from which even Egypt was not exempt. Year by year, for seven years, to follow the metaphor of the people. Osiris (the Nile) rose in his vigor, and spread himself upon Isis (the cultivated soil), causing her to bring forth abundantly. In the excess of his virility he even embraced Nephthys (the barren ground of the desert adjacent to that cultivated), causing her to yield a fruitage.

"And in the seven plenteous years the earth brought forth by handfuls." Then followed a succession of years during which the overflow was stinted in quantity, and the land, missing its usual top-dressing, refused to repay the toils of the husbandman.

The periodical rise of the Nile commences about the first of June, continues for three months, remains stationary about twelve days, and then as gradually subsides. The rise is greatest in Upper Egypt, and less toward the mouth of the river.

The rise was less at former periods than now. In the time of Mœris, it is said that eight cubits were sufficient; fifteen or sixteen were required in the time of Herodotus, 456 B. C. At the present day eighteen cubits is considered the lowest inundation at Cairo. In the time of Pliny (A. D. 70) twelve cubits were a famine, thirteen scarcity, fifteen safety, sixteen plenty. At the present day eighteen cubits is the lowest, and at this hight the canals are cut, and distribution commences: nineteen cubits are tolerable, twenty adequate, twenty-one excellent, twenty-two abundant, and twenty-four ruinous to the houses and stores which are overflowed thereby. The rise toward the Rosetta and Damietta mouths may be about four feet.

The amount of mud left by the retiring Nile raises the cultivatable soil of Egypt about six inches in a century, at Elephanta. The land at that point has been raised about nine feet in one thousand seven hundred years; at Thebes about seven feet, and less toward the Delta. Many of the sites of antiquity are now buried, together with all kinds of débris lost and forgotten during the scores of centuries the river has rolled north to the Mediterranean, and annually rejuvenated the strip of land between the Eastern and Lybian Deserts The cultivated land is gradually encroaching on the barren margin, except at points where the winds cross the mountain barriers, and bring deluges of sand from the desert. Buildings and monuments originally erected on the barren land outside of cultivation have now a depth of many feet around their bases.

The form of the ancient share is indicated by the words of Isaiah and Micah,

> "Beat your swords into plowshares."

The change would consist in flattening a portion to enable it to throw the soil laterally, and then attaching the hilt to the stock at the most efficient angle. Had the comparison been made in our times, the change of "the sword to a colter" might have been suggested.

While Saul the son of Kish was yet a young king and was the head of a little band in Gilgal, 1093 B. C., the Israelites, who had no smiths, "went down to the Philistines, to sharpen every man his share and his colter, and his axe and his mattock." — 1 Samuel xiii. 20.

But little metal was used in ancient plows, and the statement is also true of those of later date made of the old forms. It is even within the memory of some of us that wooden mold-boards were used. The beasts of draft of old time were oxen and asses, but it was forbidden by the Hebrew law to plow an ox and an ass together. The mode of plowing was to make a second furrow just alongside of the one last made; having no mold-boards they did not throw up in *lands*, as we do. This mode gave its name to the mode of writing in the time of Solon (*boustrophedon*), in allusion to the writing of the lines alternately to the right and left, and left and right, and so on. This was in the transition of the language, when the people were changing from the mode of writing of the Phœnicians, from whom they received their alphabet, — not language, — from right to left, and were by the *boustrophedon* compromise approaching the mode adopted by almost all of their allies of the Aryan race. See Fig 3513, page 1655.

The usual team was a yoke of oxen, but the yoke was also used if other animals were employed. Even the harnessing of horses in Egypt and Mesopotamia was by a yoke. See HARNESS; CHARIOT. A pair of oxen was sufficient for the light implement; and when we read of "Elisha, the son of Shaphat, plowing with twelve yoke before him, and he with the twelfth," we are to understand that twelve teams and plows were in the field

The unit of measurement of farming land was the quantity (*jugerum*) that a yoke (*juger*) of oxen would plow in a day; and we read of a time centuries before the period assigned to Romulus, that Jonathan and his armor-bearer killed "twenty men within as it were half the space which a yoke of oxen might plow" in a day. About one hundred and eighty years after the times of the scrimmage "over against Micmash," we find Hesiod writing about his farm in Bœotia and farming matters in general. These primitive plows must have been peculiarly inefficient in his land, which he describes as "bad in winter, hard in summer, and never good." The enthusiasm about Mount Helicon was and is exotic. Hesiod's recommendation to have an extra plow for use in case of accident seems well placed.

With such a tool it is no wonder the comparison was made in Luke ix. 62, of the worthlessness of the plowman who looked back in the middle of a furrow Hesiod for himself, and Pliny, quoting from "heroic, Stoic Cato the sententious," say, "Never stop in a furrow, but drive right on." The same thing is often said in our own day in laying out lands or running off corn-ground, "Look ahead and do not try to true your furrow by looking back." This is true in fact, and in metaphor, as cited by the recorder, "the beloved physician," and by him of Tarsus, the epistolarian.

Varro mentions the double mold board for ridging, and Pliny the single mold-board for covering the seed It does not appear, however, that the mold-board was common at that time.

"The plowman," says Hesiod, "must be well fed, go naked in summer, rise and go to work very early, have an annual feast, proper rest, and for winter have a coat of kid-skins, worsted socks, and ox-hide boots." A good plowman, in the time of Columella (about A. D. 50), was worth about $300, or the price of eight acres of good land. The interest on money was about six per cent per annum at that time; the rate was fluctuating, and not legally prescribed. A good yield from the land at this time was 21 to 32 bushels of wheat per acre. In Varro's time (50 B. C.) wheat was worth from 32 to 44 cents per bushel. For convenience, the figures are rendered into our currency and measures. In Columella's time, wheat was worth $1 68 per bushel in Rome. Money invested in land yielded about four per cent per annum, and the land was worth twenty-five years' purchase, or twenty-five times its rental.

Agriculture declined from the time of Cato to that of Pliny. The best of the memoranda on husbandry compiled by the latter are from Cato and Varro. It revived in the part of Gaul called Rhætia, where reaping-machines were running in the first century A. D, as recorded by Pliny, and subsequently referred to by Palladius. The latter describes them in his "De Re Rustica," about A D. 350, as driven by oxen and harvesting fields in one day. See REAPING-MACHINE.

From these authors we also find that the Gauls had mold-board plows, with and without wheels; ate good wheaten yeast-raised bread, "lighter," says Pliny, "than we have in Rome"; and this although the Romans dug down the chalk-hill Leucorgeum, between Naples and Puteoli, to get an artificial whitening.

Pliny says (A. D. 79): "Plows are of various kinds. The colter is the iron part that cuts up the dense earth before it is broken into pieces, and traces beforehand by its incisions the future furrows, which the share, reversed, is to open with its teeth Another kind, the common plowshare, is nothing more than a lever furnished with a pointed beak: while another variety, which is used in light, easy soils, does not present an edge projecting from the share-beam throughout, but only a small point at the extremity. In a fourth kind, again, this point is larger and formed with a cutting edge, by the agency of which implement it both cleaves the ground and, with sharp edges at the sides, cuts up the weeds by the roots. There has been invented at a comparatively recent period, in that part of Gaul known as Rhætia, a plow with the addition of two small wheels, and known by the name of 'plaumorati.' The extremity of the share in this has the form of a spade: it is only used, however, for sowing in cultivated lands and upon soils which are nearly fallow. The broader the plowshare, the better it is for turning up the clods of earth."

The action and object of plowing were well understood by the old Romans. As stated in the "Georgics," the purpose is to pulverize the soil, expose it to the atmosphere, and keep down weeds. Stiff soil was plowed four times for wheat; broken in spring, cross-plowed in summer, and twice in September. Richer ground was plowed three times, the earlier September plowing being omitted. Poor ground was only plowed twice for a wheat crop. They understood summer fallowing Deep plowing was recommended.

A day's work in good soil was one *juger*, equal to four fifths of an English acre.

The modern plow with a share and mold-board intended to run in a certain track and lift a furrow-slice, which it upsets against the previous one or completely reversed, seems to have been unknown till quite late times. The improvements of the last hundred years are probably greater than those of the previous thousand, and the tool is regarded as about perfect. Any great advances will now consist in the adaptation of machinery as a motor A number of forms are to be cited presently.

It would seem that until the time of the dearth in Egypt, 1708 - 12 B C, the land was held by proprietors in fee; but under the skillful financiering of Joseph it reverted to the crown, the people thereon going into vassalage also. "Behold." says Joseph, "I have bought you this day and your land for Pharaoh." Thus the nation became changed from freeholders to lease-holders. The king's share was thereafter one fifth of the crop. This was for grain; for wine, the practice in a neighboring country was the reverse. "Thou, O Solomon, must have one thousand, and those that keep the fruit thereof two hundred."

Strabo says that in India the rent was one fourth of the produce. Evidence before committees of the British House of Commons, in 1814 and 1821, showed that the English rent was about the same.

The *hectemorii*, poor Greeks who cultivated the fields of the rich, only received one sixth of the produce before the time of Solon.

The *politor*, or renter of land under the Roman system, received from one fifth to one ninth of the produce; the landlord bearing all expenses, the tenant finding the labor. All on the farm, stock, tools, and seed, belonged to the landlord; the tenant was a workman. The modern system, where the landlord finds tools and fixtures, the tenant everything else, was not generally practiced in early Roman times, although the *coloni*, described by Columella, held under a tenure nearer the modern; but the amount of the landlord's share, being from four fifths to eight ninths of the product, shows the relation of the tenants was a base and slavish one. In most cases the slavery was destitute of even a flimsy pretext, and the peasantry were serfs on the land. Of course the custom of different provinces and of the regions nearer home differed in different times and places.

The food of the Roman farm-servants was according to exposure and kind of work. Those who worked in fetters had four Roman pounds of bread per day in winter, equal to forty-seven ounces avoirdupois; five pounds in summer till the figs came in, when it was reduced to four pounds.

The grade of slaves who were not fettered had one bushel of wheat a month in winter and five pecks in summer.

Wine was allowed at the rate of forty-eight to sixty gallons a year; say a gallon a week. After the vintage, *lora* was used *ad libitum*. This was made by pouring water upon the pressed stalks and skins and re-pressing the cheese. The servants had also rations of olive-oil. The farm-servant also received a coat and a gown three and a half feet long, once in two years. Most of the inhabitants of Europe were serfs down to the sixteenth century. This is true, as to time, of a very large number of the peasantry of England, and the poor-laws of that country perpetuate it to a great extent. Excepting as to Russia, and to parts of Turkey, — the latter might as well be counted out as an anachronism on the face of Europe, — slavery survived longest in Scotland, where it was extinguished within the memory of people yet living. It was succeeded by eviction and deportation, which are no great improvement and are now the order of the day. The Scotch lord has no more bowels than Cato, who recommended to sell old and diseased slaves. The poor-law guardians, lacking a market, pay a bonus for their removal, and call it *emigration*.

In Lombardy the landlord pays taxes and makes repairs; the tenant provides cattle, implements, seed, and labor, and gives one half the produce to the landlord. In the Neapolitan territory the landlord has two thirds the produce. In Ohio and neighboring States the landlord receives one third. In Japan he receives one sixth.

The grain or produce rent, in contradistinction to the cash rent, is the more common mode of tenure throughout the Continent of Europe. In England it is on a cash basis. That country is rapidly drifting into the hands of a few proprietors. Thanks to the much-maligned French Revolution, the land of France is held in small freeholdings. The Hebrew land polity is the best yet.

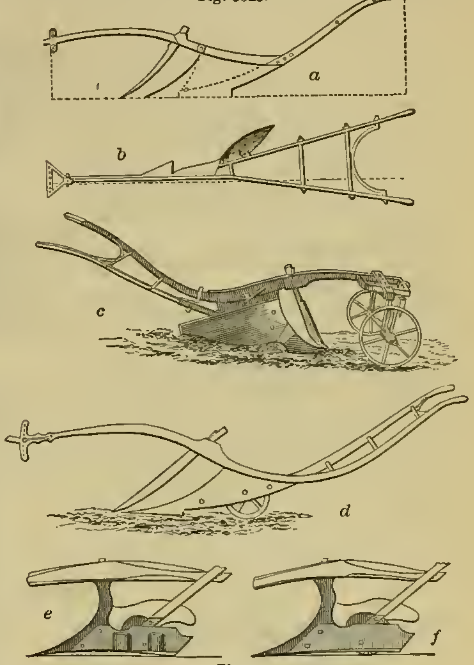
Passing over a long interval, we find that the modern plow originated in the Low Countries, so called. Flanders and Holland gave to England much of her husbandry and gardening knowledge, field, kitchen, and ornamental. Blythe's "Improver Improved," published in 1652, has allusions to the subject. Lummis, in 1720, imported plows from Holland. James Small of Berwickshire, Scotland, made plows and wrote treatises on the subject, 1784. He made cast-iron mold-boards and wrought-iron shares, and introduced the draft-chain. He made shares of cast-iron in 1785. The importation of what is known as the "Rotherham" plow was the immediate cause of the improvement in plows which dates from the middle of the last century. Whether this name is derived from Rotterdam cannot now be determined.

The American plow, during the colonial period, was of wood, the mold-board being covered with sheet-iron or plates made by hammering out old horseshoes. Jefferson studied and wrote on the subject, to determine the proper shape of the mold-board. He treated it as consisting of a lifting and an upsetting wedge, with an easy connecting curve. Newbold of New Jersey, in 1797, patented a plow with a mold-board, share, and landside all cast together. Peacock, in his patent of 1807, cast his plow in three pieces, the point of the colter entering a notch in the breast of the share. Jethro Wood of Scipio, N. Y., patented improvements in 1819, and made the best plows up to date. He met with great opposition and then with much injustice, losing a competence in introducing his plow and fighting infringers. The peculiar merit of his plow consisted in the mode of securing the cast-iron portions together by lugs and locking pieces, doing away with screw-bolts and much weight, complexity, and expense. It was the first plow in which the parts most exposed to wear could be renewed in the field by the substitution of cast pieces.

Plows in Britain are divided into *swing-plows* and *wheel-plows*; the former being without wheels. *a b* in the annexed figure give the appearance in side view and plan of the Wilkie, Scotch, *wheel-plow*; the difference between it and ours is mainly in the greater length of the stilts or handles and the shape of the beam. It is usually made of iron. The mold-board is rather long and twisted, but this may vary with its adaptation to sod or stubble. A plow like that made by Gibbs of Canton, Ohio, will do either well. His mold-board is of such a shape that it may be molded on a cylindrical former.

The Scotch *wheel-plow c* has a forward carriage to regulate the depth of furrow, one wheel running on the land and the other in the furrow. They seem generally to have that wedge-formed, convex shape to the front portion of the mold-board, which with their long handles constitutes their most peculiar feature in our eyes. The long handles give the plowman great command, and if he were to ride on the handles as we do on ours in going over a cradle-knoll he would throw the share clean out of the ground. They will not be in favor except in countries long subdued to cultivation, as they take so much room to turn. We like a short plow, and hitch the team as close to the work as possible. This matter of hitching close was well illustrated during the late war. The old rambling way of hitching up a six-mule team with six feet distance between the pairs was discarded, and their traces and fifth chains were shortened in, so that they could almost browse upon the tails of the span in advance, — as they did in fact. The old stiff tongue fourteen feet long, and the spans hitched up two or three paces apart, remind one of the practice not yet quite exploded in England, of hitching three horses, tandem fashion, to a plow, which was universal till Dawson of Frogden, Scotland, about 1770, showed how to place them abreast, for which the British farmers owe him a debt of gratitude, and after trying it fifty years to make sure it was all right, are prepared to pay on demand.

Fig. 3823.



Plows.

At the latter end of the eighteenth century, the level lands of Herefordshire and Radnorshire, Great Britain, were turned by plows which were rigged with wheels to obviate the necessity of a plowman. As usual at that time, the horses were hitched tandem, one ahead of the other, to the extent of three or four. A publication of that day (Housman's Travels, 1799) compares it with the superior husbandry of Norfolk, where horses were hitched abreast. The same writer states as follows: —

"I to-day observed a farmer sowing wheat near Abergavenny; a yoke of eight oxen were drawing one plow, attended by two men, one to drive the cattle and the other to manage the plow. Another yoke of eight oxen were drove up and down the ridges after plowing, in order to sodden or compress the earth, — an unnecessary operation. The farmer valued these oxen at £11 each, one with another. Their motion was extremely slow, and consequently little work was done in a day. In the same field, one man was sowing wheat and another harrowing with three horses, while the master sat on horseback directing the several operations of this posse."

Hitching horses by the tails to plows, harrows, and other implements was forbidden in Ireland by law in 1634. See HARROW.

In the United States we generally prefer a plow without a wheel, in England called a *swing*-plow. If this be rightly constructed and adjusted, and the team be properly hitched and even-pulling, the plow will keep a level sole and throw an even furrow in level ground, requiring merely casual assistance from the plowman The writer has used swing-plows in Ohio in clover sod, going round and round the field or the *land*, and no person touching the plows except to turn them at the corners. To those not familiar with the practice, it will be well to state, that in plowing sod the whole field is frequently thrown into one land. The Ohio plow is generally left-handed, that is, throws the furrow to the left; the near horse walks in the furrow, and the team is turned "gee" at the corners, 90° if it be a rectangular field.

After numerous careful trials of implements by the Agricultural Society of England, the committee determined that the wheeled plows had the advantage in point of lightness of draft, the difference amounting to from 10 to 20 per cent

Plows with anti-friction wheels behind the shares were invented almost simultaneously in England and Scotland, 1813-15. Wilkie's (Scotch) plow *d* of this class was invented in 1825. The wheel is journaled to run in the interval between the mold-board and landside, and answers in place of a sole, lessening the friction to a considerable extent. Wilkie's first plows of this description had a wheel whose flat rim ran upon the bottom of the furrow. In the one illustrated (Fig. 3823), the wheel has an inclination of 30°, and follows in the angle made by the colter and share, which is found to ensure greater steadiness.

The gain in draft on some plows by addition of the wheel has been proved by the dynamometer to be from 20 to 50 per cent. Much depends upon the construction and condition of the plow and the nature of the soil.

e f are two forms of the Green plow, one having a flat roller in the sole, and the other having also rollers journaled in the landside.

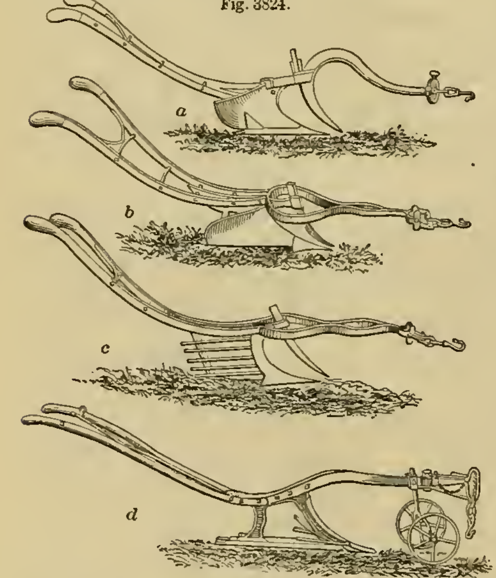
Plows with beams curved or divided to avoid catching stubble have been common in Britain for many years.

One of Finlayson's *rid-plows* (*a*, Fig. 3824) is made with a beam arched in front of the colter so as to avoid the lodgment of weeds or stubble in the angle usually formed at that point.

Another (*b*) has a beam bowed around the colter, so that the latter stands on a projecting piece, allowing any stubble to slide up and fall over without accumulating to such an extent as to interfere with the turning of the furrow.

Finlayson's *skeleton-plow* (*c*) is adapted for extremely tenacious soils, to lessen the friction of the furrow-slice upon the mold board. It was designed to suit the soil of Kent County, England, and only expose one third the usual surface to friction.

Fig. 3824.

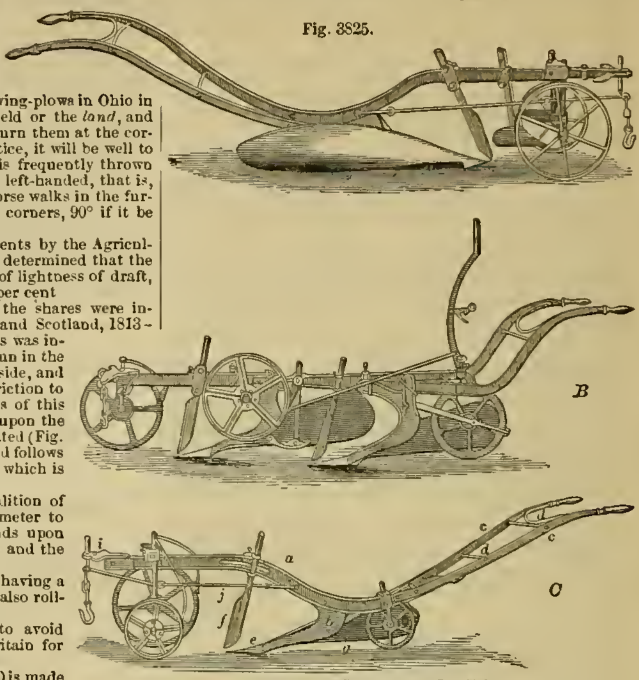


Plows.

Stothard (English) perforates the mold-board to reduce its frictional area in tenacious soils.

d is a potato-plow, having a share to pass below the tubers in the hill, and divergent arms to raise the soil and so scatter it that the tubers may be scrabbled to the top, separated, and left lying upon the surface.

Fig. 3825.



Hornsby's Wheel-Plows (English).

Fig 3825 is a view of three Hornsby's (English) prize plows. *A* is the champion model, having a small precedent share to turn over the stubble, a colter, and a share with a wing; the share gradually merges into a long, peculiarly shaped mold-board, which is convex and then concave, — a form not common with us. Of the pair of wheels, one runs in a furrow, the other on the land. The stilts are long, and great command over the plow is obtained by the leverage. The jointed draft-rod passes through an eye-bolt dependent from the nose of the beam, thence to the carriage of the wheels, and is bolted to the sheth of the plow at a point above the midlength of the mold-board.

B is a *double-furrow* plow; it has two plows stocked to a triangular beam. It has a gage-wheel forward, which runs on the land, and an anti-friction wheel which acts as the sole of the rear plow. The middle wheel is the turning-wheel. which runs clear of the soil in the space behind the forward plow, being only brought into action when the plow is to be turned at the corner of a *land*. When this is to be done, the lever, which is shown standing vertically, is depressed to the rear, throwing down the turning-wheel into the furrow of the forward plow, raising the plow from the ground, and constituting the middle wheel a pivot on which the plow may be swung round, as on an axis, turning in its whole length. The plow may also travel to and from its work on this wheel. The depth of furrow is regulated by the hind wheel and the gage-wheel. The width of furrow is regulated by sliding the hind plow-body on the frame of the implement.

The plow *C* is like the former in many points of construction, but has a single body. Its adjustment for depth of furrow is by the hind wheel.

The essential elements of a plow, in its primitive and in its varied modern forms, are, — a *share* to stir the ground: a *beam* by which it is drawn; and a *handle* or *handles* by which it is guided.

The modern plow has (1.) a wooden or iron frame or *stock*, to which the operative parts are attached, by which it is drawn through the ground, and to which the guiding handles are attached. The parts composing the stock are, —

The *beam*.
The *sheth*, *standard*, or *post*.
The *handles* or *stilts*.
The *rounds*.

2. The operative parts are of metal, and consist of, —

The steel *share*, by which the bottom of the furrow is cut and the furrow slice raised.

The steel *colter*, by which the furrow-slice is severed from the land or unplowed portion.

The *mold-board*, by which the furrow slice is turned over.

The *landside*, seen in some of the figures but absent in others, which presses against the unplowed ground and serves to steady the plow.

3. The other attachments of the plow are, —

The *clevis*, for the attachment of the draft

The *draft-rod*, extending from the *clevis* to the *sheth.*

Many modifications are found.

The *colter* is sometimes a wing from the upper forward edge of the *mold board;* or it is a cutting-wheel in advance.

The *draft-rod* is not universal, but adds to the strength of the implement.

The *mold-board* was, as its name indicates, formerly of wood. It was first made of iron by Small of Berwickshire, Scotland, about 1764.

The chilled cast-iron plowshare was patented by Ransome of Ipswich, England, 1803. The under side and points are hardened, and the top wears away, leaving a comparatively thin edge of hard, chilled iron. This is an imitation of the provision of nature, whereby the teeth of the rodentiæ are kept sharp, the external enamel keeping in advance of the softer parts which are sloped away from the cutting edge.

The points to be aimed at in the construction and management of a plow are as follows: —

A sharp, clean tapering form to the part which divides the soil.

A shape to the mold-board calculated to raise and turn the furrow-slice with as little friction as may be.

The beam and clevis should be so contrived that the team may be advantageously hitched in the line of draft Especial care is necessary when four or more horses are hitched, so that the draft of all may coincide.

The line of draft should be at right angles to the horses' shoulders, from whence it should pass through the middle hole of the clevis at the point of the beam.

The landside should be a plane, and parallel to the line of draft.

The colter should have an angular presentation of 45°.

The fin rising from the forward edge of the share, and acting in lieu of a colter, originated in Scotland.

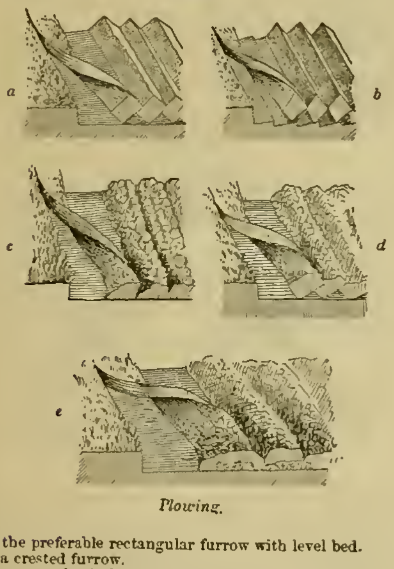
The cutting-wheel as a substitute for the colter is found in English paring-plows of many years back.

The depth and width of the furrow should be as 2 to 3.

The furrow slice should be laid over at an angle of 45°.

Fig. 3826 represents different modes of turning furrows adopted in various soils.

Fig. 3826.



Plowing.

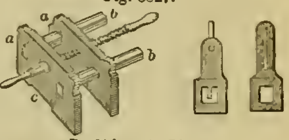
a is the preferable rectangular furrow with level bed.
b is a crested furrow.
c has a completely inverted furrow-slice.
d shows ordinary plowing, the furrow-slice broken.
e is extra wide plowing with broken furrow.

Gang-plows are now used in some of the Western States, also to a large extent in England. They are simply four, six, or eight plowshares fastened to a stout frame. In California, on the lighter soils, eight horses draw a seven-gang plow, and one such team is counted on to put in six hundred and forty acres of wheat in the sowing season; or from eight to ten acres per day. A seed-sower is fastened in front of the plow. It scatters the seed, the plows cover it, and the work is done. The plow has no handles, and the plowman is, in fact, only a driver; he guides the team; the plows do their own work. It is a striking sight to see ten eight-horse teams following one another, over a vast plain, cutting "lands" a mile long, and when all have passed, leaving a track forty feet wide, of plowed ground. On the heavier soils, the process is somewhat different. An eight-horse team moves a four-gang plow, and gets over about six acres per day. The seed is then sown by a machine which scatters it forty feet, and sows from seventy-five to one hundred acres in a day, and the ground is then harrowed and cross-harrowed. When the farmer in this valley has done his winter sowing, he turns his teams and men into other ground, which he is to summer fallow. This he can do from the first of March to the middle of May; and by it he secures a remunerative crop for the following year, even though the season be dry. See GANG-PLOW.

2. (*Wood-working.*) A grooving-plane in which the adjustable fence is secured to two transverse stems which pass through the stock of the plane, and are secured by wedges or screws. It is fitted with eight irons of various sizes, and is used in making grooves in door-stiles to receive the panel, and for similar purposes. See PLANE.

3. (*Bookbinding.*) An implement for shaving off the edges of books and squares of boards. It consists of two cheeks *a a* connected together by two guides *b b*, and a screw passing through both cheeks. In one of the cheeks, at *c*, is fixed a cutting-blade. The book to be plowed is inserted between two boards in a press, the edges of the sheets projecting sufficiently, and one of the cheeks placed in a groove in the press, which serves to guide its motion. The plow is moved back and forth, and the cheek carrying the cutter advanced toward the other by turning the screw, cutting a longitudinal strip from the edge of the book at each forward motion until its whole surface has been planed off.

Fig. 3827.



Bookbinder's Plow.

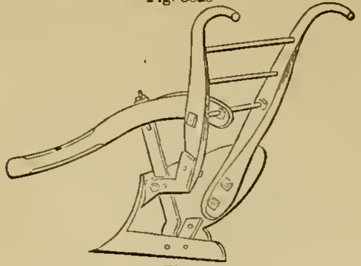
4. (*Weaving.*) An instrument for cutting the flushing parts of the pile or nap of fustian.

See under the following heads: —

Bar-share plow.
Binot.
Bog-cutting plow.
Breast-plow.
Carpenters' plow.
Corn-plow.
Cultivator-plow.
Diamond-plow.
Ditching-plow.
Double plow.
Double mold-board plow.
Double-shovel plow.
Down-share plow.
Draining-plow.
Expanding-plow.
Furrowing-plow.
Gang-plow.
Garden-plow.
Hillside-plow.
Hoe-plow.
Ice-plow.
Jumper-plow.
Marking-plow.
Mole-plow.
Paring-plow.
Prairie-plow.
Railroad-plow.
Reversible plow.
Ridging-plow.
Rotary plow.
Seeding-plow.
Shim.
Shovel-plow.
Side-hill plow.
Single shovel plow.
Skeleton-plow.
Skim-colter plow.
Snow-plow.
Sod-plow.
Steam-plow.
Straddle-plow.
Sub-oil-plow.
Sulky-plow.
Swing mold-board plow.
Swing-plow.
Tile laying-in plow.
Treble-shovel plow.
Turn-wrest plow.
Wheel-plow.

Plow-beam. That portion of the frame *A* to which the standard is attached and to whose forward end the draft is applied.

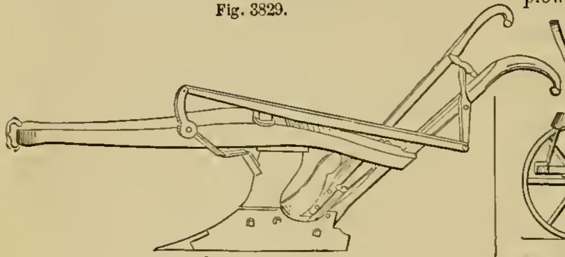
Fig. 3828



Plow.

Plow-clean'er. A long-handled thrusting implement by which the plowman may rid the plow of choking weeds, or the share of accumulated soil.

Fig. 3829.

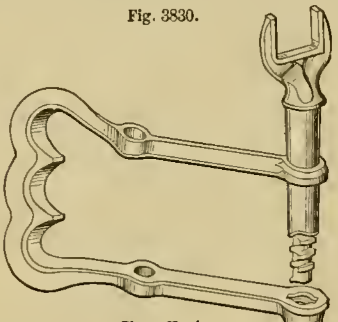


Plow-Cleaner.

Or, a vibrating clearer pivoted to the beam and operated by a handle to remove weeds from the front of the sheth.

Plow-cle'vis. The stirrup-shaped piece on the nose of a plow-beam, having three loops, in either of which the open ring of the double-tree may be placed, according to the depth of furrow desired.

Fig. 3830.



Plow-Clevis.

Plow-head. The *clevis* of a plow. That part to which the draft is attached. The *muzzle* or *bridle*. The latter are names by which the clevis is known in Britain.

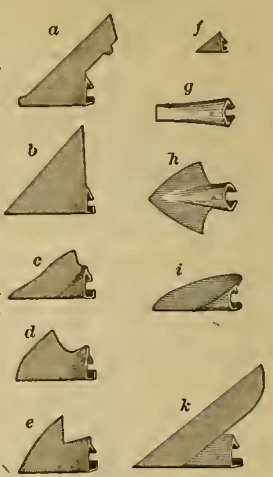
Plow-point. A detachable share at the extreme front end of the plow-body, forming an apex to the junction of the mold-board, sole, and landside.

Plow'share. (*Agriculture.*) *a.* The portion of a plow which cuts the slice loose below. The *colter* makes the vertical cut severing the slice from the *land.* The *mold*-board raises the slice and turns it over on edge. See Fig. 3831.

b. A triangular or heart-shaped blade on a shovel-plow to turn the earth over; and used in tending crops to throw the earth up to the stems of the plants. See Shovel-plow.

c. One of the blades of a Cultivator (which see).

Fig. 3831.



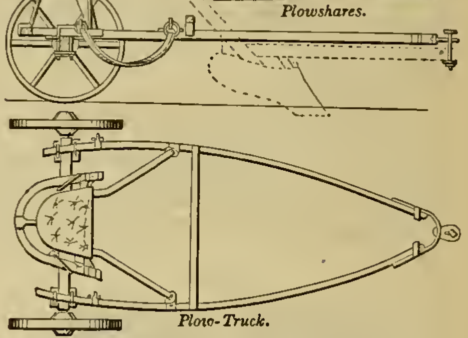
Plowshares.

Fig. 3831 illustrates varieties of plowshares suited for different kinds of work.

a, for wide work.
b, for deep work.
c, for stony land.
d, for crested work.
e, for square work.
f, skim-coulter.
g, for subsoiling.
h, for ridging.
i, for setting out.
k, for paring.

Plow-truck. A riding attachment to a plow.

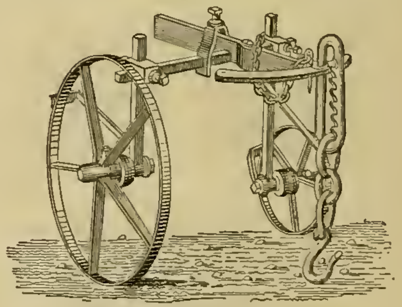
Fig. 3832.



Plow-Truck.

Plow-wheel. A wheel on the head end of a plow to limit the penetration of its share. In the illustration (an English pattern), one wheel runs on the *land* and the larger one in the *furrow.*

Fig. 3833.



Plow-Wheel.

Pluck. A two-pronged dung-drag.

Pluck'er. (*Worsted Manufacture.*) A machine for straightening and cleaning long wool, to render it fit for *combing.* It has a traveling feed-apron which, as it advances, delivers the ends of the long tufts to a pair of spiked rollers, which open the tufts and locks; it is thence introduced into a fanning apparatus whereby the wool is cleaned.

Plug. 1. (*Building.*) A block of wood let into a wall of brick or masonry, to afford a hold for nails in fixing the interior finishing.

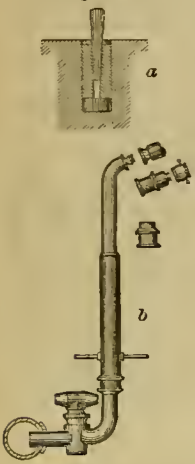
2. (*Nautical.*) *a.* A conical piece of wood used to stop the hawse-holes when the cables are unbent. *b.* A block to stop a hole made by a cannon-ball in a ship.

c. A stopper for the hole in a boat-bottom.

3. (*Steam-boiler.*) A stopper of metal which is placed in a steam-boiler or a pipe in communication therewith, and which melts at a certain temperature, so as to establish an exit from the boiler when the temperature and consequent pressure become dangerous. See Fusible Plug; High-pressure Alarm.

4. (*Die-sinking.*) A cylindrical piece of soft steel, whose end is turned to fit into a *matrix.* The indented (*intaglio*) design of the matrix is transferred to the end of the plug when the two are pressed forcibly together. The *plug* having the design in relief (*cameo*) is then hardened and becomes a *punch*, which is used to impress the faces of *dies* for *coining.* See Matrix; Die.

Fig. 3834.



Fire-Plug.

5. (*Stone-working.*) The plugs are inverted wedges with round backs placed in a hole which has been *jumped* in a rock; a *feather* or tapered wedge, being driven between the plugs, rends the rock. (*a*, Fig. 3834.)

6. (*Masonry.*) A dowel or cramp.

7. (*Railway.*) A wedge-pin driven between a rail and its chair.

8. (*Hydraulics.*) A *branch pipe b* leading from the *main* below the pavement and terminating at a point readily reached for the attachment of *hose.* This pipe is closed by a *cap* or *plug*, which is removed by a *spanner* when the hose is to be attached by its coupling to the thread on the pipe. A stop-cock on the branch pipe is reached by a turn-key introduced at an opening in the pavement.

Fire-plugs were first laid down in London in 1710. London was first supplied with water by leaden pipes in 1237. The water was brought from the Springs of Tyburn, a district long since included in the city, — not the city proper, but the metropolis as outsiders understand it. In 1613 Sir Hugh Middleton finished his aqueduct from Ware to London. This is yet called "the New River," and discharges into a reservoir at Islington, a northern suburb of London. The water was distributed by wooden mains and lead-pipe branches. Water-carriers still plied their trade in the reign of Queen Anne, supplying households from the public pumps, which were and are yet numerous, and yield abundant and excellent water.

9. (*Ordnance.*) The wooden stopper in the vent of a petard.

10. *a.* A small tompion in the muzzle of a musket-barrel.

b. The nipple of a gun.

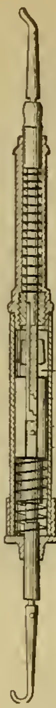
11. (*Dentistry.*) A filling for a carious tooth.

Plug-cen'ter Bit. A bit having a cylinder instead of a point, so as to fit within the hole around which a countersink or enlargement is to be made.

Plug'ger. (*Dentistry.*) A dentist's instrument for driving and packing a filling material into an excavated hole in a carious tooth. They are of various forms, — hook, curved, or straight; with square, pointed, circular, edged, rounded ends; and with star, serrated, file-marked, and other terminations.

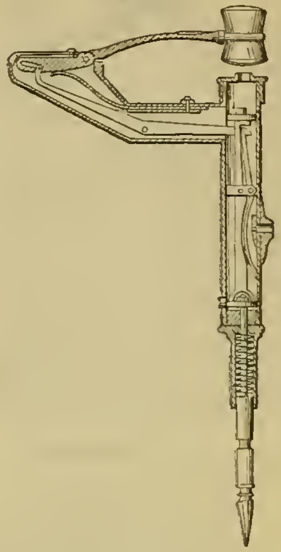
Some of the tools are pushed by the hand; others are driven, like a punch, with a mallet; a third form is automatic, and the pressure on the filling brings the mallet into operation. See Dental Hammer.

Fig. 3835.



Dental Plugger.

Fig. 3836.



Dental Hammer.

In Fig. 3835, the plugger has a pushing tool at one end and a hook-shaped pulling tool at the other, each operated upon by a hammer subject to the action of a spiral spring and other mechanism inclosed within the case.

In Fig. 3836, the pressure of the plugger upon the gold in the cavity of the tooth gives movement to a vibrating hammer which strikes upon the extremity of the plugger. The intermission of the pressure permits the extension of the spring and raises the hammer.

The *electric mallet* is an automatic dental instrument for condensing the filling or plug in a tooth by a rapid succession of strokes imparted by means of electro-magnetism. The peculiar mechanism consists of a magnet or magnets, a pulsating armature, and a retracting spring with positive and negative wires and an automatic circuit-breaker. The magnet or magnets are arranged in the handle, and an armature vibrates in a case behind the bit.

The action of the armature makes and breaks the circuit. In one form, the plugger, being fast to the coils, partakes of the jar imparted to the plunger. In another form, the plunger has a sliding motion when struck by the armature hammer, and does not involve the coils in the jar of the blow.

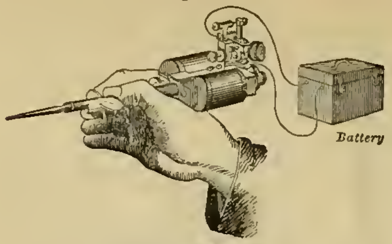
In still another form, the armature is fixed, and the magnet, in modified form, vibrates within the case and delivers the stroke. The electric attraction in each case imparts the effective stroke. The wires incased in insulating material enter the handle end of the instrument, and by their flexibility permit its manipulation by the operator, who has simply to hold the bit in proper positions until the operation is completed.

The application of this instrument in larger size to stone-cutting and other work has been proposed.

Green's electro magnetic mallet, manufactured by S S White of Philadelphia, for packing and condensing gold in filling teeth, strikes direct and very rapid blows, perfectly adjustable as to force, and either continuous or dependent upon *touch:* the blow being given when the point of the plugger is pressed upon the filling, and ceasing when the pressure is removed.

Among the ancients some success was obtained in the art of dentistry. Cassellius was a dentist in the reign of the Roman triumvirs, and gold was used for the filling. Nearly 500 B. C. gold was thus used, and gold wire was employed to hold artificial teeth in position. A fragment of the tenth of the Roman tables,

Fig. 3837.



Green's Electro-Magnetic Mallet.

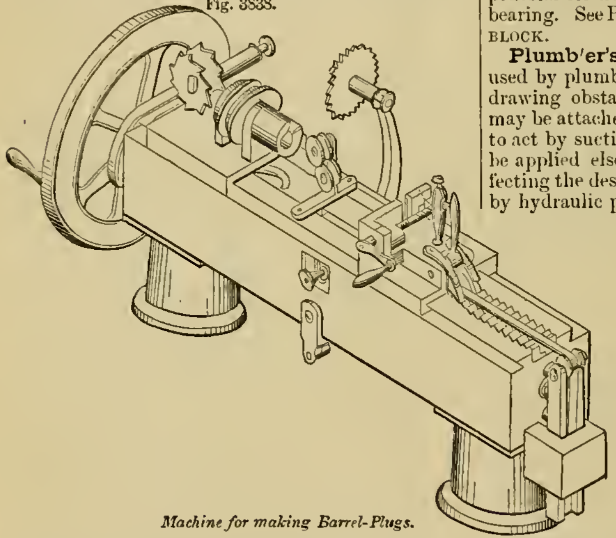
450 B. C., has reference to preventing the burial of any gold with the dead except that bound around the teeth. Herodotus declares that the Egyptians had a knowledge of the diseases of teeth and their treatment 2000 B. C. In Martial, Casselius is mentioned as either filling or extracting teeth

Plug'ging. Pins driven into the joints of brick or stone walls to receive the nails whereby battens are fastened to the walls.

Plug'ging-for'ceps. A dentist's instrument used in compressing a filling into an excavated hole in a carious tooth.

Plug-ma-chine'. A machine for making wooden plugs for faucet-holes of beer and wine barrels. The stuff is clamped in a frame moved up by the sliding ratchet which acts upon a pawl. A similar pawl-and-ratchet holds the "feed" gained. A hollow, reciprocating revolving cutter shapes the plugs. An automatically descending saw severs them. At the rear of the cutter are two saws for tenoning the plugs. A lever raises the pawls on the clutch-frame to allow of its retraction.

Fig. 3838.



Machine for making Barrel-Plugs.

Plug-rod. (*Steam-engine.*) *a.* A rod attached to the working-beam of a condensing-engine, for the purpose of driving the working-gear of the valves. Sometimes called the *plug-tree.*

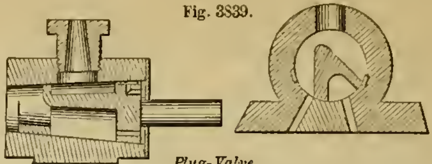
b. The air-pump rod.

Plug-tap. A *master* tap. A cylindrical tap for cutting the dies of a screw-stock.

Plug-valve. A tapering valve fitting into a seat like a faucet.

Plumb. A line with a suspended plummet to prove the perpendicularity of work.

Fig. 3839.



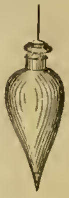
Plug-Valve.

Plum-ba'go. A non-pertinent name for *graphite.* This name and that of *black-lead* were given to it under the supposition that *plumbum* (lead) was its base. This turns out to be a mistake, as it is a form of carbon, and does not of necessity contain even iron, though a trace of the latter metal is often found in it. Samples of Ceylon *plumbago* are shown containing 98.55 pure carbon. See GRAPHITE.

Plumbago was formerly a monopoly in the Cumberland mines, but the mines of Russia, Ceylon, Ticonderoga, Greenland, California, Spain, and Bohemia have fortunately arrested imposition. See PENCIL.

Plumb-bob. A conoidally shaped piece of metal suspended by a cord attached to its upper end, and used for determining vertical, or, in connection with a level or straight edge, horizontal lines. It is indispensable in building operations, and is also employed by surveyors and astronomers for placing an instrument centrally over a station point of departure.

Fig. 3840.

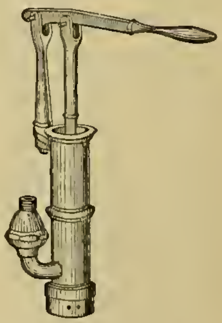


Plumb-Bob.

Plumb'er-block. A pair of jaws or a pedestal for holding the brasses of a shaft bearing. See PILLOW-BLOCK and PLUMMER-BLOCK.

Plumb'er's Force-pump. A pump used by plumbers for testing pipe or withdrawing obstacles from a gorged pipe. It may be attached to the delivery end of the pipe so as to act by suction, or may be applied elsewhere, effecting the desired object by hydraulic pressure.

Fig 3841.



Plumber's Force-Pump.

Plumb'er's Sol'der. See SOLDER.

Plumb'ing and Sheet-met'al Work and Tools. See: —

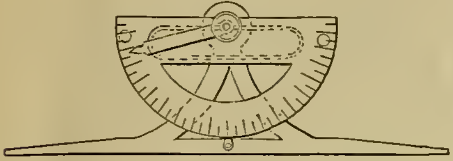
Autogeneous soldering.
Bat.
Beak-iron.
Blocking-down.
Came.
Copper-bit.
Creasing-tool.
Die.
Dinged work.
Double-seaming machine.
Dutch clinker.
Dutch tile.
Eave-trough.
Flagging.
Flashing.
Flux.
Fret-work.
Grozing-iron.
Latterkin.
Planishing-hammer.
Punch.
Raising.
Raising-hammer.
Riveting.
Riveting-set.
Seaming-tool.
Seam-set.
Share-hook.
Shears.
Sheet-metal press.
Snarling-iron.
Snip.
Solder.
Soldering-apparatus.
Soldering-furnace.
Soldering-iron.
Soldering-tool.
Spinning-metal.
Stake.
Striking-up press.
Teest.
Tin-scrap. Utilizing

Plumb-joint. A sheet-metal lap-joint in which the edges of the piece are simply laid over each other and secured by solder, without bending or *seaming*. A *lap*-joint soldered.

Plumb-lev'el. A level in which the horizontality of the base is determined by a suspended line with a plumb-bob. See LEVEL.

In the example, a plumb-level and protractor are combined in one. The base is a plane. The protractor swings by an axis coincident with its center, and a point on the base determines, in connection with the graduation of the protractor, the inclination of the object on which the base is placed. The index-finger is movable by its thumb-screw.

Fig. 3842.



Plumb-Level.

Plumb-line. The cord by which a plumb-bob is suspended.

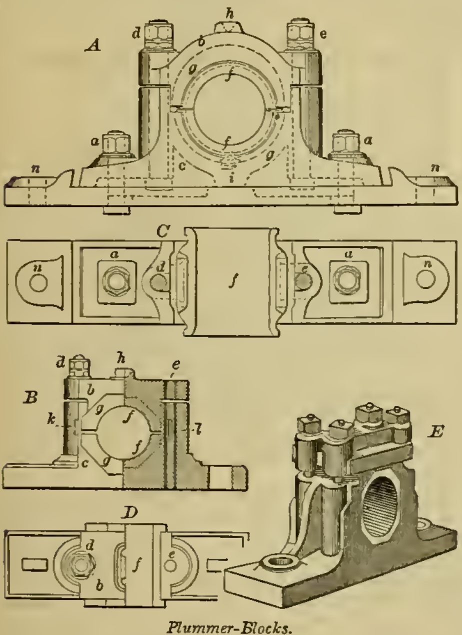
Plumb-rule. A narrow board with a plumb-line.

Plu-me'ta. (*Fabric.*) A Spanish woolen cloth.

Plum'mer-block. (*Machinery.*) An adjustable bearing for journals.

A B, Fig. 3843, are elevations (the latter partly in section) and *C D* plans of two plummer-blocks. That shown at *A C* is secured to a bed-plate *n* by screw bolts and nuts *a a*, the two parts *b c* of the block, when in position, being united by the screw-bolts *d e*, by means of which they may be approached toward each other to compensate for wear of the soft metal lining *f*. This is composed of brass, Babbitt metal, or other composition inclosed within the hard metal casing *g*, which fits into a cavity in each of the parts *b c*, and is adjusted or removed by means of the screws *h i*. The bed-plate is made fast by bolts at *n n*. The general arrangements of the blocks *C D* are identical with those above described, but the lower half is fastened directly to its support by square bolt and nut or bolt and key connection; the bolts uniting the upper and lower halves are also keyed at *k l*. *E* shows a plummer-block in perspective. See JOURNAL-BOX.

Fig 3843.



Plummer-Blocks.

Plum'met. 1. A pencil of solid lead.

2. A plug of lead for sounding. See SOUNDING.

3. A ball of lead for a plumb-line. An ordinary and simple device for uprighting a structure, a post, or what not.

The plummet is said by Pliny to have been invented by Dædalus, 1240 B. C. The vast edifices of the plains of Shinar and the Nile, not to mention the monuments of the more eastern civilization, contradict the statement of the Roman. It is, however, interesting to know the received opinion of the *literati* of 1800 years ago, and to this historian we are indebted for many details which appear to have been omitted as unimportant by contemporary writers. It is mentioned by Amos, 787 B. C., and by another Scripture author, 698 B. C.

Plum'met-lev'el. That form of a level having a suspended plummet in a standard at right angles to the base-piece. A *mason's* level. See LEVEL.

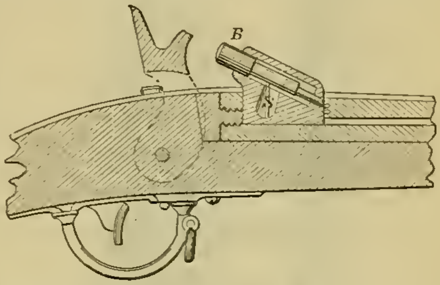
Plun'ger. 1. A long solid cylinder employed as a piston in a force-pump. See PLUNGER-PUMP.

2. (*Pottery.*) A boiler in which clay is beaten by a wheel into a creamy consistence. From this it passes to an *ark*, thence through sieves which remove nodules. The result is *slip*.

3. A form of striker used in some breech-loading fire-arms. A firing-pin.

The plunger *B* has a retaining spring *S* in the hinged block of the breech-loader. The spring is contained in a hole extending from the under side of the breech-block to the aperture in which the plunger works.

Fig. 3844.



Plunger or Firing-Pin.

Plun'ger-buck'et. One without valve. See PLUNGER-PUMP, *E F*, Fig. 3845.

Plun'ger-pole. A hollow pump-rod of a CORNISH STEAM-ENGINE (which see). See also *G*, Fig. 3845.

Plun'ger-pump. One having a solid piston (*plunger*) which acts by displacement of the water in the barrel, in contradistinction to a bucket-pump which has a hollow piston (*bucket*) through which the water passes during the down stroke, to be lifted when the bucket rises.

A is one form of plunger-pump adapted for mines. The delivery-valve *b* is placed on top of the suction-valve *c*, which has a branch to the barrel *e* of the pump. The plunger-pole *a* is cased with a cast-iron pipe turned true and draw-filed, and works through a stuffing-box on top of the barrel.

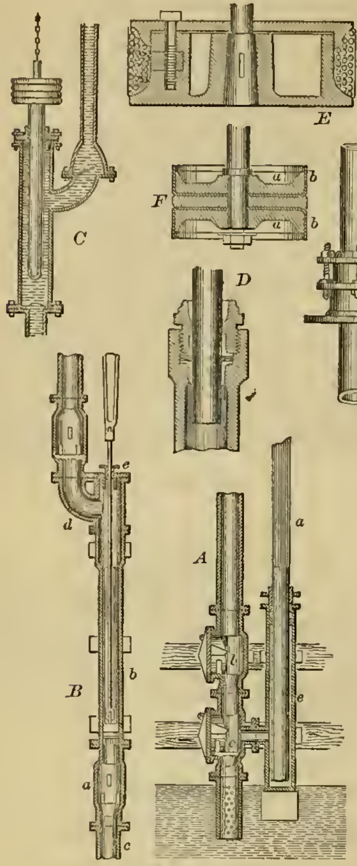
B is a jack-head lift-pump introduced for the purpose of illustrating the distinction between *lift* and *plunger* pumps. It is also a form of mining-pump.

The working-bucket is packed with leather, which is secured to the body of the bucket by a brass ring. The suction-chamber *a* is bolted directly to the lower end of the working-barrel *b*, and has a suction-pipe *c* and windbore bolted to its lower flange. The *gooseneck d* (in which consists the peculiarity of the jack-head) is bolted to the top of the barrel, and has a bonnet and stuffing-box *e* through which the bucket-rod passes. The upper clack sits on the branch of the gooseneck, with the column bolted on its upper flange. The clack-chambers have doors through which the clacks are removed for repairs. A door is sometimes made in the gooseneck, through which the working bucket may be taken out without taking off the bonnet from the top Jack-head pumps are best adapted for lifting water from a cistern or a permanent *sump*, although they are very commonly used in sinking See MINING-PUMP; LIFT-PUMP; FORCE-PUMP, etc. See also list under PUMP.

C shows a pump with a loaded plunger.

D shows a piston fitting in the top of a pump-cylinder. The

Fig. 3845.



Mining-Pumps.

gland is screwed down upon the packing, which consists of two leather rings and one of metal.

E F are two plunger-pistons; one is represented as cast cylindrical, having a cap-plate screwed on to the bottom part.

Another is made up of circular disks *a* clamping rings of leather *b*.

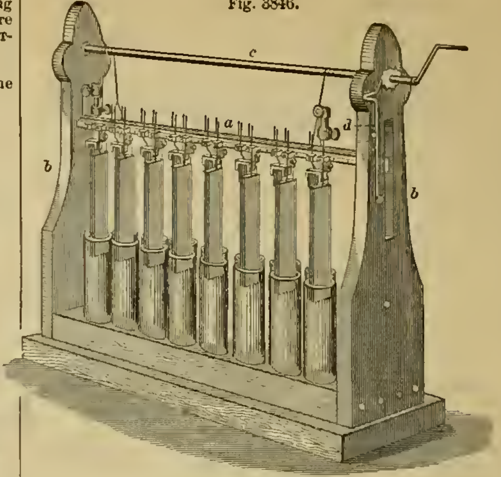
G is a portion of a plunger-pole, showing the coupling of sections.

Plun′ging-bat′ter-y. (*Electro-magnetism.*) A battery so arranged that the plates may be readily lowered into their cells, or raised therefrom when not required for use. In the arrangement (Fig. 3846), this is effected by attaching all the sets of the series to a horizontal bar *a* working in slots in the standards *b b*, and supported by cords attached to the shaft *c* provided with a crank, and a ratchet-wheel, which engages with a spring-pawl *d*, so that the plates may be held clear of the fluid in the cups or immersed therein to any desired depth.

Plun′ging-fire. (*Gunnery.*) Shot fired at an angle of depression below point-blank.

Plush. (*Fabric.*) A shaggy pile-cloth of various materials. *Shag.* An unshorn velvet of cotton, silk, or mixed fiber. Sometimes of a silk nap and cotton back. It has two warps, one of which is brought to the surface to make the nap. The warp is gathered in loops by wire, and cut in the manner of velvet.

Fig. 3846.



Plunging-Battery.

It is composed regularly of a woof of a single woolen thread and a double warp; the one wool of two threads twisted, the other goat's or camel's hair. Some imitation *plushes* are made of other materials.

> "Put on my new, fine, coloured cloth suit, with my cloak lined with plush, which is a dear and noble suit, costing me about £17." — PEPYS'S *Diary*, October 26, 1664.

Plush-cop′per. (*Mining.*) A miner's name for *chalcotrichite*, a fibrous variety of red copper-ore, which occurs in reticulated capillary crystals of red color.

Plu′vi-am′e-ter. A RAIN-GAGE (which see).

Ply. 1. (*Fiber.*) A fold, twist, or plait.

a. A strand in a rope.

b. A thickness or fold in a carpet.

2. (*Nautical.*) To work against the wind.

Ply′ers. 1. (*Mechanics.*) A kind of balance used in raising or letting down a drawbridge.

2. A form of grasping tool. A small pinchers. See PLIERS.

Pneu-mat′ic Bat′ter-y. A contrivance invented by Mr. Taylor of Dublin for exploding a blasting-charge in mining operations. A priming of mingled white sugar and chlorate of potash is placed over the charge, and connected by a siphon tube with a vessel containing sulphuric acid; another tube connects this vessel with an air-pump placed at a convenient distance for the safety of the operator. On working the pump, a blast of air is forced through the tube, carrying with it a portion of the sulphuric acid, which inflames the chlorate mixture, igniting the gunpowder.

Pneu-mat′ic Cais′son. One which is closed at top and sunk by the exhaustion of the air within or by the weight of the masonry built thereupon as the work progresses. Such caissons are necessarily provided with air-locks to prevent the escape of the air, which is forced in at a pressure equal to that due to the water pressure at the depth to which the caisson may be sunk.

Those used by Captain J. B. Eads for the piers of the St. Louis bridge had central shafts 10 feet in diameter, around which the masonry was laid as the caisson descended. The shafts were open at top, and had but a single air-lock, which was at the bottom. See AIR-LOCK; CAISSON.

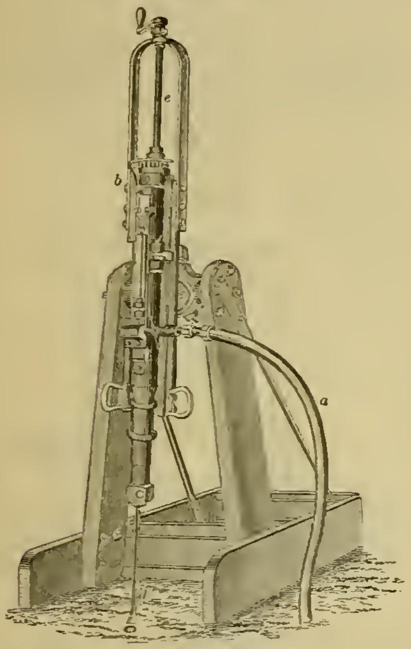
Pneu-mat′ic Car. A car driven by compressed air contained in reservoirs, which are filled by means of air-pumps. This application of compressed air is important as affording a means of dispensing with animal power on street railroads, and has been applied in practice with a certain degree of success. The cars employed in Chicago have four hollow tanks between the ceiling and roof, having a capacity of 150 cubic feet. The air is condensed to a pressure of 260 pounds to the inch, and drives two small engines, one on each side, at one end of the car. These are controlled by means of a wheel adjacent to the brake-wheel and immediately under the hand of the conductor. See STREET-CAR.

Pneu-mat′ic Dis-patch′-tube. See PNEUMATIC TUBE.

Pneu-mat′ic Drill. A drilling-machine operated by compressed air admitted alternately above and below a piston connected with gear-wheels which rotate the drill. The air-reservoir and force-pump may be placed at any required distance from the cylinder, and connected therewith by a flexible pipe.

Fig. 3847 is Burleigh's pneumatic drill. *a* is a pipe by which air is brought from the compressed air-chamber; *b c*, the cylinder, provided with proper valves for admitting the air alternately above and below the piston and for exhaust. The drill *d* is attached directly to the piston-rod, and is driven down by the admission of air above the piston, and retracted when the air is admitted below, giving from 150 to 250 blows per minute. The cylinder, with the piston and drill, is advanced by the screw *e* as the drill penetrates the rock, the drill being rotated at the same time. Five sizes of drill, forming holes from 1¼ to 5½ inches diameter, may be used, the engine being of about three horse-power with a pressure of 50 pounds to the square inch. A small amount of power is lost by the transference of the air from the surface of the ground when the apparatus is employed in subterranean operations in mining or tunneling, but this is more than compensated by the cooling and ventilation effected by the exhaust. The cylinder, with its working apparatus, is rotatable vertically on trunnions for varying the direction of the blows given by the drill

Fig 3847.



Burleigh Drill.

By the *pneumatic drill*, the Mt. Cenis Tunnel, seven miles in length, was bored through the Alps. The Hoosac Tunnel in Massachusetts, five miles in length, was cut by the same means. Compressed air is also used in the St. Gothard Tunnel in Switzerland, lately commenced, which is to be 13 miles in length; and also in the operations at Hell-Gate, East River, N. Y. See SUBMARINE EXCAVATION; TUNNEL.

Pneu-mat′ic El′e-va′tor. A hoisting device in which compressed air is the agent for lifting. See PNEUMATIC HOIST; FURNACE-HOIST.

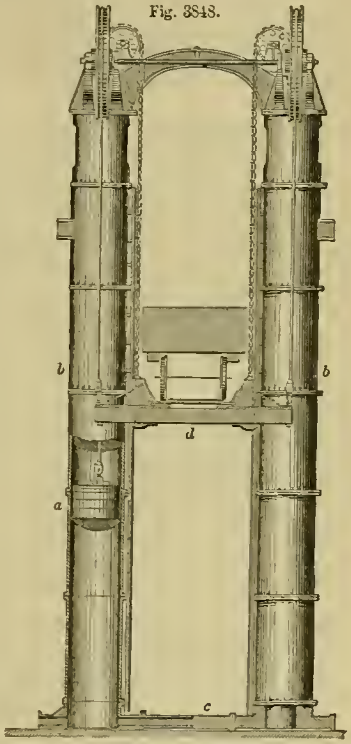
In planing-mills, the pneumatic method is used to carry the shavings from the planers to the furnaces of the steam-boilers; in grain and wool houses, to convey the stock.

Pneu-mat′ic Ham′mer. A hammer in which compressed air is the agent for lifting the helve or the head. See ATMOSPHERIC HAMMER.

Pneu-mat′ic Hoist. An elevating apparatus in which a platform is lifted by suspension chains passing over drums and thence to pistons working in vertical tubular shafts.

In the apparatus used at the Ayresome Iron Works, Great Britain, the cast-iron pistons *a* are packed with double cupped leathers, and are worked by creating a plenum above or a partial vacuum below, according as the elevating-table *d* is required to be lowered or raised For lifting ordinary loads, from 15 to 16 tons, an exhaustion equal to about 6 pounds per square inch is required; a plenum of about 4 pounds brings the table down. Two engines coupled to a crank on the shaft, which has on its ends a pair of opposite cranks, operate two single-acting air-pumps, which exhaust from one pipe and deliver into another, each of which is connected with a casing fitted with a slide-valve, so that it acts alternately for exhaust and delivery. The two cylinders *b b* communicate by a pipe *c* at bottom.

Fig. 3848.



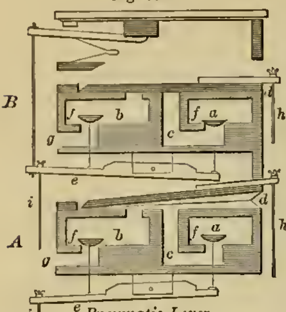
Pneumatic Hoist.

Pneu-mat′ic Le′ver. (*Music.*) A device invented by Barker of Bath, England, in which the elasticity of the air itself is made to overcome the resistance of the valve. The valve, being kept to its seat by a spring and the pressure of the air in the wind-chest, requires a certain expenditure of force to withdraw it from its seat on the *sound-board.*

The pneumatic lever admits air from the wind-chest to overcome the resistance to the action.

In Fig. 3849, *A* is in open and *B* in closed position. The two chambers *a a b b* are connected by an intermediate passage *c c*, opened or closed by means of the bellows *d d*. Each key of the instrument is connected with its appropriate lever *e e*, and on being struck depresses one end of this lever, lifting one of the valves *f f f f* and admitting air to the bellows *d d*, which carry a lever to whose projecting end is attached a rod *h h*, connected with one of the valves of the wind-chest; this is by this means pushed from its seat, allowing the air compressed in the chest to flow to the proper pipe On withdrawing the finger from the key, a reverse action of the valves is produced, as shown in the upper figure, the air from the bellows escaping into the chamber *b* and making its exit through the passage *g g* to the outer atmosphere. *i i* are the rods connecting the keys with their appropriate levers. In consequence of the width of the device, about three inches, every fifth lever is placed in the same row, the whole forming five tiers.

Fig 3849.



Pneumatic Lever.

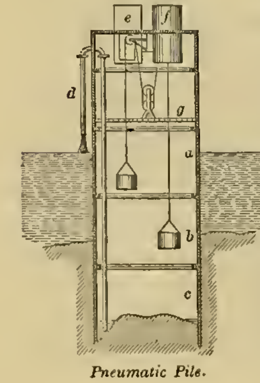
Pneu-mat′ic Par′a-dox. That peculiar exhibition of atmospheric pressure which retains a valve on its seat under a pressure of gas, only allowing a film of gas to escape. It is supposed to be owing to the thin film of escaping gas or vapor that passes out all round the disk, creating a partial vacuum, by which the disk is held on to its seat by the atmospheric pressure on the outside of the disk.

Pneu-mat′ic Pile. (*Hydraulic Engineering.*) *a.* A hollow iron cylinder or tube closed at its upper end, with the exception of an aperture, through which passes a pipe connecting the pile with a receiver. The receiver communicates with an air-pump, and by exhausting the air when the pile is in position over the spot where it is to be sunk, it is caused to penetrate the bottom; the mud, sand, or other deposits through which it passes being withdrawn and discharged into the receiver, while the pile is forced down by atmospheric pressure.

This method was patented by Dr. L. H. Potts in 1843, and through its means piles were secured in the hard bottom of the Goodwin Sands, off the coast of Kent, England, after passing through 75 feet of sand.

The pile is filled with concrete, and the inventor also proposed the injection of chemical solutions at its foot to consolidate the sand and form a firmer foundation.

Fig. 3850



Pneumatic Pile.

b. A caisson with a means of excluding water, so that excavations may be carried on in the submerged end. It was first used in France.

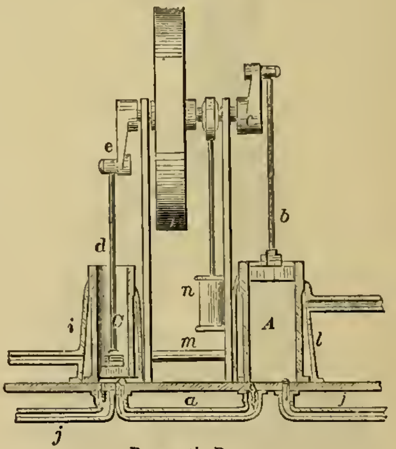
A mode of sinking cylinders for foundations by means of compressed air, as shown at Fig. 3850, was adopted to meet difficulties incident to building a bridge over the Medway at Rochester, England. It was at first intended to sink the hollow cast-iron piles for the piers by means of the exhaustive process, but the remains of an old timber bridge imbedded in the mud of the river rendered this impossible.

This foundation cylinder is composed of several sections, as *a b c*, bolted together through interior flanges; the edge of the bottom section is beveled, that it may more readily penetrate the ground. The top may be either dome-shaped or flat, and strengthened by interior transverse ribs or braces. *d* is a siphon through which water is discharged by the pressure of the condensed air; *e f*, air-locks through which the workmen enter and return and supplies are introduced; *g*, a platform for the hoisting apparatus, which removes excavated material. The cylinder has a supply-pipe and valve for introducing compressed air, a safety-valve, pressure-gage, and a large escape-valve for discharging the compressed air suddenly when required. The operation of sinking is as follows: a sufficient number of sections being bolted together to reach the bottom are placed in position, and, the air being allowed to escape, the cylinder sinks until bottom is reached; air is then forced in, and workmen are sent down who excavate the material beneath to as great a depth as possible; this is removed by the hoisting apparatus and passed out through the air-locks. When this is effected the workmen withdraw, the escape-valve is opened, and the water rushes in, filling the cylinder, and allowing it to sink still farther, the closed top is removed. and another section added and secured to the one beneath, when the top is replaced, air is again forced in, and the operation proceeded with as before. It is obvious that the weight of the cylinder must be adequate to resist the upward pressure of the condensed air, or that it must be sufficiently loaded to enable it to do so. When sunk to a sufficient depth it is filled with grouting, concrete, or béton. See Air-lock; Caisson, where the operations of sinking the piers of the East River Bridge, N. Y., and those of the Mississippi Bridge at St. Louis, are described.

Pneu-mat′ic Pump. An air-exhaust or forcing pump. (See Air-pump.) That illustrated is principally designed for forcing air into oil-wells, etc.

The cylinder *A* is of greater capacity than the cylinder *C*; their respective pistons *b d* are so connected with cranks *c e* on the driving-shaft that while one is ascending the other descends and *vice versa*. Exterior air is drawn into the cylinder *A* through the induction-pipe *j*, and forced through the pipe *a* into *C*, where it undergoes a reduction in bulk proportionate to the lesser capacity of this cylinder. and is forced through the pipe *j* into the well-chamber or other receptacle under a corresponding pressure. When used for forcing liquid from a well, the liquid is caused to pass through the jackets *i l* surrounding the cylinders and connected by the pipe *m*; if air or gas is to be forced into a tank, water is made to circulate through the jackets by the action of the pump *n*, whose piston-rod is also connected with the driving-shaft. See also pages 28 – 30, Vol. I.

Fig. 3851.



Pneumatic Pump.

Pneu-mat′ic Rail′way. A railroad whose rolling stock is driven by the compression or exhaustion of air in a tube laid parallel to the track. The plan has a number of variations, which are considered under Atmospheric Railway.

Medhurst's plan (1810 – 12). and the one adopted in the Crystal Palace Railway, Sydenham, England, was to run the car on rails laid in the tube, a fringe on the carriage acting as a packing to keep the air from passing the carriage, which thus forms a piston in the tube.

The plan adopted by Pinkus, Clegg, and others, was to have a traveling piston connected by a colter with the carriage, the colter displacing a continuous valve which occupied a slot in the whole length of the pipe's upper surface.

Pilbrow's plan was a traveling piston having a rack on its side operating in succession spur-pinions in bearings on the side of the pipe. The pinion-shafts have other pinions which mesh into racks on the side of the carriage, and impart motion thereto.

Keene and Nichols operated by the expansion of air in elastic tubes against rollers journaled in a pedestal beneath the carriage.

Hallette improved the valve.

Taylor and Condor used magnetic power to connect the traveling piston and the carriage. See ATMOSPHERIC RAILWAY.

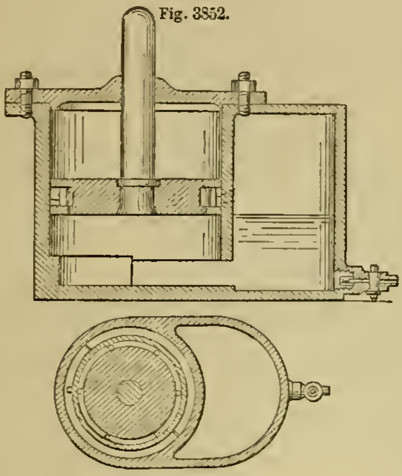
The application of compressed air to driving the machinery of a locomotive does not constitute the line an *Atmospheric Railway* as ordinarily understood. See AIR-ENGINE; AIR-ENGINE, COMPRESSED. See also PNEUMATIC TUBE.

Pneu-mat′ic Spring. *Air confined in bags* and used as a *spring* in *carriages* is specified in the English patent of Walker and Mills, July 3, 1845.

It has been used to receive the recoil of a gun in firing, to arrest the blow of a reciprocating bed in a printing-press, and in many other positions.

Fig. 3852 represents its adaptation to a car-spring. Air is confined in the upper part of the chamber, and acts as a spring when force is applied upon the surface of the water in the other chamber. The water extends below the piston, and enters by openings to the inside of the packing-rings, which are thereby driven against the inside surface of the cylinder.

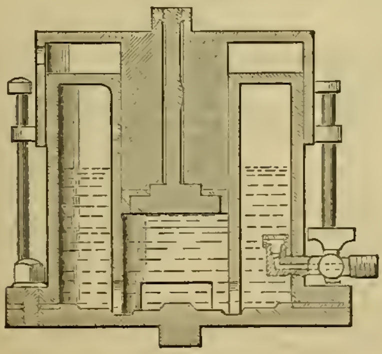
Fig. 3852.



Pneumatic Car-Spring.

Fig. 3853 shows a modified form. The plunger reciprocates vertically in the central cylinder, which is surrounded by an annular air-chamber. A liquid is interposed between the cushion of air and the head of the plunger.

Fig. 3853.

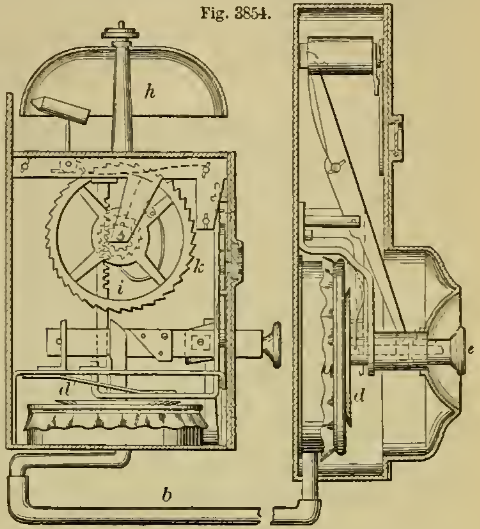


Pneumatic Spring for Cars.

Pneu-mat′ic Tel′e-graph. A telegraph used before the times of Morse and Wheatstone for communicating information by the impulse given to a column of water by pneumatic pressure.

A device in which air instead of water is the transmitting medium was patented in 1868 by Count Sparre of Sweden. The transmitting apparatus consists of a drum covered by an elastic diaphragm *a*, to which an impulse is communicated by a disk *d* at the inner end of a plunger *e*. The air thus set in motion communicates its vibrations through the tube *b* to a similar elastic covering over the head of a receiving drum, over which is a disk *d′* moving a rack *i* that gears with a pinion on the axis of the ratchet-wheel *k*; the movement of this wheel causes one of its teeth to lift the tail of a pivoted hammer sounding a signal on the bell *h*.

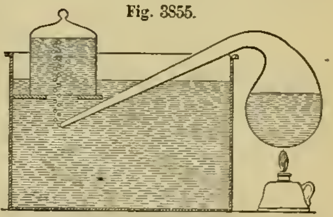
Fig. 3854.



Pneumatic Telegraph.

Pneu-mat′ic Trough. The pneumatic trough, with its jars for the collection of gases, is the invention of Hon. Henry Cavendish; it is generally credited to Priestley. The jar, filled with water, rests upon the shelf, and the beak of the retort extends beneath the shelf, so that the gas passing off from the retort passes up into the jar and displaces the water therein.

Fig. 3855.



Pneumatic Trough.

Pneu-mat′ic Tube. To the fertile brain of Dr. Papin of Blois, who lived about the end of the seventeenth century, we are indebted for the first suggestion of conveying parcels in a tube by means of compressed air. This distinguished Frenchman was the first to adopt a piston in the cylinder of a steam-engine. He invented the digester, which is the progenitor of a host of lard-tanks and rendering devices. He was the inventor of the weighted-beam safety-valve. He was the first, so far as we know, to suggest the use of compressed air conveyed by pipes as a means of transmitting power. See page 26.

After the death of the doctor, the invention took a sleep for a century, which might be a long sleep for anything else, but is for an invention only a reasonable nap. Sixteen or seventeen centuries elapsed between the double-cylinder fire-engine of Ctesibus of Alexandria and the similar engine of Nuremberg. The æolipile of Hero is substantially analogous to the water-wheel of the worthy Dr. Barker, who left us a century back or thereabout, except that the fluid agent of one is *steam* and of the other *water*. The principle is the same, and the turbine invented by Fourneyron, in 1823, does not differ in its principle of action from the æolipile of Hero, 150 B. C., or the reaction water-wheel of Barker, say A. D. 1740.

We are much indebted to the worthy Otto Guericke, a magistrate of Magdeburg, for re-inventing the air-pump, about 1650; but Hero, 1,800 years before, had used an air-pump to condense air in a chamber above water to make an artificial fountain. The splendid French edition of Hero's "Spiritalia" was published in Paris during the reign of Louis XIV., — not so very long after the good burgher of Magdeburg had set the ball rolling again. What Archimedes did for the fleet of Marcellus at Syracuse, 212 B. C., Proclus did for the ships of Vitalian at Constantinople some 700 years afterward, and Buffon performs the same feats with burning mirrors in a peaceable way, about the middle of the last century, upon metals, green wood, and various intractable minerals. See page 410.

In 1810, Medhurst took out a patent in England for a means of conveying goods, letters, parcels, and passengers by means of a tube and a blast of compressed air. (*Plenum.*) He proposed to apply it to driving passenger-cars at the rate of fifty miles per hour, the cars taking the shape of the tube.

In 1824, Vallence received an English patent for a substantially similar mode, excepting that the air was exhausted in front of the carriage, and the latter was driven by atmospheric pressure. (*Vacuum.*)

In 1835, Pinkus, an American in England, changed the scheme, the motion of a piston in the tube being transferred to a carriage traveling outside. This takes it out of the domain of our subject, in which the tube is the means of transmission. The subject of farther improvements in the line of the invention of Pinkus is pursued under ATMOSPHERIC RAILWAY.

The pneumatic dispatch-tube was started by a company in London in 1859, for conveying parcels and light goods between the Euston Square Station and the Post-Office in Eversholt Street, London. A continuation to Holborn was opened in 1865.

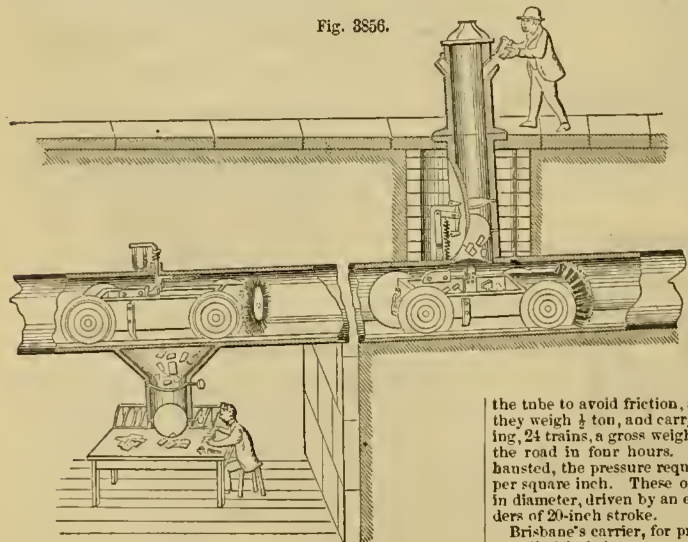
The pneumatic tube for the transmission of passengers or goods has been brought into prominence in the United States by the exertions of A. E. Beach of New York, and passengers were conveyed in an experimental section of tube at the Cooper Institute Exhibition, 1867. Mr. Beach has patented many special appliances having reference to the working of pneumatic tubes, and among the rest one for delivering letters, parcels, etc., November 13, 1866. The pneumatic tube is traversed by a car, which receives and delivers letters at intermediate stations and at the ends of its route. Devices actuated by the car in passing, or controlled by an electro-magnetic apparatus from an office, arrest the car either for the reception of letters from a receiver or their deposition at a given point, as the devices may be arranged or actuated by the electro-magnetic connection. A passenger and freight railway on Beach's plan has been constructed for some distance under Broadway, New York, the intention being to extend it from the Battery to Harlem.

For a number of years past the telegraph-offices of London have communicated with the central office by pneumatic tubes, in which the air is exhausted in front of the carrier and condensed behind it: these tubes are arranged in circuits, so that the current of air is continuous and conveys parcels in each direction at the same time. At each way-station on the line is a receiving apparatus consisting of two short barrels parallel with the main tube, either of which may be put in or out of connection with the line: one of these is open at both ends, so that a carrier may pass through unimpeded, but the other is closed at one end, with the exception of a small opening, so that when it is switched into line with the main tube it intercepts the carrier. The time when a carrier may be expected to arrive is telegraphed to the receiving station. In the telegraph pneumatic dispatch at Liverpool the messages are placed in little round bags, accurately fitting the tube, and urged forward by compressed air under a pressure of eleven pounds to the square inch. The tubes are connected, one with a vacuum chamber and the other with a compressed air-chamber; air being compressed in one and exhausted in the other at the same time by a double-barreled air-pump, operated by an engine working at about one horse-power. A speed of about forty miles an hour is attained.

Within the past few years the pneumatic tube has been applied to some extent for the transportation of passengers and freight as well as letters and parcels. Such is that between Holborn and Euston Square in London. In this the tube at the straight portions consists of iron pipes, cast in 9 feet lengths, 4 feet wide, and 4 feet 6 inches high. The curves vary from 70 to 300 feet radius, and the gradiants from 1 in 60 to 1 in 40, some portions of the line being level. The trucks run on rails laid on longitudinal sleepers, and are about 10 feet long; they have an elastic binding at their ends, allowing a small interval between this and the sides of the tube to avoid friction, a perfect vacuum not being required: they weigh ½ ton, and carry a load of 1½ tons; in ordinary working, 24 trains, a gross weight of 240 tons, have been carried over the road in four hours. The air may be either forced or exhausted, the pressure required usually not exceeding ½ pound per square inch. These operations are effected by a fan 22 feet in diameter, driven by an engine having a pair of 24-inch cylinders of 20-inch stroke.

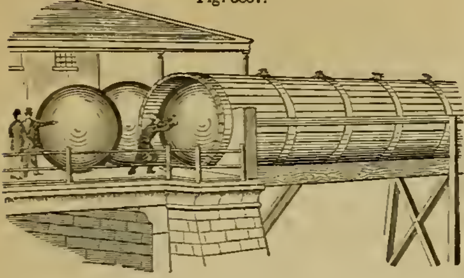
Brisbane's carrier, for pneumatic tubes, is made of spherical or cylindrical shape, so as to rotate when set in motion, avoiding the friction due to the pressure of the weight on bearings.

Fig. 3856.



Beach's Pneumatic Dispatch.

Fig. 3857.

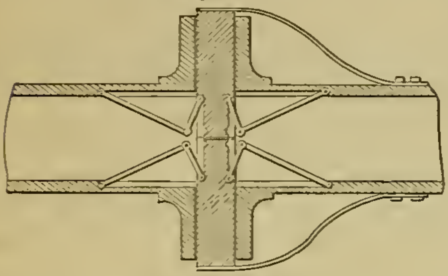


Pneumatic Tube.

Pneu-mat'ic Tube-valve. An interior slide-valve so arranged as to be withdrawn automatically or otherwise when the conveyor or train is to be started, or at passing any particular point.

Beach's valve (Fig. 3858) consists of two parts sliding in vertical guides. The end of a train passing in either direction strikes a pair of toggle-joint levers which force apart the halves of the valve, which are afterward forced together again by springs exterior to the tube.

Fig 3858.

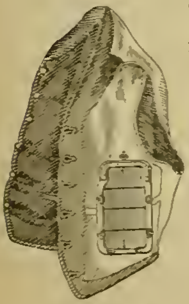


Pneumatic Tube-Valve.

Pneu-mat'ic Valve. A valve of the kind employed in an air-pump. A clack-valve of leather or membrane supported and held tense by a metallic ring. Its seat is sometimes greased to insure perfect contact and prevent any air from escaping backward.

Pneu'ma-tom'e-ter; Pneu'mo-nom'e-ter. (*Surgical.*) An instrument for measuring the amount of air exhaled at a single expiration. A *pulmometer*, or *spirometer*.

Fig. 3859.



Safety-Pocket.

Pock'et. 1. (*Mining.*) A cavity or hollow in a rock in which grains or nuggets of gold have been intercepted and retained.

2. A bag at the corner or midlength of one of the longer sides of a billiard-table.

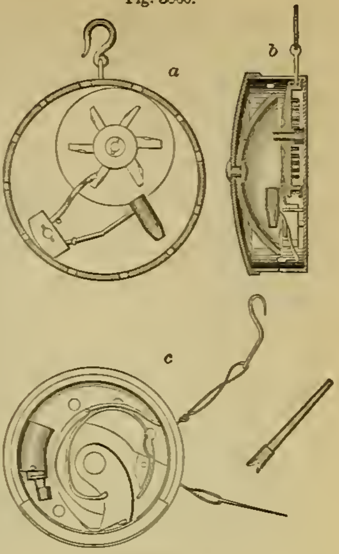
3. (*Apparel.*) A bag inserted in the clothing to contain articles carried upon the person.

Fig. 3859 illustrates a safety-pocket. It is surrounded by a light metallic framing, and its mouth is secured by a device opened or closed by a screw to prevent articles being withdrawn by picking or cutting.

Pock'et-a-larm'. A device worn like a watch and having a chain attached to the hook at its upper end. A pickpocket, in pulling the chain to abstract the supposed watch from the pocket, will turn the spring-wheel whose projections will actuate the hammer and sound the alarm on the bell. *a* is an elevation and *b* is a vertical section of the device.

In *c*, the alarm is attached to any article and also to the pocket. When an attempt is made to abstract the article, the trigger is tripped and the hammer falls upon and explodes the cap. The shell of the device is of such form and size as to be conveniently carried in the pocket. The hammer is capped and cocked by an independent lever, and the working parts do not project beyond the outside shell.

Fig. 3860.



Pickpocket Detectors.

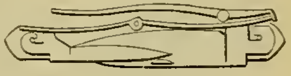
Pock'et-book. A leathern receptacle, divided into compartments for bank-notes, etc., and of shape and size suitable for carriage in the pocket. It has an exterior flap, usually secured by a tongue and loop. See PORTE-MONNAIE.

Pock'et-knife. A knife having one or more pivoted blades, which shut within the handle, and are held firm by the back, which constitutes a spring. The blades are forged on a small anvil with a light hand-hammer by drawing down a rod of steel and cutting off sufficient to form the blade and joint. In making the latter a second heat is taken, and the finish is completed at a third heat; they are then hardened by plunging while red-hot in cold water, and tempered by laying them side by side on an iron plate over the fire, where they remain until their surfaces assume a purple or brown color.

Fig. 3861 is a knife in which the shank of the blade is so slotted that it can be readily slipped on or off the customary pivot in the handle. A lever device is used to retract the spring when the blade is to be inserted or removed.

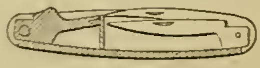
Fig. 3862 has a watch-key in place of one of the blades.

Fig. 3861.



Knife with Detachable Blades.

Fig. 3862.



Knife with Watch-Key.

Pod-bit. A boring-tool adapted to be used in a brace. It has a semicylindrical form, a hollow barrel, and at its end is a cutting lip which projects in advance of the barrel. See BIT.

Poil. (*Fabric.*) *Feather shag.* A kind of velvet with long pile.

Point. 1. (*Bricklaying.*) To fill the joints of masonry, brickwork, tiling, slating, etc., with mortar, pressed in by the point of the trowel.

When the mortar of a brick building, by exposure to the air, has become rotten or has fallen out at the surface of the joints, the space is *pointed* or filled with mortar, pressed in, and made flush with the surface of the bricks.

When the joint receives a line of white paint to make it more conspicuous, it is said to be *penciled*.

Filling up the joint with fresh mortar, leaving it flush, is *flat-joint pointing*. If plaster be inserted in the joints with a regular projection, and neatly pared to a parallel breadth, it is called *tuck-pointing* or *tuck-joint pointing*.

2. (*Masonry.*) *a.* The stone-mason's punch, used in the reduction of the face of the stone, leaving it in narrow ridges, which are dressed down by the *inch-tool*. See Stone-workers' Tools.

b. A pointed chisel for nigging ashlar.

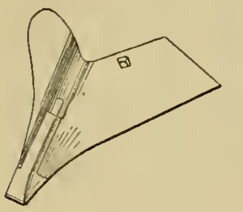
3. (*Nautical.*) *a.* One of the 32 divisions into which the circumference of the horizon and the mariner's compass are divided, each comprehending 11° 15′. See Mariner's Compass.

b. A flat piece of braided cordage attached to the reef-band of a sail to tie up a reef. See Reef-point.

c. To prepare the end of a rope so that it may reeve through a block and not unlay. A few yarns are taken out and a mat worked over it by its own yarn.

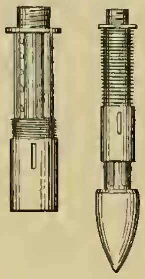
d. To brace a yard so as to bring it end on to the wind.

Fig. 3863.



Plow-Point.

Fig 3864.



Drive-Well Point.

4. (*Plow.*) The extreme forward end of the *share* as distinguished from the *wing*.

5. A railway switch.

6. The lower end of a driven-well tube.

7. (*Bookbinding.*) A register mark made by the printer in aligning his sheet on the tympan and forming a guide to the folder.

8. (*Engraving.*) The etching-needle of an engraver.

9. A fragment of diamond containing a natural angle adapted for glass-cutters' uses. Fragments which are to be made into powder for the lapidary are called *bort*.

10. (*Knitting-machine.*) Beardless needles; also known as Shifters (which see).

11. Lace wrought by the needle.

12. (*Machinery.*) Position in relation to power or accessory portions; as, —

The *dead point* of a crank.

The *fixed point* on which a body moves.

The *point of suspension* of a balance, etc.

13. (*Perspective.*) That part on the drawing sheet to which lines converge; as, the *accidental* or *vanishing point*, the *point of distance*, the *point of sight*.

14. (*Physics.*) *a.* A line of demarcation or limit; as, —

The *boiling* point of a liquid.

The *melting* point of a solid. See Fusing-point.

The *evaporating* point, as of water.

b. Said also of instruments; as, —

The *freezing* point of a thermometer.

The *dew* point on a hygrometer, etc.

15. (*Turning.*) A lathe center.

16. (*Printing.*) One of the pins placed on the tympan or feed-board of a printing-press, to perforate the sheet at the time of the first printing to secure a *register* when the sheet is turned.

The points are generally covered by a perforated spring plate at the first feeding, and the sheet fed by a guide. After the sheet is punctured, it is *laid on* so that the points pass through the same holes.

Perfecting-presses sometimes use points to perforate the printed sheets, and the point-holes serve as guides for feeding to a folding-machine.

Campbell's single-cylinder book-press is provided with electric points, and the electric circuit must be completed by bringing the perforations over the needles before the feeding can go on.

17. (*Harness.*) A short strap stitched to a wide one for the purpose of attaching the latter to another strap by a buckle. The end of any strap that is provided with holes for the buckle-tongue.

18. (*Fortification.*) The junction of certain lines of defense, as the *point of the bastion*, the salient angle formed by its meeting faces; the point of intersection of the curtain and the flank; the point at the shoulder of the bastion, etc.

19. (*Ordnance.*) To lay a gun, including the direction and elevation.

Point′al. 1. (*Carpentry.*) A king-post.

2. (*Masonry.*) A pavement of diamond-shaped slabs.

Point-blank. (*Gunnery.*) *a.* A shot discharged in a horizontal direction.

b. A gun horizontally leveled.

Point-blank range is the extent of apparent right-line of a ball horizontally discharged.

Point′ed Arch. (*Architecture.*) One struck from two centers and meeting above, forming a lancet shape. It is a feature of the Gothic order of architecture. See Arch.

Point′er. 1. (*Stone-working.*) A stone-mason's chisel with a sharp point, used in spawling off the face of a stone in the rough.

2. (*Bricklaying.*) A tool for clearing out to a given depth the old mortar between the courses of bricks in a wall, to be replaced by a fresh body of mortar.

3. (*Railway.*) The adjusting lever of a switch.

4. The index finger or hand of a dial or scale.

5. A graduated circle with one fixed and two adjustable radial legs. By placing them at two adjoining angles taken by a sextant between three known objects, the position of the observer is fixed on the chart.

Point-hole. (*Printing.*) A hole made in a sheet of paper by a register-pin or by points on the tympan.

Point′ing. (*Bricklaying.*) The finishing or renewing a mortar-joint in a wall.

Flat-joint pointing consists in filling the joint even and marking it with a trowel.

Tuck-joint pointing. The joints are finished with fine mortar pared to a parallel edge and slightly projecting.

Point′ing-ma-chine′. One for pointing rails, pickets, matches, etc., as the case may be.

Point′ing-rods. Rods used in the exercise of guns and mortars.

Point′ing-wire. An iron wire with a loop at one end, used for sighting mortars by, when the proper line of fire has once been found.

Point-pa′per. Pricked paper for making, copying, or transferring designs.

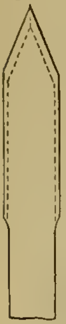
Poin′trel. A graving-tool.

Point-tool. (*Turning.*) One ground off to a sharp point at the midwidth of the end of the blade.

Poi′tral. (*Harness.*) A breast leather for saddles or for draft.

Poke. A device to be attached to a breechy animal to prevent its jumping over, crawling through, or breaking down fences. As David says, "that there be no breaking in nor going out." They vary with the kind of stock to which they are attached, — horses, cattle, hogs, or geese. They are sometimes called yokes; as, for instance, goose-yoke. It is more convenient, however, to class them as pokes, the term "yoke" being applied to the device by which animals draw their loads, for which see YOKE.

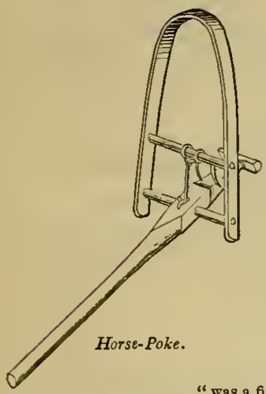
Fig 3865.



Point-Tool.

In Ohio, a fence which is pig-tight, horse-high, and bull-strong is said to be a thoroughly good fence.

Fig. 3866.



Horse-Poke.

Fig. 3866 is a poke for horses. The bar is pivoted to the bow, and inclining forward serves ordinarily to cover the points, but when brought in contact with a fence the points are unmasked to pierce the animal.

Po′ker. 1. A metal used in hooping masts.

2. A stoking-bar.

Po-lac′ca. (*Nautical.*) A vessel with three masts used in the Mediterranean. Beppo's ship

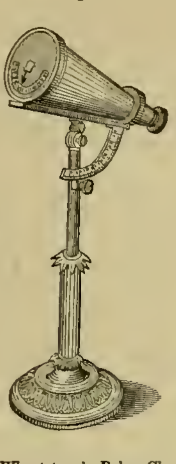
> "was a fine polacca,
> Manned with twelve hands and laden with tobacco."

Po′lar Cir′cle. Two small circles on a globe, 23° 28′ from the poles and parallel with the equator, — the arctic or north polar circle, the antarctic or south polar circle.

Po′lar Clock. An optical instrument invented by Wheatstone, for ascertaining the time of day by means of polarized light. A glass disk is fixed within a ring at the extremity of a vertical pillar, and so inclined that its plane is perpendicular to the earth's axis. The lower half of the disk is graduated, with the hours from 6 to 6. Within the ring the broad end of a conical tube is fitted so that it may turn freely, and is closed by another glass disk which carries centrally a star or other figure composed of thin films of selenite, exhibiting strongly contrasted colors under exposure to polarized light; and an index is painted in the prolongation of one of the principal sections of the selenite films. At the smaller end of the tube is a Nicol prism, having its diagonals at angles of 45° with the principal sections of the selenite.

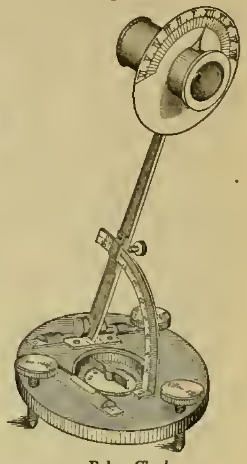
The axis of the conical tube is adjusted in line with the earth's axis. On looking through the prism, the selenite star will appear colored, except in two positions. In one of these a circular disk in the center of the star will appear of a certain color, as red, and in the other it will exhibit the complementary color. This is caused by its axis being placed at an angle of 22½° with the other films of selenite composing the star. The tube is turned until the star shows no color, the central disk then appearing red. The index will then point to the hour.

Fig. 3867.



Wheatstone's Polar Clock.

Fig. 3868.



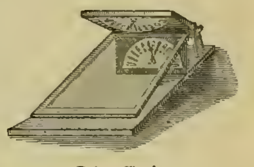
Polar Clock.

The principle of the clock consists in the fact that the light scattered from the minute particles of the atmosphere is polarized, and this effect is best marked when the reflected light is examined at right angles to the course of the original light; all the changes of color resulting from the operation of the instrument as above described show the position of the sun, or, in other words, give the time of day.

Fig. 3868 is a portable form of this instrument, adapted for adjustment to any latitude.

Fig. 3869 is a simpler though less accurate form, in which twenty-five films of selenite are arranged equidistantly and radially in a semicircle upon a plate of glass fixed in a frame in a plane inclined to the horizon at an angle equal to the complement of the polar elevation, and adjusted perpendicularly to the earth's axis. The light passing through this plate falls upon a reflector of black glass adjusted at an angle of 56° 45′ with the plate, and is polarized. The hours are denoted by figures at the ends of the radial films of selenite; these will at all times appear of various shades of two complementary colors; that plate which exhibits most vividly a particular color, as red, indicates the hour.

Fig. 3869.



Polar Clock.

Po′lar Di′al. A dial having a plane parallel to the axis of the earth and perpendicular to the meridian of the place. The style or gnomon is parallel to the plane of the dial, and the hour lines are parallel straight lines, whose distances from the meridional line are respectively proportioned to the tangents of the angles which the hour-planes make with the plane of the meridian.

The *common dial* becomes a polar dial at the equator.

Po-lar′i-scope. An instrument for observing the phenomena exhibited by polarized rays of light proceeding from a luminous object, as the sun. The principle upon which its action depends is thus explained by Professor Airy :—

"Common light consists of undulations in which the vibrations of each particle are in the plane perpendicular to the wave's motion. The polarization of light is the resolution of each vibration into two, one passing through the direction of the wave's motion, and the other perpendicular to that plane, which become in some instances the origin of waves that travel in different directions. When we are able to separate one of these from the other, we say that the light of each is polarized." When the resolved vibration parallel to the plane is preserved unaltered, and that perpendicular to the plane is diminished in a given ratio (or *vice versa*) and not separated from it, we say that the light is partially polarized."

Light may be polarized by reflection at a proper angle from the surfaces of transparent media; by transmission through crystals possessing the property of double refraction; and by transmission through a sufficient number of uncrystallized transparent plates placed at proper angles.

If two plates of glass be placed at the open ends of two tubes turning one within the other, the plates being fixed at an angle of 33° with the axes of the tubes and revolved, it will be found that when the two plates are parallel to each other the amount of light reflected from one to the other and transmitted to the eye will be at a maximum, and when they are at right angles to this no light at all will be reflected. It thus appears that a ray reflected from the surface of glass at this angle cannot be again reflected from a similar inclined surface; this is expressed by saying that the light is polarized in the plane of reflection.

When a reflected ray is received upon a tourmaline plate the whole of the light will be transmitted, if its axis, that is, the axis of the crystal from which it was cut, be parallel to the reflecting surface; on revolving the plate the amount of light transmitted will diminish until its surface is at right angles with that of the reflector, when it will entirely disappear. Light is only completely polarized by reflection, when it strikes the reflecting substance at a particular angle; this varies in different substances, being in the case of glass 33°, the complement of which, 57°, is called the angle of polarization. Sir David Brewster, from numerous experiments, deduced the following law: "The tangent of the polarizing angle for any medium is the index of refraction for that medium."

The phenomenon of double refraction, exhibited by Iceland spar (crystallized carbonate of lime), is a familiar one.

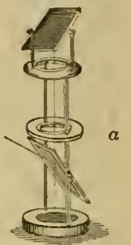
If any small object be placed in contact with a piece of this spar and viewed through it, two images, separated by a slight interval, will appear, and by turning the piece round, the same surface still resting on the object, these images will be caused to revolve around each other. By sawing the piece in two in the proper direction and cementing the two surfaces with Canada balsam, one of these images may be entirely got rid of. A piece thus treated constitutes Nicol's prism, and forms the means by which a very large proportion of the observations on polarized light are made. A device of this kind is furnished with all the better class of microscopes. Tourmaline and various other minerals also possess this property in a greater or less degree. The two pencils of light formed by double refraction are found to be polarized in planes at right angles to each other, exhibiting the same phenomena as light polarized by reflection. The images may be received on a reflecting surface at the proper polarizing angle, viewed through a plate of tourmaline, or through a second crystal having the power of double refraction. In the latter case it is found that when the homologous faces of the two crystals are parallel, neither of the pencils formed by the first will be separated by the second crystal, but on turning the latter round, each pencil is separated into two, forming four images; the two which succeed those originally seen appear faint, but when the axes of the crystals are at an angle of 45° with each other, will be equally bright with the first; the first gradually diminish in brightness as the angle approaches 90°, and the four increase their proximity until at 90° they coincide, forming but two images as before, the relative positions of which are, however, reversed from those they occupied at the beginning; that which was above now appearing below, and *vice versa*. These phenomena were first observed by Huyghens. Circular polarization is produced when light is twice totally reflected from the second surface of bodies at their angle of maximum polarization; it may also be produced by the passage of light through rock crystal, as was discovered by Arago, or through some fluids, as oil of turpentine or solution of sugar, as was ascertained by Biot and Seebeck.

Elliptic polarization is produced by reflection from the polished surfaces of metals at angles between 70° 45′ and 78° 30′, gold having the least and tin the greatest polarizing angle. This property was discovered by Sir David Brewster.

"When Huyghens was occupied with the double refraction of light in crystals of Iceland spar, *i. e.* with the separation of the pencils of light into two parts, he also discovered, in 1678, that kind of polarization of light which bears his name. More than a century elapsed before the discovery of this isolated phenomenon was followed by the discoveries of Malus, Arago, Fresnel, Brewster, and Biot. Malus, in 1808, discovered polarization by reflection from polished surfaces; and Arago, in 1811, discovered colored polarization. A world of wonders of variously modified waves of light gifted with new properties was now opened. A ray of light which reaches our eyes from the regions of space, from a heavenly body many millions of miles distant, when received in Arago's polariscope, tells, as it were of itself, whether it is reflected or refracted, whether it emanates from a solid, a fluid, or a gaseous body, and even announces its degree of intensity. Pursuing this path, which takes us back through Huyghens to the seventeenth century, we are instructed respecting the constitution of the solar orb and its envelopes, the reflected or the proper lights of the tails of comets, and of the zodiacal light, the optical properties of our atmosphere, and the position of the four neutral points of polarization, which Arago, Babinet, and Brewster discovered. Thus man makes for himself as it were new organs which, when skillfully used, open to him new views of nature."—**Humboldt.**

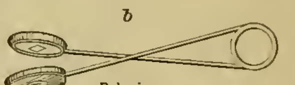
Various devices for inducing and observing the phenomena of polarization have been contrived.

Fig. 3870.



In Fig. 3870 *a* illustrates Norremberg's polariscope, for use with the magic-lantern. Two mirrors are arranged at an angle of 35° from the vertical, and the object placed on the stage between them; on revolving the upper mirror the field of vision appears clear at 0° and 180°, and dark at 90° and 270°.

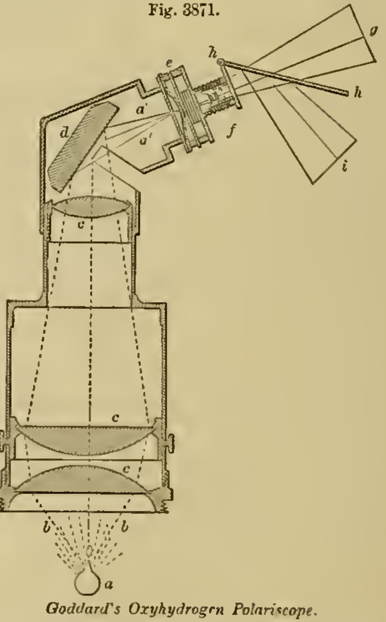
b is the tourmaline polariscope: two plates of tourmaline are inserted in the jaws of a forceps-like wire. By inclosing an object between them and imparting a rotary motion, colored rings are exhibited.



Polariscope.

Fig. 3871 represents Goddard's oxyhydrogen polariscope. *a* is a ball of lime exposed to the ignited jet from the compound blowpipe; *b b*, its rays refracted by the condensing-lenses *c c c*, and falling upon the mirror *d*, composed of ten plates of thin flattened crown-glass and placed within the elbow of a tube bent to the polarizing angle of crown-glass. *a′ a′*, the polarized rays after reflection; *e*, a double refracting crystal (selenite) in the focus of the object-glass *f*, which forms an image of the crystal upon a screen at *g*; an analyzing plate *h* composed of sixteen plates of mica being caused to turn upon its axis, the image of the selenite upon the disk is caused to exhibit alternately the primary and secondary colors at the same time, one being reflected in the direction *i*, and the other thrown upon the screen at *g*.

Fig. 3871.



Goddard's Oxyhydrogen Polariscope.

Po′lar-is-tro-bom′e-ter. The title given to an instrument devised by Professor Wilde of Berne for investigating the relations of various liquids to polarized light.

Po-lar′i-ty. The property of attraction or repulsion, or of taking certain directions.

Po′lar-iz′er. The lower prism. The one beneath the stage of the microscope in polarizing apparatus.

Pol′da-ry. (*Fabric.*) A kind of coarse canvas. *Poldway.*

Pold′way. (*Fabric.*) Coarse bagging stuff for coal-sacks, etc.

Pole. 1. The tongue of a vehicle.

The *pole* was the universal appendage to the ancient vehicle. The animals, of whatever kind, were attached to the vehicle by yokes. See YOKE; CHARIOT.

Chariots with two or three poles were used by the Lydians. Here we perhaps see the first shafts, unless the bilateral poles of the Scythian nomad, fastened to a surcingle and dragging behind the animal, may be so considered.

2. (*Nautical.*) *a.* A mooring-pole.

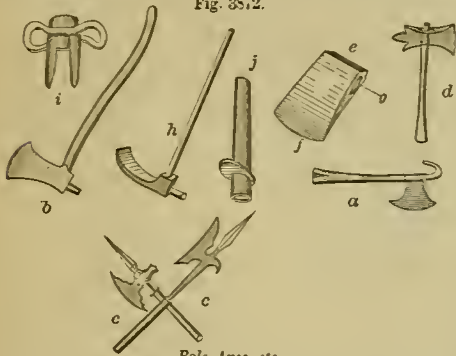
b. A setting-pole.

3. (*Galvanic Batteries.*) *a.* The poles are the ends of the wires or the terminal points of the connections which proceed from the battery, and convey *positive* and *negative* electricity (so called) respectively. As the course of the current is from the positive metal to the liquid, and thence to the negative metal, proceeding from the latter by the circuit wire to the positive metal, whence it started, so the wire from the copper conveys positive electricity and is the *anode*, while the zinc is the *cathode*.

The north end of a magnetic needle.

Pole-axe. Originally, an axe on a pole or long handle. The *poll* of an axe is the head. The pole-axe (*b*) now used by butchers in felling bullocks and hogs has a handle of ordinary length, and is used to deaden the animal by a blow on its *poll*, but the name is not thence.

Fig. 3872.



Pole-Axes, etc.

As a long-handled axe it was used as a weapon in the Middle Ages.

In the navy it is a heavy hatchet (*a*) having a handle 15 inches long and a sharp point turning downward on the side opposite the blade. It is used for boarding, resisting boarders, cutting ropes or nettings, etc.

c c are pole-axes of the time of Charlemagne. The handles are shown as broken short off. *d* is a battle-axe of medieval times.

Pole-car′riage. A carriage furnished with a *pole* or *tongue*, in contradistinction to one with *shafts* or *thills*.

Pole-chain. (*Vehicle.*) The chain on the fore end of a carriage-pole, leading to the collar or the breast-chains of the harness.

Pole-crab. (*Vehicle.*) A double loop (*i*, Fig. 3872) on the fore end of a carriage-pole, to receive the breast-straps of the harness.

Pole-foot. (*Vehicle.*) The hind end of a pole which goes into the cleaves of the futchels.

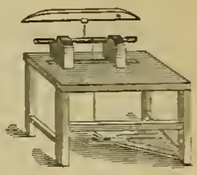
Pole-futch′el. (*Vehicle.*) The jaws between which the hinder end of a carriage-tongue is inserted.

Pole-hook. 1. The hook on the end of a carriage-tongue.

2. A boat-hook.

Pole-lathe. A lathe in which the work is supported between centers on posts rising from the bed, turned by a strap which passes two or three times round the work. The lower end of the strap is connected to the treadle, and the other end to a spring-bar on the ceiling. One of the centers is an iron pin, and the other is on a screw in the other standard. The rest is a rail or bar extending from one puppet to the other. The work is intermittent, the chisel cutting as the treadle descends; the pressure of the foot being relaxed, the spring-bar raises the treadle, running the work in the other direction. See LATHE.

Fig. 3873.



Pole-Lathe.

Pole-mast. (*Nautical.*) A mast made with a single pole, in contradistinction to a mast built up, and secured by bands.

Pol′e-mit. (*Fabric.*) A French camlet.

Po-lem′o-scope. A glass with a mirror at an angle of 45°, designed to enable a person to view objects not directly before the eye. Invented by Helvetius.

It is used in opera-glasses to view persons obliquely without apparently directing the glass at them.

It is also used for viewing objects beyond an obstructing wall or bank, as in the interior of a fortress. See ALTISCOPE.

Pole-pad. A pad of leather stuffed with wool and distended by an interior frame of iron, slipped and keyed on the end of the pole of a gun-carriage, to prevent injury to the horses.

Pole-plate. (*Carpentry.*) The plate of a frame which supports the heels of the rafters. A *wall-plate.*

Pole-prop. A bar for supporting the end of the pole or tongue, especially used with the various carriages of the artillery service.

Pole-pro-pel′ler. A mode of propulsion of boats in which the ends of poles are pushed against the bottom of the river to propel the boat.

Pole-strap. A heavy strap by which the pole of the carriage is attached to the collar of the horse. Also called *pole-piece.*

Pole-tip. A tubular iron at the front end of a wagon-pole. See *j*, Fig. 3872.

Po-lim′i-ta. (*Fabric.*) A variegated stuff.

Pol′ing. 1. (*Glass-making.*) An operation for ridding glass of a lilac color due to an excess of manganese. The molten glass is stirred with a pole, which introduction of a carbonaceous element changes the sesquioxide into a protoxide, and the color disappears.

2. (*Copper-manufacture.*) An operation to cause an ebullition in molten copper to accelerate the effect of the supernatant charcoal. The green pole yields its juices in a gaseous form, which causes the fluid metal to bubble.

Pol′ings. Boards supporting the side-earth in excavating tunnels.

Pol′ished Brick. Bricks which are rubbed upon a bench plated with iron, to make their surfaces perfectly even. This process is only gone through with the very best bricks, and its cost is such that it is not employed to any very great extent.

Pol′ish-ing. The different kinds of polishing-wheels have distinguishing names, according to their material.

Polishing-wheels are usually leather covered.

Lapping-wheels have *metallic* rims.

Glazers are of wood.

Buffers are of leather.

Each has a powder or paste of a fineness adapted to its work. The *buffer* is a finisher, and usually has *rouge*.

Pol′ish-ing-block. *a.* A block between the jaws of a vise on which an object is laid to polish it by an emery strip or otherwise.

b. A block shod with polishing material and moved over the face of the object to be polished.

Pol′ish-ing-cask. 1. A rolling barrel in which articles are placed to polish by mutual attrition or by grinding against some polishing-powder placed in the barrel with them.

2. A barrel in which grained gunpowder is placed with a small quantity of graphite, which gives it a polish.

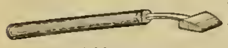
Pol′ish-ing-file. A smooth file. A burnisher.

Pol′ish-ing Glass. Plate-glass is polished after grinding by means of rubbers set in a frame which is caused to traverse back and forth over the plate. See Plate-glass.

Pol′ish-ing-ham′mer. A hammer for fine-dressing the surfaces of plates.

Pol′ish-ing-i′ron. (*Bookbinding.*) An implement for finishing the covers of books. It is heated and passed over the leather, the lining paper, and such other parts as require smoothing and polishing. They are made of various shapes and sizes.

Fig. 3874.



Polishing-Tool.

Pol′ish-ing-ma-chine′. 1. A machine in which rice, deprived of its hull, receives a farther trituration to deprive it of its red skin or cuticle. A *whitening-machine*.

2. (*Cotton.*) A machine which brushes the surface of sized yarn, or burnishes sized thread.

Pol′ish-ing-ma-te′ri-als. These are derived from various sources, principally from the mineral kingdom, though vegetable substances and the skins of animals and fish are used for particular purposes, as is also the interior shell of the cuttle-fish. Pure carbon in the diamond is the hardest substance known in nature, and is much employed in the form of powder for cutting and polishing gems. As charcoal, carbon is also used for polishing copper and other soft metals.

Alumina, when pure and crystalline, as in the ruby, sapphire, etc., is next in hardness to the diamond. In combination with a small proportion of silex and iron, it composes the principal part of corundum, emery, and rotten-stone, which are largely employed in grinding and polishing the harder metals, minerals, and glass.

Some clays and loams of which alumina constitutes a large part are also used for like purposes.

Silex in its various forms, as quartz, sand, etc., and mixed with alumina and other mineral substances constituting grits or grindstones, hones and slates, pumice-stone, and some others, are used for abrading and polishing. Tripoli and rotten-stone are employed in polishing the surfaces of metals and other substances. The oxide of iron, called crocus and rouge, and the oxides of tin and lead, known as *putty-powders*, are extensively used in the arts for producing very smooth surfaces. These are prepared artificially. Lime and chalk are also employed in some polishing processes.

Pol′ish-ing-mill. A lap of *tin* or of wood coated with *list* or *leather*, used for the finishing processes of the lapidary. See Lapidary's Mill.

Pol′ish-ing Nee′dles. The polishing of needles is effected by treating from 40,000 to 50,000 at a time.

The needles are arranged in heaps upon a piece of canvas, the needles in each heap lying parallel, without regard, however, to heads or points. Emery, oil, and soft soap are sprinkled over the heaps, after which they are rolled up in the canvas and bound by a coil of twine, making a bundle three or four inches thick and two or three feet long. A number of such rolls are laid on a table with raised edges, a weighted and reciprocating slab resting upon them, so as to roll the bundles back and forth, causing the needles to roll and rub against each other, removing the scale, and eventually scouring and polishing each other.

The rubbers work at the rate of 20 or 30 movements in a minute, and the process is carried on from 48 hours to 8 days, according to the quality. The rubbing is suspended every 8 hours, to renew the canvas, which becomes worn out, to wash the needles, and to add fresh emery, putty-powder, oil, etc., as the case may require, the abrading material being applied of a gradually increasing fineness.

Pol′ish-ing-pow′der. Diamond, sapphire, ruby, corundum, emery, rotten-stone, flint, tripoli, pumice-stone, oxide of iron, oxide of tin, and chalk are all employed in a pulverized state for polishing. The first three are used by the lapidary; corundum and emery principally by metal-workers. They, as well as oxide of iron (crocus, rouge) and oxide of tin, are also, however, employed for polishing glass. Pumice is more commonly used on wood-work, while tripoli and chalk, under the form of whiting, are particularly employed for domestic purposes, in cleaning brasses, window-glass, etc.

Pulverized graphite, either alone or in combination, is also largely used in domestic economy for polishing stoves, etc.

Pol′ish-ing-slate. A hone. Schist.

Pol′ish-ing-snake. A lithographer's tool.

Pol′ish-ing-tin. A bookbinder's tool.

Pol′ish-ing-wheel. A wooden wheel covered with leather and charged with crocus, rouge, putty-powder, etc. It is used in polishing metallic articles of relatively small size which are presented to it. A coarser grade of powder, such as emery or tripoli, constitutes a *grinding-wheel* or *glazer*.

A polishing-wheel prepared from a leather dressed with oil, like chamois and buckskin, is called a *buff-wheel*. The soft and fluffy surface is charged with polishing-powder.

The cutler's polishing-wheel has a wooden center, is covered with leather, and charged with crocus, used dry. It has a speed of 70 to 80 feet per second. The development of heat by friction improves the polish, and the blade is moved to and fro, from end to end, by a quick motion. Skill and practice, it is almost needless to observe, are necessary in this as in all other manipulations. The hand is protected from the heat by a piece of felt.

Polishing-wheels for small steel instruments are made as follows: —

Take a piece of sole-leather of a size suitable for the desired wheel, make a hole through the center, slip it on the mandrel of the lathe; turn it down to the size desired: coat the face of it with glue, and apply as much coarse emery as the glue can be made to take; put it aside to dry. Make another in the same way, only using flour of emery instead of the coarse. Form a third wheel in the same manner, but instead of the glue and emery, apply crocus with water. The wheels may be of any size, by fastening several thicknesses together with common shoe-pegs.

A wheel for carrying the pumice, in polishing vulcanite, can be formed by fastening together two of these leather wheels with brass screws, between which are three or four thicknesses of woolen cloth cut somewhat larger than the leathers.

Poll. 1. The blunt end of a hammer. The *head* of a hammer, the smaller end, is the *peen*, whether an edge or a point.

2. The *butt* of an axe or hatchet as distinguished from the *bit*, which is the cutting blade. See Fig. 3872, *e poll*, *f bit*, *g eye*.

Not to be confounded with *pole*-axe, which has a halberd, or axe on a pole.

One form of tool may be a *poll*-axe which has a stud on the poll for felling beeves and hogs.

Poll-adze. An adze with a striking face on the *head* (*poll*) opposite to the *bit*. See *h*, Fig. 3872.

Poll-pick. (*Mining.*) A pick on the end of a pole so as to be worked by blows endwise, like a crow-bar.

Pol'roz. (*Mining.*) The pit underneath a water-wheel.

Pol'ver-ine. Glass-makers' ashes.

Pol'y-chord. (*Music.*) An octave-coupler.

Pol'y-chrome. A picture executed in various colors. Anciently applied to a statue colored to imitate nature. Some of the remains of Grecian sculpture yet exhibit traces of the color upon them.

Pol'y-gon. (*Fortification.*) The *exterior* polygon is the figure formed by lines connecting the angles of the bastions round the work.

The *interior* polygon, a figure formed by lines connecting the centers of the bastions all round.

Pol'y-graph. 1. An instrument for making a number of drawings or writings simultaneously. It is on the principle of the pantograph, and was invented by Hawkins (English).

A number of pencils are placed in a framework of jointed rods, so arranged that each subordinate one partakes of the motion of the principal one, which is guided by the writer or draftsman.

2. A manifold writer or a copying-machine.

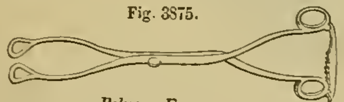
Pol-ym'e-ter. An instrument for measuring angles.

Pol'y-op'tron. A lens, one side of which is plane and the other convex, with a number of concave facets. The effect is to give a number of diminished images. It is a toy.

Pol'y-pan'to-graph. An instrument on the principle of the pantograph, by which a number of similar designs may be simultaneously executed upon a metallic plate or roller from a single pattern. Invented by M. Gavard, Paris.

Pol'y-pus-for'ceps. A ring-handled forceps, from 4 to 7 inches in length, of various curves, slender blades, grooved and deeply serrated margins.

Fig. 3875.



Polypus Forceps.

It is used for extracting tumors and polypi, taking hold of them by their pedicles and twisting them until they come off. The cut represents one of a larger kind used for uterine polypi.

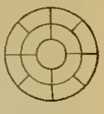
Pol'y-scope. A multiplying lens. A planoconvex lens whose protuberant face is cut into numerous facets, each of which gives an image of the object viewed.

Pol'y-zo'nal Lens. A burning-lens constructed of segmental lenses arranged in zones.

In the illustration, the lens is shown with a central piece surrounded by four segments which are encircled by eight segments.

The object is to obtain lenses of large size for lighthouses, free from defects, and having but slight spherical aberration. Buffon first suggested the idea. Brewster made them. See Burning-glass; Burning-mirror, pages 410, 411; Mirror, page 1452.

Fig. 3876.

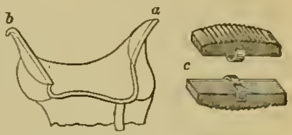


Polyzonal Lens.

Pom'el. A boss or knob on the summit of a turret roof.

Pom'mel. 1. (*Saddlery.*) A knob on the front part of a saddle. The seat of a saddle is between the *pommel a* and the *cantle b*. In the Murdoch saddle the seat is suspended between the *pommel* and *cantle*, which are united by spring-bars called *side-plates*. In the *Spanish* saddle the *pommel* and *cantle* are high, so that the rider sits in a deep seat. In the *half Spanish* the parts named are less elevated. In the *English* and *Somerset* trees, still less so. A high pommel is sometimes called the *horn*.

Fig. 3877.



Pommel and Cantle.

2. (*Currying.*) A block of hard wood *c* used by curriers in pressing and working skins to render them supple. It is flat above and rounded below, the lower surface having transverse, parallel straight grooves. It is also used in *graining* and *boarding* leather, and is otherwise known as a *crippler*.

3. A knob on the hilt of a sword.

4. The butt-end of the stock of a fire-arm.

5. The knob on the cascabel of a cannon.

Pom-mel'ion. The knob on the cascabel of a gun.

Pom'pet. A printer's inking-ball.

Pond. (*Hydraulic Engineering.*) A *reach* or *level* of a canal. Two ponds of varying levels are connected by a *lock*.

Pon-gee'. (*Fabric.*) A coarse silk goods.

Pon'iard. A dagger.

Pon'til; Pon'ty; Pon'tee. The iron rod used by a glass-blower to support the glass while working.

The blowing-rod is the tube on which the mass of glass is withdrawn from the pot and blown into shape.

Pon-ton'. 1. (*Military Engineering.*) A bateau of wood or metal, or a light framework covered with water-proof material, used as a float for supporting a temporary bridge. *Pontoon.*

In the United States Engineer Service they are made of wood. Corrugated metal and rubber have also been employed.

The British service employs either Colonel Blanchard's or Colonel Pasley's pontons. The former are cylindrical and are made of tin-plate; they have hemispherical ends, and are divided into compartments by longitudinal and transverse partitions, which serve as braces.

Pasley's consist of a light timber frame covered with copper; they are transversely divided into two halves, which are united by lashings for use and separated for transportation. Each half is also divided into compartments. The whole forms a decked canoe adapted for rowing. See Ponton-bridge.

2. (*Nautical.*) *a.* A barge or lighter of large capacity, used in careening ships, raising weights,

drawing piles, etc., or capable, in pairs, of acting as *camels*. See Camel.

b. A barge or flat-bottomed vessel furnished with cranes, capstans, and hoisting tackle, used in wrecking, in connection with a diving-bell, or in raising submerged vessels.

3. (*Hydraulic Engineering.*) *a.* A water-tight structure or frame covered with water-resisting material placed beneath a submerged vessel and then filled with air to assist in refloating the vessel.

b. A water-tight structure which is sunk by filling with water, and raised by pumping it out, used to close a sluiceway or entrance to a dock. It works in grooves in the dock walls, and acts as a lock-gate. See Plate XIX. page 884.

Pon-ton′-bridge. (*Military Engineering.*) A temporary military bridge supported on flat-bottomed boats or floats, termed *pontons.*

The use of boats or floats for supporting temporary bridges is of great antiquity

Darius Hytaspes and his army crossed the Bosphorus on a bridge of this kind in order to invade Greece, 493 B. C., and his successor Xerxes constructed one across the Hellespont, 480 B. C., for the same purpose, of which we have a description in Herodotus. Its length was 500 paces. Ships were used as pontons; suspension-cords of flax and *biblos* united them; transverse beams were laid on the ropes, planks on the beams, soil on the planks, and the armies crossed thereon.

Cyrus, according to Xenophon, threw over the Meander a bridge supported on seven boats. Pompey crossed the Euphrates by a boat-bridge during the Mithridatic war.

Portable bridges were designed by the Marquis of Worcester, 1655; Leonardo da Vinci, 1452-1520; Bourne, 1578; and by others a little later. It was so much the fashion of that day to conceal the particular points of invention under the obscurity of general phrases, that the exact devices can hardly be ascertained. The Marquis states that a six-horse wagon will carry a bridge to span a river half a mile broad.

The ponton equipage of the United States army consists of wooden bateaux, 31 feet long, 2 feet 6 inches deep, 5 feet 4 inches wide at top, and 4 feet at bottom, tapering to a width of 4 feet at the bow and 2 at the stern.

To construct the bridge, the bateaux are placed at distances of 13 feet 10 inches apart, and moored by anchors both up and down stream; they are then connected to each other by spring-lines extending from the bow of each to the stern of the next, and so on reciprocally; over the gunwales of the boats are laid the *balks* or beams in such a way that each shall extend quite across each adjacent pair of boats; over the balks are laid the *deck-plank* (*chesses*), which again are kept in place by pieces of scantling termed side-rails, the whole being firmly lashed to each other and to the boats by cords. The width of roadway is eleven feet. A bridge of this construction and dimensions has been found to be amply strong to sustain any weight which will be likely to be brought on it in service.

The pontons with their appurtenances are carried on wagons which follow in the train of the army.

Boats of corrugated iron, being lighter than those of wood, have also been employed.

Colonel Blanchard's pontons, used in the English service, are made of tin-plate, 22 feet long, 2½ feet in diameter, with hemispherical ends, and divided by several longitudinal and transverse partitions to act as braces and prevent their sinking if pierced by a shot or by accident.

Colonel Pasley's copper ponton is also used in the same service. It is in the form of a decked canoe, 22 feet long, 2 feet 8 inches in width and depth. It has a timber frame covered with sheet-copper. The ponton is formed of two equal parts, which are locked together for use and dislocated for transportation. Each half has also divisional diaphragms, which prevent its sinking if one chamber be pierced below the water-line. Small pumps are provided for discharging water to keep a ponton afloat in an emergency.

The system adopted is to make up the bridge in a series of rafts, each of which consists of two pontons united by the balks or joists so as to be about twelve feet apart, the ends of the balks resting on frames lying longitudinally upon and lashed to the pontons. The rafts are then floated into position, moored and united by balks, which form them into a continuous bridge frame, which supports the *chesses*, or planking.

The complement of men is 1 non-commissioned officer and 6 privates to a pair of pontons. The time occupied under favorable circumstances is 15 minutes to unload and form the raft, and another 15 minutes to put all the rafts together ready for the passage of troops.

A *flying-bridge* is merely a boat which, being made fast to a cable attached to an anchor up stream, is propelled across by the action of the current against its side, its head being kept in the proper direction by an oar; for this purpose the cable should be about 1½ times the width of the river to be crossed. See Military Bridge.

Po′ny-chaise. A lady's low chaise, to be drawn by a pony or two.

Po′ny-en′gine. A locomotive-engine kept at a railroad station for moving cars and making up trains.

Pool′er. A stick for stirring the vats of a tannery.

Poop. 1. (*Shipbuilding.*) *a.* The aftermost, highest part of the hull.

b. A deck over the after part of a spar-deck, abaft the mizzen.

2. The roof truss.

Poop-cab′in. (*Shipbuilding.*) The apartment in a poop.

Poop-lan′tern. (*Nautical.*) A lantern carried on the taffrail at night to indicate a flag-ship or act as a signal when a ship is moored bow and stern.

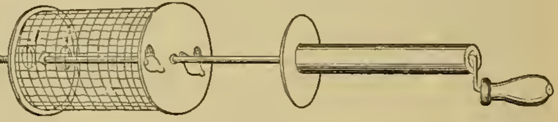
Pop′lin. (*Fabric.*) A stuff having a silken warp and woolen weft, in this respect resembling bombazine. Dublin has attained preëminence in this particular branch of manufacture, the *Irish* poplins being widely and favorably known.

A silk and worsted stuff, watered, figured, brocaded, or tissued. Originally an all-silk French goods. Irish poplins have a silk warp and worsted weft, and in the common grades cotton or flax is mixed with the silk.

Pop′per. A domestic implement for popping corn. It is usually a wire basket, which is held over the fire and shaken or revolved so as to keep the corn moving.

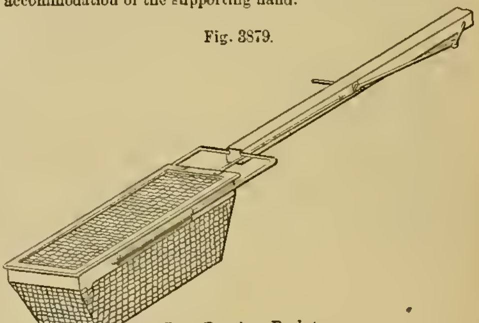
In Fig. 3878, the gauze cylinder has a lengthened crank-shaft by which it is turned, and a sleeve-handle and screen-plate for accommodation of the supporting hand.

Fig. 3878.



Popper and Roaster.

Fig. 3879.



Corn-Popping Basket.

In Fig. 3879, the corn is placed in a gauze case reciprocated in a gauze tray by a crank upon the staff.

Pop′pet. 1. (*Shipbuilding.*) *a.* Poppets are square timbers (*shores*) erected on the *bilgeways* and forming a part of the cradle on which the vessel rests in launching. The heads of the poppets are confined by a plank bolted to the bottom of the ship, and their heels rest on sole-pieces on the upper sides of the bilgeways.

b. Small stakes on the gunwale of a boat to form rowlocks and support the wash-strake.

2. One of the *heads* of a lathe.

3. (*Steam-engine.*) A valve having an axial stem and reciprocating vertically on its seat. See Puppet-valve.

Pop'pet-head. (*Turning.*) The part of a lathe which holds the back-center and can be fixed to any part of the bed.

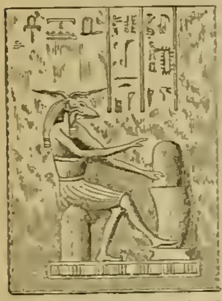
Por'ce-lain. Pottery — using the word as generic — made of a material which becomes vitrified and translucent by burning. The term *burning* is here used in preference to *baking*, as that term is applicable to the first heating which converts the plastic clay into *biscuit*.

The tests of porcelain, as contradistinguished from pottery in its specific sense, are the glassy fracture, its clear ringing sound when struck, the homogeneity of its outer and inner coat, its resistance to fire, water, and all acids but fluorhydric.

Porcelain is said to have been invented in China the fourth century A. D. The name is derived from *porcellana* (Portuguese), a fine white shell which was held to resemble the ware.

The potter's wheel is shown among the very earliest of the Egyptian mural paintings. In more than one instance the wheel is shown as being used in the molding of man from clay.

Fig. 3880.



Kneph, the Creative Spirit of the Egyptians, making Man on the Potter's Wheel from Clay.

Porcelain, as well as other kinds of earthenware, is found in the Egyptian tombs. One green porcelain jar has hieroglyphics which define it as Egyptian Other vases from Thebes, Sakkarah, and Ghiseh are evidently Chinese, and indicate the commercial acquaintance of the two peoples.

Two of these bottles were brought to England by Mr. Rawlinson, another was found in a previously unopened tomb, and others are in European museums.

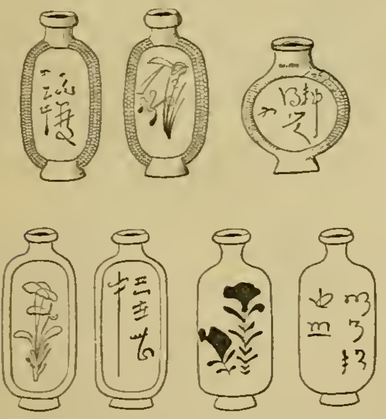
They are of a rather inferior article of porcelain, and probably contained a drug, perfume, or dye when imported.

Many blue porcelain emblems and images are in the Abbott Egyptian Collection, New York.

Many of the cups and vases discovered at Thebes are elegant in form, proportion, and coloring, and are deeply vitrified in burning.

The porcelain of China is believed to have been known to the Romans under the name of *murrhina vasa* or *murrea vasa*, although they had no idea of its mode of formation. It was first introduced by Pompey, who dedicated cups of this kind to Jupiter Capitolinus. They are mentioned by Pliny, Martial, and others. Pliny's guess at the way in which they are formed, "a substance formed by a moisture thickened in the earth by heat," shows that they were not glass. The latter was no novelty in the time of Pliny. See Glass.

Fig. 3881.



Chinese Bottles.

Oriental porcelain was imported into Europe by the Portuguese in the beginning of the sixteenth century; but this was not the first of the trade, though perhaps the first important venture in the way of porcelain merchandising. Early in the fifteenth century, the French king, Charles VII., had pieces in his collection; in 1487, Lorenzo de Medici received several valuable porcelain vases from the Sultan of Egypt The Marchese Campori of Modena cites a letter, written in 1567, referring to Bernardo Carnigiani as the rediscoverer of the art of making porcelain. This was more than a century before Botticher, who was, however, an original (not first) discoverer.

The incident which directed Botticher's attention to the subject was observing the contents of some crucibles in which some alchemical preparations had been heated. This was noticed to resemble porcelain, which then was a curiosity and of great value. The material which gave the peculiar charactar to the compound was ascertained to be a fine white clay, found on the road near Aue, which was excessively tenacious and clammy, but capable when dry of being reduced to a very fine powder, so that it had been used for hair-powder and went by the name of "Schnorr's white earth." It proved to be kaolin.

The French porcelain works were first established at St. Cloud, in 1695, by Louis XIV.; at Vincennes, 1740; removed to Sevres, 1786.

The Meissen, Saxony, porcelain manufactory was established by Augustus II., Elector of Saxony, in 1710. Botticher invented the hard paste in 1706; the red ware like jasper, in 1711; white porcelain, in 1709; the perfect, white kind, in 1715. He died in 1719. Höroldt introduced gilding and painting in 1720; modeled groups, in 1731; porcelain made in England, at Bow, in 1698. Wedgwood ware was first patented, 1762.

Porcelain may be distinguished from the coarser earthenware as a pottery which is fine grained, compact, very hard, and somewhat translucid. The latter quality is derived from its partial vitrification. It has various colors

Porcelain is divided into hard and tender. The former is made in Germany and in Asia, and the latter is held to include the ironstone china and similar ware, so heavily manufactured in England. Kaolin is the principal ingredient, mixed with a peculiar mineral, as related elsewhere in this article in a report of the French emissary who went to China to discover the secret of the manufacture. Its glaze is earthy and non-metallic.

Tender porcelain, on the contrary, consists of a vitreous frit, which is rendered opaque and less fusible by mixture with a calcareous or marshy clay. Its glaze is an artificial glass composed of lead, silica, and an alkali. This porcelain would melt at the heat which the other requires to burn it.

It is held to occupy a place between the hard porcelain and fine stone ware. It differs from the first in the friability of its paste, and its metallic glaze, and from the second in its transparency and stronger glaze.

The information gathered from the French emissary who went to China to spy out the process is published by the Royal Academy of Paris, and is in substance as follows: —

There are three materials employed in forming the body of the ware, but all the three are never used at once.

The first is called *petuntse.* It contains scattered shining particles, is fine grained, and is quarried from certain rocks. It is prepared for use by first breaking it with hammers, then grinding it in mortars with iron pestles, and, lastly, it is washed over, taking only the white creamy matter which floats on the surface, which, after being dried and pressed into small cakes, is fit for use

The second material is called *kaolin*, and appears to be porcelain clay, namely, that which results from the decomposition of feldspar. It is described as occurring in lumps in the clefts of mountains, covered with a reddish earth. It is prepared for use exactly in the same manner as the *petuntse.*

The third material is called *hoaché* It is used instead of kaolin. It has a smooth, soapy feel, and no doubt is either steatite or soapstone or agalmatolite. It is prepared in the same manner as the preceding. Porcelain made with this latter is much dearer than that made with kaolin. It has an exceedingly fine grain, and is very light, but at the same time more fragile, and it is not easy to hit on the precise degree of heat that suits it For the finest porcelain, four parts of hoaché are added to one of petuntse Sometimes the body of the ware is made with kaolin; and then the article, when dry, is dipped in the hoaché, brought to the consistency of cream: what adheres forms a thin layer, on which, when dry, are laid the colors and the glaze: and thus a porcelain finer than the common is obtained. Hoaché is also laid with a pencil, before glazing, on those parts of the common porcelain that are intended to have an ivory-white color

For the fine kaolin porcelains, equal parts of that substance and of petuntse are employed: for the less fine, two parts of the former and three of the latter The ingredients being put together in due proportions, the mass is carefully tempered and kneaded by hand, and then the ware is wrought on the wheel, or for articles of irregular figure, which cannot be thus formed, is made by pressing the composition into molds and then uniting the several pieces by moist clay. The piece, being formed, is very carefully dried, and is then covered with the glaze The white semi-transparent glaze is thus prepared: The white petuntse with green spots is pulverized and washed over, as already described; and to one hundred parts of the cream thus obtained is added one part of *che-kao* (burnt alum or perhaps gypsum) previously pulverized. A caustic potash lye is also prepared, into which *che-kao* is stirred, and the cream thus produced is collected. The two creams are then mixed together in the proportion of ten measures of the former to one of the latter. This composition it is which gives to porcelain glaze its whiteness and luster.

A brown glaze is made of common yellow clay washed over and brought to the consistence of cream and then mixed with the former glaze. If the brown glaze is not to cover the whole of the surface, wet paper is laid on the reserved parts, which, after the glaze has been put on and has ceased to be fluid, is removed, and such blank parts are then painted in colors and covered with the common white glaze.

When the glaze is thoroughly dry, the ware is put into the furnace for the first time, whence it appears that the ware is never in the state of biscuit, — a circumstance in which the process materially differs from that adopted by the European manufacturers, who put on the glaze after the first firing of the ware.

The flux used with those colors that are laid on over the glaze is made of quartz, calcined and pulverized, and then mixed with ceruse in the proportion of one of quartz to two of ceruse.

Red is given by peroxide of iron, produced by calcining green vitriol; and a finer red is made of copper, but the particular process is kept secret.

The enamel colors are tempered to the proper consistence by a solution of glue, except those into the composition of which the ceruse enters; these latter are tempered only with water.

Petuntse and *kaolin* (Chinese names) are both derived from feldspar, which consists of silica, alumina, and potash. Kaolin consists of decomposed feldspar, and petuntse is the powder of *un*decomposed feldspar. The radical difference seems to be that by decomposition and exposure to the air the kaolin has acquired plasticity, has become a *clay*. This being the case, it is easy to conceive the propriety of keeping the prepared clay in a condition to improve by exposure and age, before working it. Marco Polo, who was from 1274 to 1291 in the service of Kublai Khan, the Conqueror of China, states that the heaps of porcelain clay were exposed in China for thirty to forty years before using; so that men gathered the materials for their children and grandchildren.

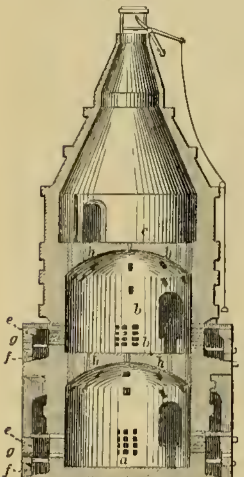
The other material mentioned is hoaché, and probably, as the Père d'Entrecolles remarks, is steatite; which is a compound of silica and magnesia

We cannot go into all the particulars of the history of the art, nor describe the ingredients and compositions of the porcelains of China, Dresden, Sèvres, Berlin, Vienna, Bohemia, but must refer our readers to Birch's "History of Ancient Pottery" (1858); Marryat's "History of Pottery and Porcelain, Medieval and Modern" (1857); and Brogniart's "Arts Céramiques."

Por′ce-lain-cem′ent. Stir plaster of Paris into a thick solution of gum-arabic; apply with a brush.

Por′ce-lain-gild′ing. Porcelain is gilded with a magma of gold, quicksilver, and flux, thinned with turpentine and oil, like paint, and laid on with a brush. A stencil-plate and powdered charcoal may be used to delineate the design upon an adhesive surface spread upon the ware. The black magma turns to a dead gold color by firing as the volatile ingredients are sublimed, and the brightness of gold is obtained by burnishing.

Fig. 3882.



Porcelain-Oven.

Por′ce-lain-mill. An arrangement of vats for the mixing and decantation of slip, straining and feeding it to the grinder, which consists of a runner and bed-stone of chert (hornstone), by which the feldspar and flint are reduced to an impalpable and creamy consistence.

Por′ce-lain-ov′en. The porcelain-oven (Fig. 3882) is built in three stages, *a b c*; the conical top has an opening which serves as the chimney. The lower stages *a b* are used for "strong firing" the porcelain, while the upper stage *c*, called the *howell, crown,* or *cowl,* serves for "raw burning." Each of the lower stages is provided with fireplaces *e e* and ash-pits *f f*, the openings of which are closed while burning. The fuel (wood) is introduced through the openings *g g*, and openings *h h* permit the circulation of the hot gases through the oven; *i* is the entrance-door.

Por′ce-lain-pa′per. A kind of French glazed, fancy paper. Figured, painted, or gilt.

Por′ce-lain-pic′ture. A kind of photographic picture in which a positive is produced upon a milky or semi-translucent glass. The *collodio-chloride* process is frequently adopted, which see.

Por′ce-lain-print′ing. The transferring of an impression of an engraving to porcelain in the *biscuit* or the glazed condition. The former is called *press-printing;* the latter, *bat-printing.*

In *press-printing*, the engraving is very heavy, is taken on *pottery-tissue* paper, transferred to the biscuit by rubbing with soaped flannel and then a roll of flannel; the paper is then damped off, and the oil of the ink driven off by heating the biscuit in a hardening-kiln, previous to glazing.

In *bat-printing*, the lines of the engraving are more delicate. The impression is taken in linseed-oil on a slab of damp glue, and transferred from thence to the glazed ware. Color is then dusted on to the oil, and the ware is fired in an enamel kiln.

Printing on porcelain, or the transferring of printed impressions to *biscuit*, was introduced by Dr. Wale of Worcester about 1751. The Prussians refer the discovery of the process to the year 1757.

Porch. (*Architecture.*) A covered entrance to a building. With a row of columns it is a portico.

Porch-post Sup-port′. A casting placed between the foot of a post and the floor of a porch to prevent decay of the two at that point.

Por′cu-pine. (*Fiber.*) A heckling apparatus for flax; or a cylindrical heckle for worsted yarn.

Por′phy-ri-za′tion. A mode of grinding substances by a muller upon a slab. Porphyry, from its extreme hardness, is eminently suitable, and has given its name to the process.

Triturating mortars of porphyry, 29 inches in diameter, have been made in France, but are very expensive, owing to the difficulty of working the material. See ARRASTRA; MORTAR; ORE-MILL.

Por′phy-ry. 1. A rock having a hard base, usually feldspathic, through which crystals of feldspar are disseminated.

2. Also, among stone-cutters, a hard and valuable description of marble. There are varieties of red, green, and gray colors.

Port. 1. (*Shipbuilding.*) *a.* A framed opening in a ship's side through which a gun is fired, a hawser passed out, or cargo passed in or out. They are known as *gun*-ports, *ballast*-ports, *cargo*-ports, etc., and are closed by *shutters* or *lids.*

Row-ports are for sweeps.

The aft and forward ports are known as *stern, quarter,* or *bridle* ports; also as *chase*-ports, *stern-chase* ports, etc.

A *half*-port is one hinged to the sill of the port and closing the latter up to the line of metal of the gun.

A *light*-port is an opening provided with a glazed lid or *side-light.* A water-tight shutter over the *side-light* is called a *dead-light,* and is used in stormy weather.

An *air*-port is an opening through the side below decks for ventilation.

2. (*Nautical.*) The left side of a vessel to a person standing on deck and facing toward the bows. It was formerly called *larboard.*

3. (*Steam-engine and Hydraulics.*) A steam opening. An aperture for the passage of a fluid; as, a *steam*-port, *water*-port, *gas*-port.

The entering port for live steam is the *inlet* or *induction* port; the port of departure is the *outlet*, *eduction*, or *exhaust* port.

4. (*Harness.*) The curve in the mouth-piece of some bridle-bits.

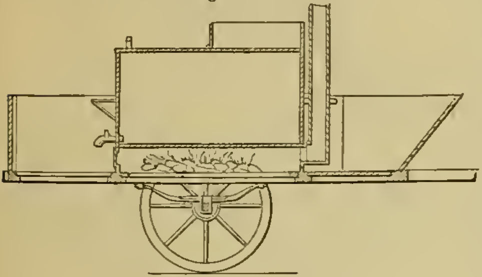
Port-bit. (*Harness.*) A general name for all bits having a *port* mouth-piece.

Port'a-ble Boat. One adapted for being reduced to a small compass for land transportation. Various devices of this kind have become the subject of patents. See Folding-boat.

One form has diagonal thwarts and ribs pivoted at their centers by upright standards and having hinge-joints at their ends; it is longitudinal, strengthened by two pieces one above and one, corresponding to a keelson, below; the frame is covered with water-proof material, and may be folded up so as to occupy a space not exceeding the length of the ribs. In another, the longitudinal pieces are hinged, admitting of being folded; the transverse pieces are scarfed together and secured by bands and quoins so as to be readily disunited. The floor and sides may be of plank, or the frame may be covered with canvas so laced as to be quickly applied and removed.

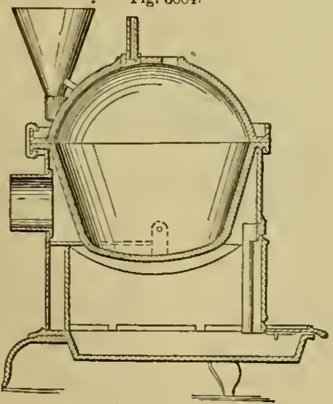
The frame of a third form has an inner and outer keel, to the former of which a folding wing on each side is hinged; two iron rods running from end to end are pivoted so that they can be brought near together. The middle rib, seat, and cross-bar are turned upon a pivoted standard until parallel with the keel, and the wings folded in upon them. The frame has a flexible covering. See also Folding-boat; Buggy-boat; Ponton; Canoe.

Fig. 3883.



Roofing Boiler and Furnace.

Fig. 3884.



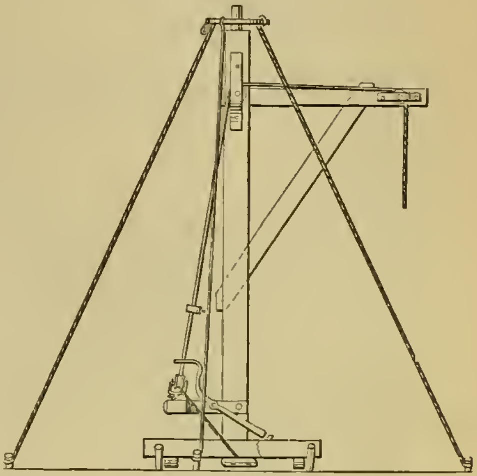
Agricultural Furnace.

Port'a-ble Boil'er and Fur'nace. A furnace on wheels for paving or roofing purposes, to heat the tar or other material. In the example, the furnace, boiler, and other incidentals are mounted on a spring dray for convenient transportation.

Fig. 3884 is an agricultural furnace for cooking feed for stock.

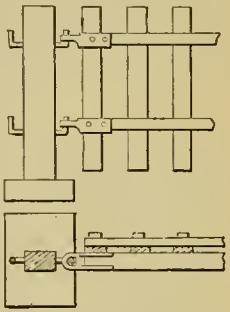
Port'a-ble Der'rick. One for stacking hay in the field, loading stone in a quarry, or in other situations where it may require to be occasionally moved. In the example, the hoisting-rope has an adjustable block which comes in contact with the trip-lever when the load is at the proper elevation. The tripping of the lever allows the swinging around of the derrick.

Fig. 3885.



Portable Derrick.

Fig. 3886.



Shifting-Panel Fence.

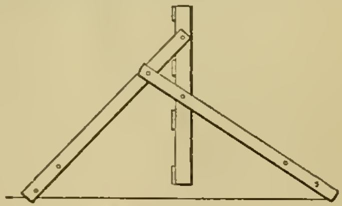
Port'a-ble Fence. (*Husbandry.*) One which may be shifted as convenience may require.

In Fig. 3886, the string-pieces have eyes which engage hooks on the posts.

In Fig. 3887, one brace is pivoted to the other, and the latter to the post.

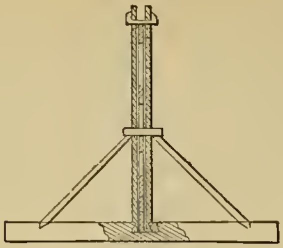
In Fig. 3888, the posts and braces are framed into the sills, and the parts secured by keys and wedges, without nails.

Fig. 3887.



Diagonal-Brace Fence.

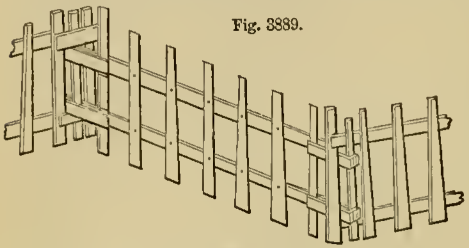
Fig. 3888.



Fence with Sill-Piece.

Figs. 3889 and 3890 are picket-panels, interlocking at the ends. The latter has also a brace-piece.

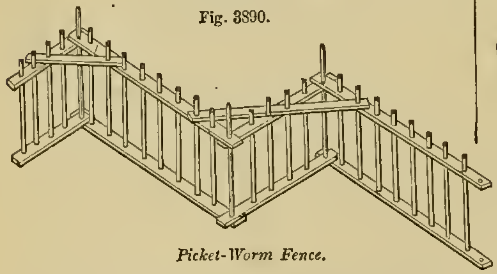
Fig. 3889.



Picket-Worm Fence.

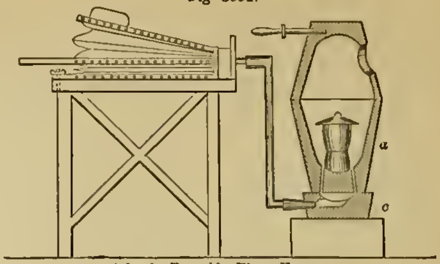
Port′a-ble Fur′nace. Aiken's portable blast-furnace is in three parts, all made out of the black-lead melting-pots used by goldsmiths. The lower piece *c* is the bottom of one of these pots, cut off so low as only to have a cavity about an inch deep, and ground smooth above and below. The middle piece or fireplace *a* is a larger portion of a similar pot, with a cavity about 6 inches deep, measuring 7½ inches over the top, and being perforated with 6 blast-holes. An upper pot of the same dimensions as the lower one is added to confine the heat and protect the eyes from the glare. A hole allows the exit of the flame and smoke. An iron handle is provided for unshipping the top section when the crucible is to be removed. The bellows are fixed to a heavy stool, the nozzle is received into a hole in the pot *c*, which conducts the blast into the cavity. The furnace is suitable for a laboratory and for metallurgic operations on a small scale.

Fig. 3890.



Picket-Worm Fence.

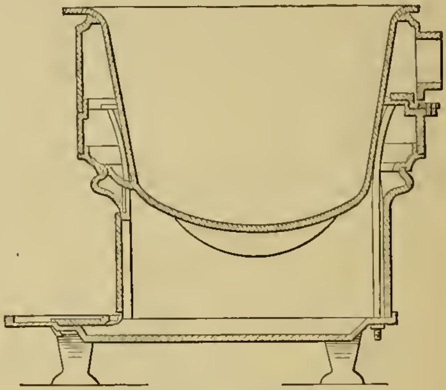
Fig 3891.



Aiken's Portable Blast-Furnace.

Fig. 3892 is an apparatus for boiling stock feed, tar, or what not. It is made wholly of cast-iron, and the kettle is made to fit into a recess directly over the fire, the whole being so constructed that the products of combustion are made to act more equally on the bottom and sides of the kettle, which is accomplished by a peculiar arrangement of horizontal partition-plates forming flues.

Fig. 3892.

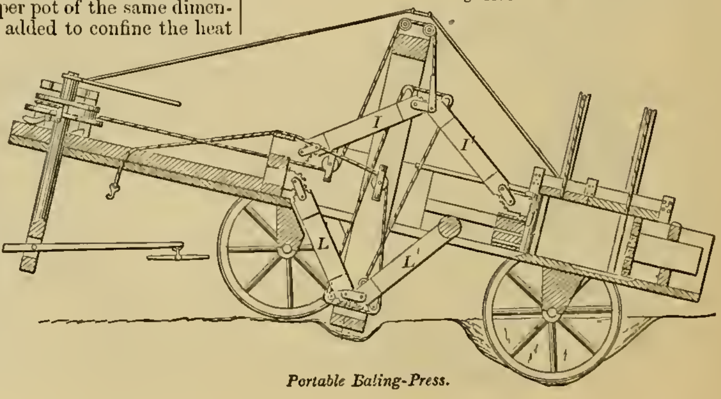


Portable Kettle and Furnace.

Port′a-ble Press. This may be any one among many of the different mechanical constructions. Placing a press on wheels may be said to constitute it a *portable* press, but the necessities of the case sometimes require peculiarities of construction.

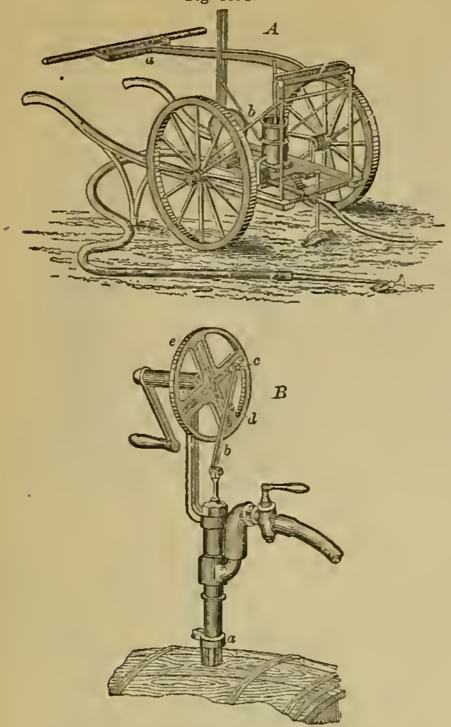
In the example shown, the press is on wheels. The hind wheels are sunk into pits, throwing up the forward end so that draft animals may work the sweep below the fore end, upon

Fig. 3893.



Portable Baling-Press.

Fig. 3894.



Portable Pumps.

which is placed the capstan on which winds the rope by which the toggles are worked.

The abutment head of the press-box is adjustable. When operating as a beater, the follower is operated by toggle-arms *l l'*. The arms are drawn up by a cord, which is tripped from its pulley to allow the said arms to descend. For completing the pressure, additional toggle-arms *L L'* are brought in operation. Both pairs of toggle-arms are operated by a single rope in this latter operation. The lids of the box are balanced by weights to assist in their opening. The passages in the heads for introduction of the hoops are recessed beneath to permit the passage of the arm of the operator, and the box bottom is grooved to guide the hoops from side to side beneath the bale.

Port'a-ble Pump. One for use in an emergency, or for watering gardens, or emptying cisterns or casks.

Baddeley's (*A*, Fig 3894) is a combined suction and force pump, designed for irrigating and manuring purposes. It may also be used as a fire-engine. It is mounted on a carriage, and is operated by means of a brake *a*. An air-chamber *b* enables a continuous stream to be thrown.

Fully and Reece's pump (*B*) is designed for transferring liquids from casks, etc. For this purpose, it is provided with a conical sleeve *a* entering the bung-hole and secured by a clamp-screw. It is operated by a crank which causes two reciprocations of the piston at each revolution by means of the pitman *b*, which has sliding-boxes *c d* working in slots of the arms of the *slosh-wheel e*.

Port'a-ble Rail'way. (*Civil Engineering.*) One so constructed as to be taken apart for transportation and relaid at the different points where a temporary track may be required for bringing or removing earth or other materials during the progress of a work.

Peteler's is composed of sections, each 20 feet long, the rails being of wood, faced on top with iron and united by ties mortised therein. The ends of the sections may be united by bolt, mortise, and tenon attachment, or by hooks and eyes.

Light cars capable of holding from one half to one cubic yard of earth, and of form adapted to the requirements of the ground or material to be moved, are used in connection with the road.

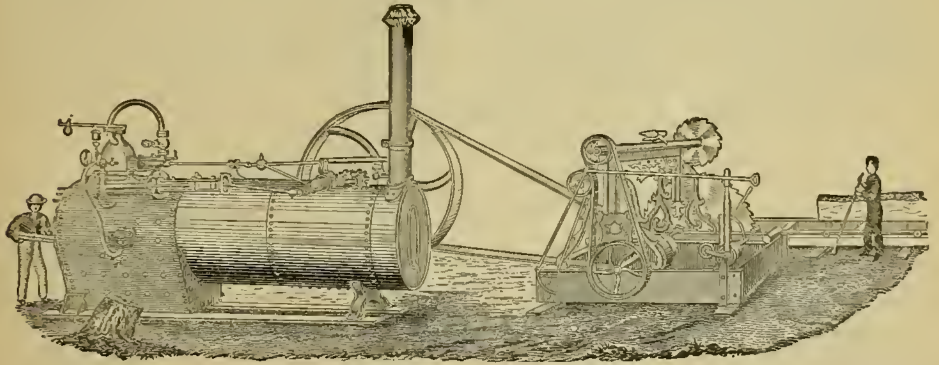
Portable railroads have frequently been made for temporary purposes, such as the conveyance of locomotives, cars, etc., from shops to the permanent way of a railway; also for carrying and dumping earth, gravel, or stone for fillings, embankments, backing of wharf, for ballast and for freight.

Peteler's organized arrangement of detached sections, turn-out, frogs, supporting trestles, bridges, crossings, and turn-tables, patented September 4, 1866, has been utilized in some cases where the distance is not great, and found more economical than carts.

Port'a-ble Steam-en'gine. A steam-engine attached to a boiler and capable of easy transportation. It is generally adapted for out-door work. Locomotives and traction-engines are, strictly speaking, portable engines, but are not generally referred to by that name. See LOCOMOTIVE; TRACTION-ENGINE.

Fig. 3895 shows a form of portable engine much used in the West. The engine is secured to a hollow cylindrical bed-plate, which in turn rests in saddles on the boiler. The object of this bed-plate is to prevent damage to the engine or boiler due to unequal expansion and contraction from the effect of heat The bed-plate is also made to serve as a feed-water heater by the passage of exhaust steam through it on the way to the smoke-stack. The boiler is of the locomotive pattern.

Fig. 3895.



Portable Engine and Saw.

The cut shows the engine at work in the field driving a portable saw-mill.

In Fig. 3896, *A* shows the English form of portable steam-engine for thrashing and grinding grain, grinding bark, pumping, sawing wood, cutting feed, etc. In this, *a* is the tubular boiler with oval fire-grate; *b*, fire-box; *c*, cylinder of engine; *f*, connecting-rod; *g*, governor; *h*, fly-wheel; *i*, cold-water tank, to which is attached the pump for supplying the boiler; *w*, traveling-wheels; *s*, shafts for two horses abreast; *v*, safety-valve.

B, in this figure, is a self-moving engine intended for use with a thrashing-machine, but capable of making short journeys over country roads by its own power and of being used as a traction-engine.

Fig 3897 shows two views of a portable engine adapted for out-door work, and provided with draft attachments for horses

Fig. 3896.

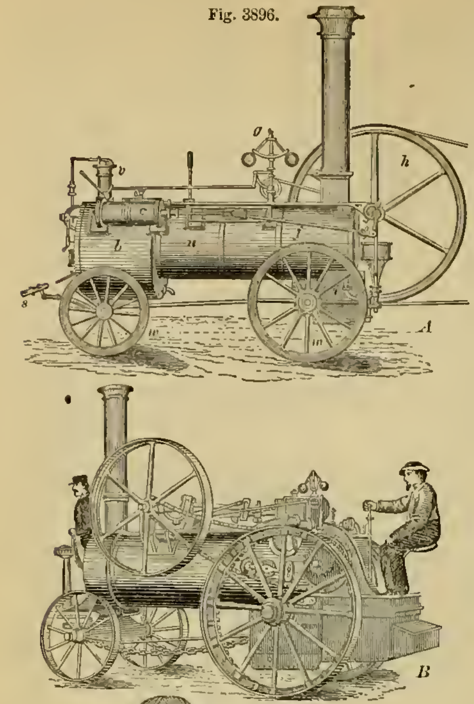
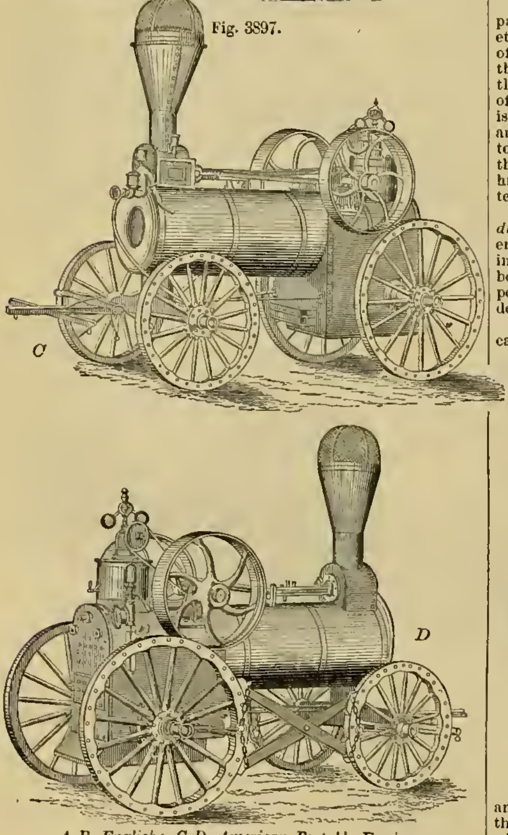


Fig. 3897.



A B, English; C D, American Portable Engines.

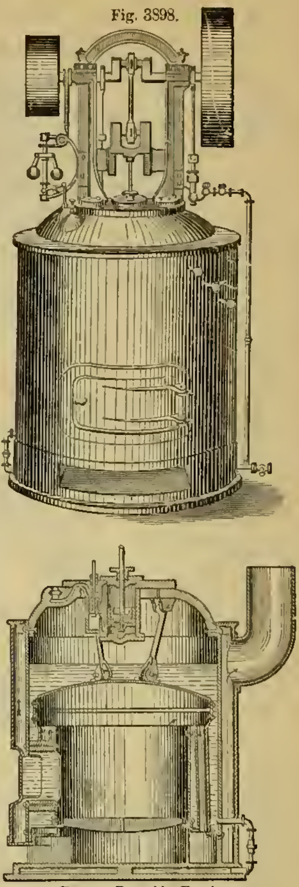
The boilers are of the locomotive pattern, with steam-dome over the fire-box. The steam-cylinder in these engines is in the base of the smoke stack.

D, Fig. 3897, is provided with a locking brake attachment for the wheels, to prevent vibration while the machine is running.

The Baxter portable engine is mounted on top of an upright boiler, and the cylinder, which is also vertical, is within the steam-dome, whereby it is kept hot, preventing condensation of steam in the cylinder. In Fig. 3898, the upper view shows the arrangement of parts of the engine, while the lower cut is a sectional view, showing the position of the cylinder, piston, steam-chest, valves, and valve-rod. It shows also how the interior of the boiler is braced, so as to give it the requisite strength; the position of the grate and combustion-chamber, and the pipe by which the heated water from the water-bottom is forced into the boiler.

Owing to the comparatively large diameter and the placing of the cylinder below the top of the boiler, the center of gravity of the whole machine is brought down low, and shaking of the top frame, on which the driving-wheel is hung, is to a great extent prevented.

Fig. 3898.

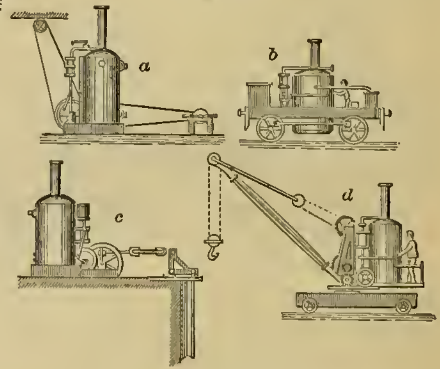


Baxter Portable Engine.

The best reported *duty* of the English portable steam-engine was a 7 horse-power engine built by Hornsby, in which 36 pounds of coal were used in getting up steam; the consumption was 37 pounds per hour, being 5.28 pounds per horse-power per hour, and 370 pounds per day of 10 hours. The Baxter engine has been known to develop 1 horse-power for each 3½ pounds of coal per hour.

In Fig. 3899, *b d* are forms of portable engines mounted on carriages which can be moved from place to place. The engine and boiler *d* swiveled on the carriage form a counterpoise for the weight on the crane *b* is a contractor's locomotive. *a* is adapted to hoisting, and *c* to driving a pump.

Fig. 3899.



Portable Engines for various Purposes.

Port'a-ble Stove. A stove for army, emigrant, or mechanical uses, which require its removal and transportation. Such are used by plumbers, and by those who follow the business of roofing with paper and bituminous compounds, tar, etc. See page 1767.

The stoves are of sheet-iron, and adapted to heat kettles, caldrons, or ovens, as the case may be.

Por'tal. (*Architecture.*) The arch over a door or gateway; an entrance under cover.

Port-cul'lis. (*Fortification.*) A frame of iron or wooden bars sliding in grooves, and capable of being lowered to close a gateway.

Porte-ai-guille'. (*Surgical.*) A fine forceps forming a handle or holder for a needle, having jaws closed by a sliding ring. It is also used for passing a ligature needle around an artery in deep-seated places, out of the reach of an ordinary tenaculum.

Porte-bou-gie'. (*Surgical.*) A silver canula for conducting a bougie into the urethra.

Porte-caus-tique'. (*Surgical.*) An instrument like a porte-crayon for applying a stick of luna-caustic to a deep-seated part.

Porte-cor'don. An instrument made in halves, of whalebone or hard rubber, with an open loop in front, which may be closed by one sliding on the other; it is used for holding or changing the position of the umbilical cord, in obstetrics.

Porte-cray'on. A pencil-case. A handle with sliding jaws to grasp a crayon.

Porte-mèche. (*Surgical.*) A wire instrument having a notch at one end and a button at the other; used to carry a tent or *mèche* into deep ulcers or fistulous openings. See PROBE.

Porte-mon-naie'. A leathern pocket-book for holding money, etc.

Porte-mox'a. (*Surgical.*) An instrument with a ring and handle, and used for applying a moxa to the skin.

Porte-nœud. (*Surgical.*) An instrument for carrying a ligature around the base or pedicle of a tumor.

Porte-pi-erre'. (*Surgical.*) A handle with sliding-jaws to hold a stick of luna-caustic.

Porte-pol'ish-er. A dentist's instrument by which a polishing stick or slip is held and applied. It is like a forceps, and forms a handle for the corundum-points or other abradant.

Por'ter. 1. (*Forging.*) *a.* A long bar of iron attached in continuation of the axis of a heavy forging, whereby it is guided beneath the hammer or into the furnace, being suspended by chains from a crane above. A cross lever fixed to the porter is the means of rotating the forging beneath the hammer.

b. A smaller bar from whose end an article is forged, as a knife-blade, for instance.

2. (*Weaving.*) A weaver's term in Scotland for twenty splits in plain work. In England it is called a *beer*. A *split* is a *dent* of the reed, and when two threads go to a split forty threads go to a *porter*. In England *reeds* are rated by the number of splits to an inch.

Porte-sonde. (*Surgical.*) An instrument resembling a *porte-crayon* or *porte-caustique*, to introduce a *style* or *sonde* into the nasal duct in *fistula lachrymalis*.

Port-fire. A paper tube filled with a composition of niter, sulphur, and mealed gunpowder; formerly used to fire guns. Now superseded by the friction-primer and gun-lock.

The *common port-fire* is sixteen inches long, and is packed with a composition which burns at the rate of about one inch per minute.

The *slow port-fire* consists of paper impregnated with saltpeter and rolled into a solid cylinder about sixteen inches long. It will burn three or four hours.

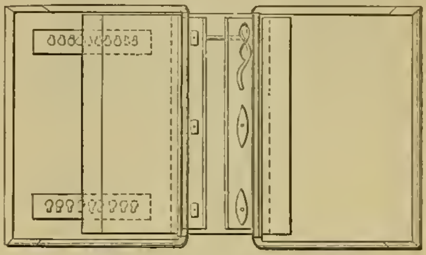
Port-fires may be made by boiling square rods of poplar or other light porous wood in a solution composed of one quart of water to one pound of nitrate of lead for six hours. These are then dried and afterward boiled in spirits of turpentine. One yard will burn three hours.

Port-fire Clip'per. A nippers for cutting off the ends of port-fires.

Port-flange. (*Shipbuilding.*) A batten above the port to keep drip from entering.

Port-fol'io. A case for holding loose drawings or papers. That shown has an adjustable back-piece, which may be extended or contracted in such a way as to increase or diminish the distance between the side covers, and adjust them in any desired position, for the purpose of accommodating any number of sheets of paper. See also PAPER-FILE.

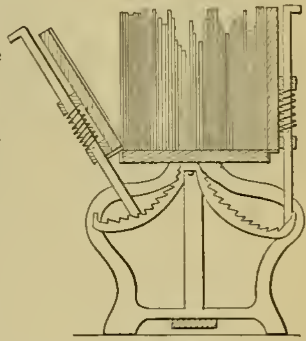
Fig. 3900.



Expansible Portfolio.

Port-fol'io-stand. A piece of furniture for holding folios, music-books, or engravings. In that shown, the side wings can be turned down and adjusted at any desired inclination, and the portfolio opened without removing it from the stand.

Fig 3901.



Portfolio-Stand.

Port-hole. 1. (*Shipbuilding.*) An embrasure in a ship's side.

2. (*Steam.*) The steam-passage into or from the cylinder; an *induction* or *eduction* port.

Port-hole Clos'er. (*Nautical.*) A shutter to close a submarine port; opened for the projection of a torpedo spar or the firing of submarine ordnance.

Por'ti-co. (*Architecture.*) *a.* A sheltered walk with columns.

b. A covered colonnade at the entrance of a building.

c. A porch or gateway.

Port'land Cem'ent. A silicate of lime and alumina obtained by calcination of the stone quarried at Portland on the south coast of England.

A hydraulic lime obtained by the calcination of argillaceous limestone, such as the septaria and lias rocks. Also obtained by the calcination of chalk and clay together. See HYDRAULIC CEMENT.

Port-lan'yard. (*Nautical.*) The rope to draw up a port-lid.

Port-lid. (*Shipbuilding.*) A shutter for closing a *port-hole* in stormy weather. It is hung by hinges above; is held up by ring-bolts and a chain or rope called a *port-pendant;* is secured by bolts, and has *bull's-eyes* for lighting 'tween-decks.

The port-lids of the upper decks are sometimes in two parts. The lower is hung with hinges below, and falls. It is called the *bucklar.* The upper is a half-port to put in by hand, or is hinged above.

Port-man'teau. A hand-trunk. Literally, a *cloak-bag.*

Port Mouth-bit. (*Menage.*) A bridle-bit with a fixed mouth-piece having a light arch.

Port-pen'dant. (*Nautical.*) A tackle to trice the lid of a lower-deck port. It is connected to a ring-bolt on the lid.

Port-rig'gle. (*Nautical.*) A piece of wood nailed over a port to carry off the water.

Port-rope. (*Nautical.*) The lanyard of a port-lid.

Port-sail. (*Nautical.*) A waste sail extended between the ballast-port and ballast-lighter.

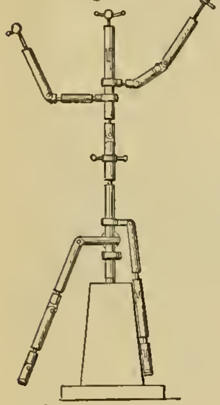
Port-sash. (*Shipbuilding.*) A half-port fitted with sash, to light a cabin.

Port-sill. (*Shipbuilding.*) A short timber lining the port in a ship. Known as *upper, side,* and *lower* port-sills.

Port-tack'le. (*Nautical.*) The purchase for hauling up the lower-deck ports.

Pos'ing-ap'pa-ra'tus. A contrivance for steadying a person in a *pose* or position for a portrait, especially before the camera. The example has a body-rest provided with flexor joints and extension torsion joints, leg-rests, and arm-rest.

Fig. 3902.



Posing-Apparatus.

Po-si'tion-mi-crom'e-ter. (*Optics.*) A micrometer for measuring angles of position, having a single thread or wire which is carried around the common focus of the object-glass and eye-glass, and in a plane perpendicular to the axis of the telescope, the angle being indicated on the graduated circle of the instrument.

Pos'i-tive. 1. *a.* (*Voltaic Electricity.*) The metal, zinc (usually) in the voltaic battery, the pole being called the *anode.*

The negative may be coke, carbon, silver, platinum, or copper, and this pole is called the *cathode.*

The following is the order of the metals, the upper being the most positive: —

Zinc.
Cadmium.
Tin.
Iron.
Lead.
Copper.
Bismuth.
Nickel.
Silver.
Antimony.
Gold
Platinum.

b. (*Vitreous Electricity.*) According to Dr. Franklin's theory and nomenclature, that which a body contains above its natural quantity.

The terms *positive* and *negative,* as applied in electric science, were used by Franklin in 1747; the terms *vitreous* and *resinous* electricity, by Dufay, in 1734–37.

2. (*Photography.*) A photographic print in which the lights and shades have their natural relation, as distinguished from a negative, in which they are reversed.

Pos'i-tive Eye-piece. A combination of lenses at the eye end of a telescope or microscope, consisting of two plano-convex lenses in which the convex sides of the glasses are turned toward each other. See NEGATIVE EYE-PIECE.

Its principal use is in the *micrometer,* and it is often called the micrometer eye-piece, being used to measure a magnified image.

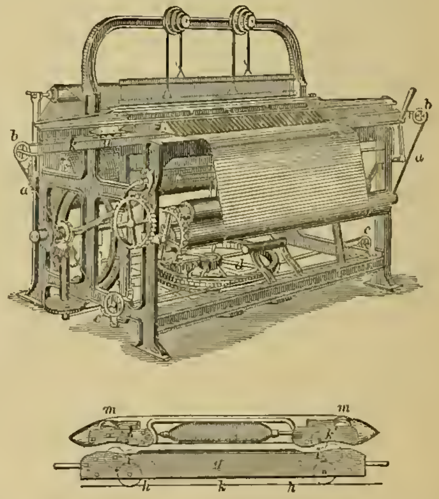
The lenses are separated by a distance a little less than the focal distance of the one nearest to the eye, the image of the object being viewed beyond both lenses.

Pos'i-tive Mo'tion. One derived from the prime mover by complete connection of the intermediate mechanism, in contradistinction to that which acts by the gravitation, friction, elasticity, or other agency residing in the limb or part to be moved.

Pos'i-tive-mo'tion Loom. A loom in which a definite motion both in velocity and amount is imparted to the shuttle.

In Lyall's, this is effected by means of a cylindrical band *a* (Fig. 3903), which passes over and under the pulleys *b b c c,* motion being imparted by the band-wheel *d* actuated by the reciprocating rack *e* and pinion *f,* and is attached to each end of the carriage *g.* The carriage has two sets of wheels *h h i i,* the lower of which roll upon the upper surface of the raceway *k*; the pivots of these wheels turn in slotted bearings, allowing a limited amount of play, and their upper surfaces turn against the lower surfaces of the wheels *i i,* the upper portion of whose peripheries run in contact with the warp-threads. These cause the wheels *k' k'* in the shuttle to turn at precisely the same speed in an opposite direction, so that no lateral motion is imparted to the warp-threads over which they pass. The wheels *m m* roll on the under surface of a beveled rail, which keeps the shuttle down to its work.

Fig. 3903.



Positive-Motion Loom.

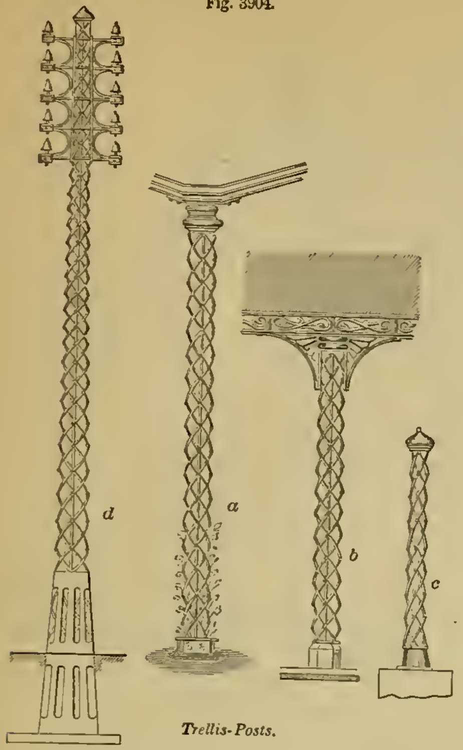
Post. 1. (*Carpentry.*) An upright timber in a frame; as, *king*-post, *queen*-post, *corner*-post, *door*-post, *crown*-post, etc.

2. A pillar or column in a structure.

The celebrated Phœnix post, used extensively for posts and girders for iron structures, is made of four flanged pieces riveted together.

a b are trellis-posts for light superstructures.

Fig. 3904.

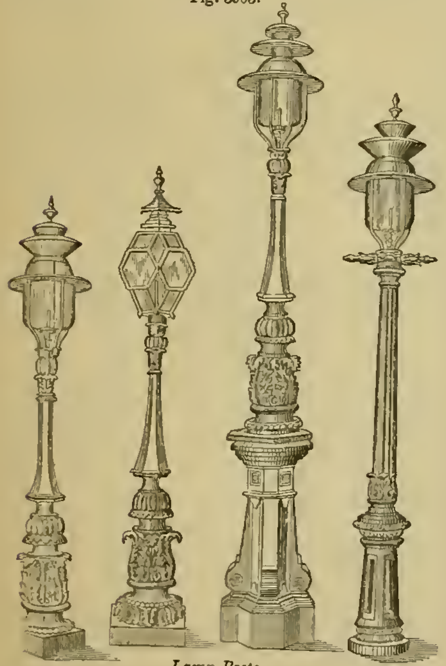


Trellis-Posts.

3. A vertical pillar forming a part of a fence (*c*), or for holding aloft telegraph-wires (*d*).

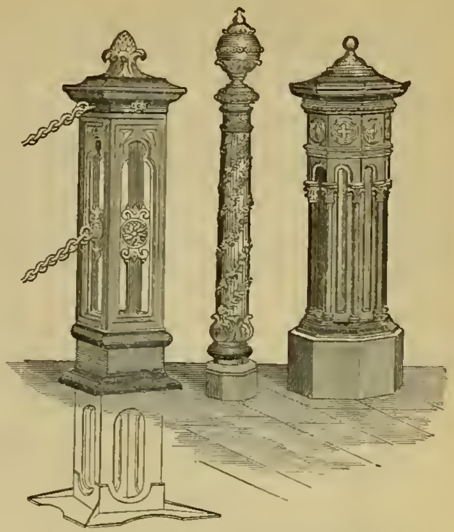
4. (*Furniture.*) *a.* One of the uprights of a bedstead.

Fig. 3905.



Lamp-Posts.

Fig. 3906.



Posts for Urban Use and Cemetery Lots.

b. One of the standards of a chair-back.

5. (*Mining.*) One of the pillars of coal or ore which support the ceiling of a mine.

6. (*Paper-making.*) *a.* A pile of one hundred and forty-four sheets of hand-made paper, fresh from the mold, and made up with a web of felt between each sheet, ready for the first pressure in a screw-press. This is a *felt*-post.

b. A *white* post is the pile of paper sheets when the felts are removed.

c. A size of writing-paper, so called because its original water-mark was a postman's horn.

Twelve varieties of post paper are made in England, of three sizes and various grades of thickness. They are as follows: —

	Size.	Weight per Ream.
Extra large thick post.........	22¼×17¼ inches.	25 pounds.
Extra large thin post..........	22¼×17¼ "	18 "
Extra large bank post.........	22¼×17¼ "	13 "
Large thick post..............	21 ×16½ "	22 "
Large middle post.............	21 ×16½ "	19 "
Large thin post...............	21 ×16½ "	16 "
Large bank post...............	21 ×16½ "	11 "
Extra thick post..............	19 ×15¼ "	25 "
Thick post....................	19 ×15¼ "	20 "
Middle post...................	19 ×15¼ "	17 "
Thin post.....................	19 ×15¼ "	14 "
Bank post.....................	19 ×15¼ "	7 "

Post paper is seldom sold in the *folio*, that is, *flat*, but is cut in halves, folded, and forms quarto post, or common letter-paper.

Cut again and folded, it becomes octavo post, or note-paper. Again cut and refolded, it becomes 16mo, or small note.

Post'al-car. A railway-car specially arranged for the reception, distribution, and delivery of mail matter. Some recently introduced on the Michigan Central Railroad are 48 feet in length, two thirds of the interior being occupied by cases for letters and papers, arranged in semicircular form, and by distributing-tables; the remainder is used as a "through-mail room," where the bags are placed after distribution. A patent bag-catcher, which snatches the mail-bags from cranes at the different stations as the train passes, is fixed to each door of the car.

Post'age-stamp. A stamp attached to a letter or package, to pay for its carriage by mail.

Postage-stamps were in use in Paris in the reign of Louis XIV., 1653. A private post, under royal authority, was established by M. Velayer, August 16, 1653, a stamp being attached to pay for the transportation of the answer. The stamps were on sale at different public places, and had a portrait of the king. They were sold at one sous each. Boxes were placed at street-corners for the reception of the letters, which were collected three times a day.

Postage-stamps for prepayment of letters were adopted in England about 1840, and about eight years afterward in France. Subsequently the idea spread to almost all civilized nations.

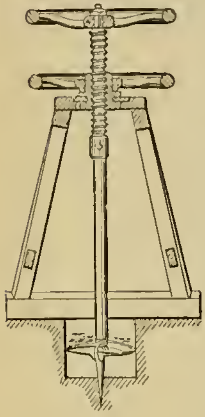
The perforating-machine, for partially dividing the postage-stamps in the sheet, was invented by Mr. Archer of England, 1852, and he received £ 4,000 from Parliament for his invention.

Rowland Hill's penny-postage scheme was adopted January 10, 1840. The number of letters mailed in England rose from 76,000,000 in 1838 to 642,000,000 in 1863. The gross returns rose from £ 2,346,000 to £ 3,870,000; the profits from £ 1,660,000 to £ 1,790,000.

Post and Stall. (*Mining.*) A mode of working coal in which so much is left as pillar and so much is worked away, forming *rooms* and *thurlings*. *Pillars* and *rooms.*

Post-au'ger. An earth-auger for boring post-holes. Fig. 3907 has a screw shaft provided with a point and auger at the bottom, and a wheel at the top which rotates in a nut and feeds the auger into the ground. On retracting the auger the shaft remains stationary and the nut is rotated. See also AUGER; EARTH-AUGER.

Fig. 3907.



Post-Auger.

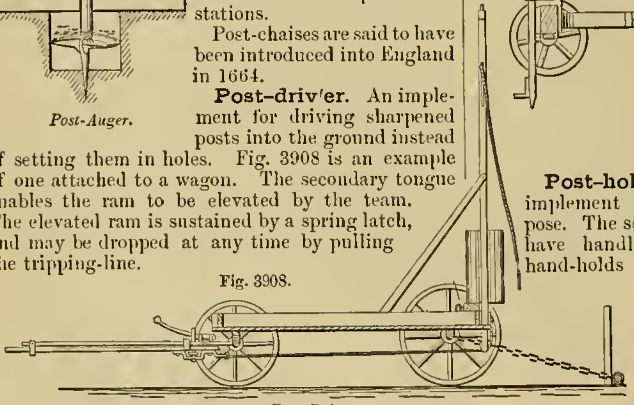
Post-butt. A block inserted in the ground and having a socket to hold a post.

Post-chaise. A closed vehicle for hire, designed to be drawn by relays of horses, hired for each trip between stations.

Post-chaises are said to have been introduced into England in 1664.

Post-driv'er. An implement for driving sharpened posts into the ground instead of setting them in holes. Fig. 3908 is an example of one attached to a wagon. The secondary tongue enables the ram to be elevated by the team. The elevated ram is sustained by a spring latch, and may be dropped at any time by pulling the tripping-line.

Fig. 3908.



Post-Driver.

Fig. 3909 is attached to a sled. A weight is operated within the frame by means of an adjustable hook and rope.

Post'er. A printed sheet to be attached to a wall or boarding, as an advertisement.

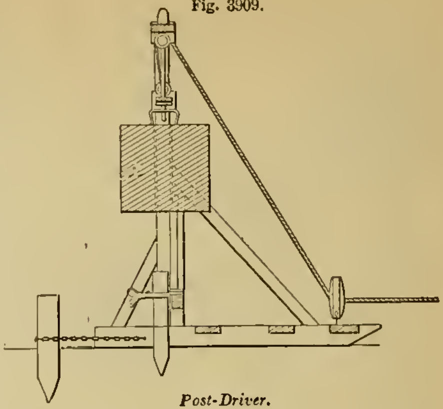
Pos'tern. 1. (*Fortification.*) *a.* A vaulted passage underneath a rampart, leading from the interior to the ditch and closed by a gate.

b. A passage-way at a retired part of a bastion.

2. A small doorway or gateway at the back of a building.

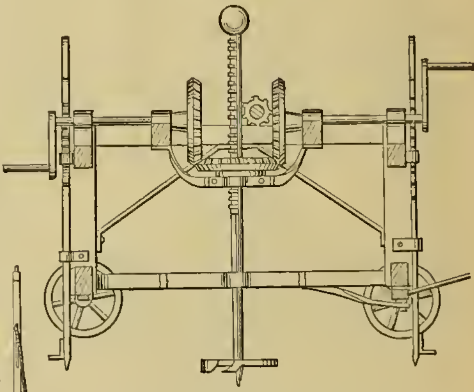
Post-hole Bor'er. An implement for boring holes for fence-posts. In the example, the square shaft of the auger is turned by a bevel-wheel through which it slides, and has a rack into which the spur-wheel is meshed when the earth is to be raised. The wheel is rotated by a hand-crank.

Fig. 3909.



Post-Driver.

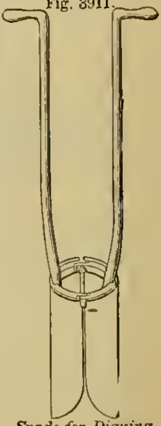
Fig. 3910.



Post-Hole Borer.

Post-hole Dig'ger. Fig. 3911 is a hand implement for this purpose. The segmental spades have handles with radial hand-holds by which they may be turned or oscillated to cut a cylinder of earth, which is withdrawn with the spade. They are so pivoted as to admit of flaring to form an undercut hole. See EARTH-AUGER.

Fig. 3911.



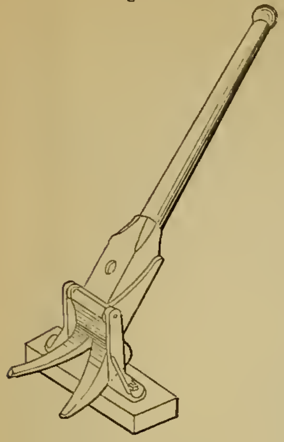
Spade for Digging Post-Holes.

Post-hook. (*Harness.*) A check-rein hook, having an ornamental post extending up above the opening for the rein.

Post-horn. (*Music.*) A small horn for stages and canal-boats, to sound an alarm for relay of horses, notice to keepers of canal-locks, etc. See HORN.

Post-jack. An implement for lifting posts out of the ground. It is a crow-bar pivoted in a base piece and having a claw which catches against the post.

Fig. 3912.



Post-Puller.

Post-mill. An old form of windmill which was mounted on a post. The post was continued through several stories, and formed the axis on which the mill veered as the wind changed.

Post-mor'tem Case. A small pocket-case of instruments in which the box, like a knife-handle, is made the receptacle for the necessary tools, a small saw, scalpels, bone-chisels, needles, and a tool-handle. Other cases are made larger, but the above is designed to avoid notice on the part of the relatives in cases of autopsy.

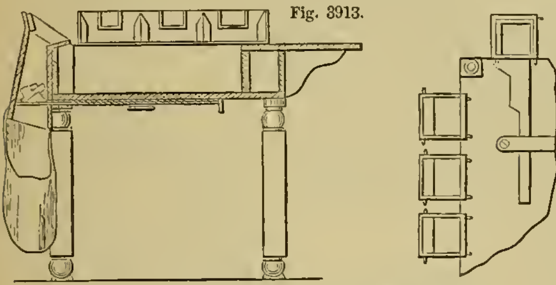
Post-of'fice Box. 1. A case or a locked box into which the letters of a person or firm are distributed, so that they can be handed thence by an official or taken thence by the owner by opening a door at the other end from the distributor.

2. A series of pigeon-holes into which letters for a given destination or mail-bag are distributed at the receiving station or in a postal car.

Fig. 3913 is a table for the distribution of mail matter, having a series of boxes at its edges, with hooks upon them for the attachment of bags. The sides presented to the operator have racks to hold cards of designation.

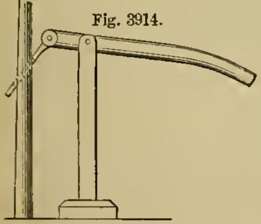
3. A box at a post-office or convenient place in a street, on a lamp-post or otherwise, to receive letters to be gathered by the carrier.

Fig. 3913.



Post-Office Distributing-Table.

Fig. 3914.



Hop-Pole Puller.

Post-pull'er. An implement to pull posts out of the ground. Fig. 3914 is one form in which a lever pivoted to a post has a shackle on its end which grips and lifts the hop-pole.

Post-tab'u-la. (*Architecture.*) The wall or screen at the back of an altar. *Retro-tabula* ; *reredos*.

Pot. 1. (*Sugar.*) A perforated hogshead in which crude sugar is placed for drainage of the molasses.

2. (*Tinning.*) *a.* A vessel filled with melted tallow in which the charcoal-iron plates are dipped before tinning. *Grease-pot.*

b. A bath used in the same work, known as a *wash-pot.*

3. (*Founding.*) A brass-founder's name for a crucible. Graphite pots are most generally in use.

Po'tance. (*Watchmaking.*) The stud which forms a step for the lower pivot of a verge.

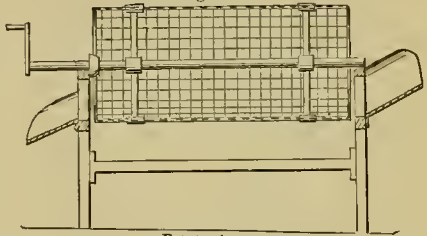
Po'tance-file. A small hand-file with parallel and flat sides.

Po-tas'si-um. Equivalent, 39.2 ; symbol, *K* (kalium) ; specific gravity, 0.865 ; fusing-point, 136° Fah. This metallic base of the alkali potassa was discovered by Sir Humphry Davy in 1807. It is a brilliant, silver-white metal, tarnishes immediately on exposure to the atmosphere ; is soft at ordinary temperatures, brittle at 32° Fah. Its affinity for oxygen is so energetic that water is decomposed by contact, the liberated hydrogen being inflamed.

The salts of potash are very useful in the arts, as ingredients in glazes for pottery, fluxes in glass, in soap-making, washing, gunpowder, etc., etc.

Po-ta'to-as-sort'er. A rolling screen with open meshes to allow small potatoes to be sorted from the larger merchantable ones.

Fig. 3915.



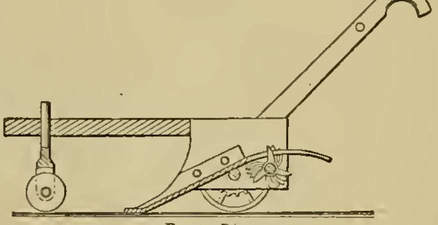
Potato-Assorter.

Po-ta'to-bug Clean'er. An implement to travel down the rows of plants and beat off the bugs into a tray, in which they are collected and killed.

Po-ta'to-dig'ger. (*Husbandry.*) An implement for digging potatoes from the row or hills, and depositing them on the surface of the ground or in a box on the machine.

Fig. 3916 is supported on a wheel, and has a grating or bars which lift the tubers, sift the earth from among them, and drop them on the surface of the ground.

Fig. 3916.

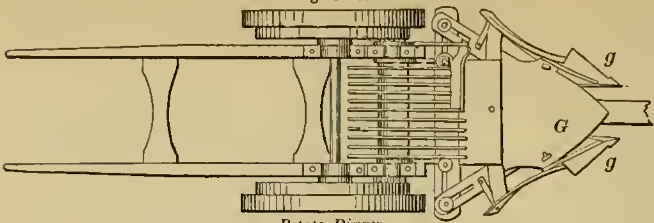


Potato-Digger.

Fig. 3917 is a more complicated implement, which has a pair of side plows *g g*, a middle plow *G* with a large wide share which slips under the hill of tubers and lifts them : they are then pushed back on the grating, which allows the dirt to fall through, and the tubers drop off the end of the grating.

In Fig. 3918, the potatoes, after lifting, are carried over the longitudinally barred screen, and then divested of the earth upon the rotating-screen. The cams near the fore end regulate

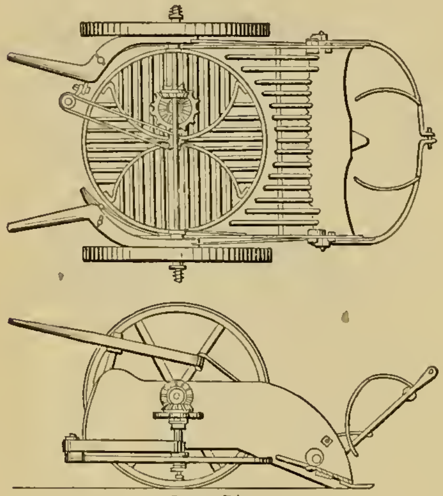
Fig. 3917.



Potato-Digger.

the inclination of the scraper at the fore end of the fixed screen.

Fig. 3918.



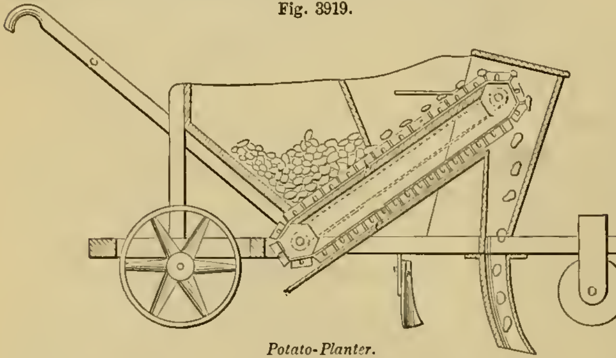
Potato-Digger.

Po-ta'to-hook. (*Husbandry.*) An implement with bent tines, used in digging potatoes.

Po-ta'to-mash'er. (*Domestic.*) A kitchen implement for mashing cooked potatoes. It is often a mere wooden pounder, but may also be made of wire. In the example (Fig. 3920), the lower face of the masher consists of a coil, and it is attached to the handle by ribs.

Po-ta'to-plant'er. (*Husbandry.*) An implement for dropping potatoes into a furrow and covering them. There are many kinds. The example has an endless traversing belt with a series of pockets which pass under a striker to remove superfluous sets, and open to drop their sets into the planting share, which precedes the covering shares and the roller, which acts as a driving-wheel.

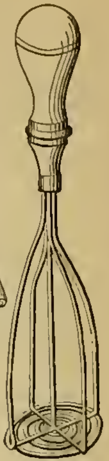
Fig. 3919.



Potato-Planter.

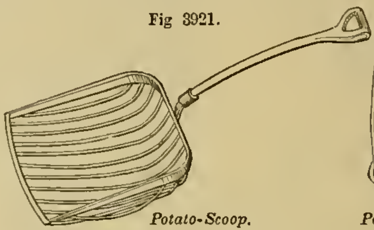
Po-ta'to-scoop. (*Husbandry.*) A grated shovel which allows the soil to sift through while detaining the potatoes. The iron rods or wires are placed at equal distances on an iron frame, which is attached to a wooden handle and acts as a screen in shoveling potatoes or other roots.

Fig. 3920.



Potato-Masher.

Fig 3921.



Potato-Scoop.

Po-ta'to-sep'a-ra'tor. An implement used for the purpose of sorting the tubers in sizes; for feed, market, seed, etc.

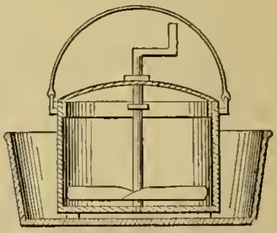
One form consists of three screens with meshes of different sizes, spouts conducting to separate receptacles the tubers detained by each screen.

Another form is a revolving drum, which has different sized meshes at different parts of its length.

Po-ta'to-wash'er. For washing potatoes in large quantity for feed or starch-making, they are placed in a slatted cylinder which is rotated by a hand-crank, the axis being supported on the ends of a trough of water. The friction of the potatoes on each other and against the slats of the cylinder cleans the dirt from them.

The example is one on a small scale for kitchen use. The tubers are stirred round and round by the arms on the revolving shaft.

Fig. 3922.



Potato-Washer.

Potch'er-en'gine. (*Paper-making.*) A machine in which washed rags are intimately mixed with a bleaching solution of chloride of lime, after which they are allowed to steep in bins, from which the liquor is drawn off when the bleaching process is completed.

Pot-eye. (*Spinning.*) A guide-eye for a yarn in a spinning-frame. Through it the yarn passes from the rollers to the flyer. Made of metal, glass, or porcelain.

Pot-gun. A mortar for firing salutes. The name is derived from its shape.

Pot-hook. An S-shaped hook for suspending a culinary vessel from a chimney-crane.

Po'ti-cho-ma'ni-a. Glass-ware coated with paper or linen flowers and varnished, in imitation of old China.

Pot-lid Valve. 1. A cap-formed valve which shuts down like a cover upon a port or the end of a pipe.

2. The cover of the air-pump of a steam-engine.

Pot-met'al. 1. A cheap alloy for faucets, etc. : copper, 10 ; lead, 6 to 8.

2. A grade of cast-iron suitable for casting hollow ware.

3. A species of stained glass, the colors of which are incorporated with the glass while the latter is in a state of fusion in the *pot.*

Pott. An English size of writing-paper, the smallest measuring 15½ × 12½ inches, and weighing 10 pounds to the ream.

Pot'ter's Lathe. (*Pottery.*) The revolving disk on which the potter whirls the clay while he shapes it with his hand and with tools. A *whirling-table ; jigger ; thrower ; throwing-machine.*

A sharp tool is employed, which at once turns off and polishes the surface of the work. The band-wheel is turned by means of a winch.

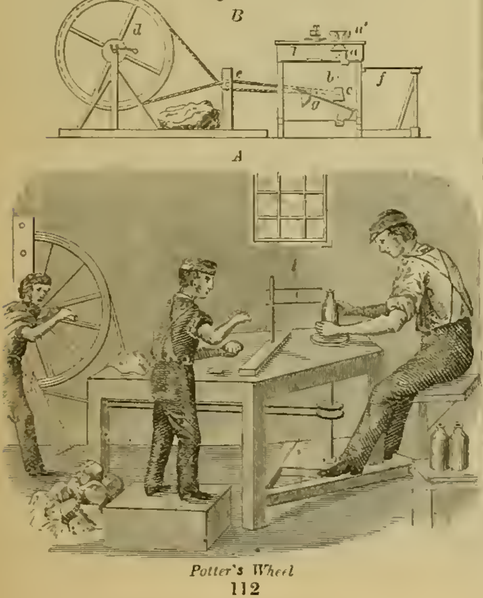
In large potteries, where steam-power is employed, cone-pulleys are applied to the lathe, which impart motion to the shaft (*b*, Fig. 3923) through the medium of bevel-gearing, the speed being varied to correspond with the demands of the work.

The potter's lathe is also known as a *throwing-machine* or a *jigger.* See POTTER'S WHEEL.

Pot'ter's Wheel. A horizontally revolving disk (*A*, Fig. 3923) driven by a treadle or by an assistant. The lump of clay, being placed upon it, is molded into form by pressure on the inside and outside, properly applied, the circular form being maintained by the passage of the clay between the hands, assisted by a piece of horn or shell, which is called a "rib," and acts as a former, straight-edge, or scraper, as the case may be. (See POTTERY.) Also known as a *jigger, thrower, thrower's engine, thrower's wheel.*

No wheel was used in the construction of the pottery found in the ancient British tumuli. The same is stated by Mr. Bateman of the ceramic remains in the Roman tumuli. The latter seldom have handles, are destitute of spouts, and the ornaments are straight lines, dots, or marks made by cords.

Fig. 3923.



Potter's Wheel

The potter's wheel was also unknown in the ancient pottery of the North American tumuli. Some of the jars of the "Stone age" show that a kind of templet has been used inside, held by one hand, probably against the pressure of the other hand on the outside.

After it has been roughly fashioned on the *wheel* and allowed to become partially dry, the work is finished on the lathe *B*, which is merely the *wheel* somewhat modified and refined. *a* is the head, carrying a disk upon which the mass of clay *a*' is placed, and turned by the shaft *b*, which carries a set of grooved pulleys *c*, of different diameters, driven by a belt from the band-wheel *d*; *e* is a guide-pulley which converts the vertical motion of the hand so as to cause the horizontal revolution of the pulley *c*; *f* is a seat on which the workman sits astride, placing his feet on the treadle *g*. The lower figure shows adjustable rods serving as a gage for the guidance of the workman ; *l* a ledge-board for receiving the clay shavings.

Pot'ter-y. Earthenware glazed and baked.

Clay possesses the property of plasticity ; that is, when moistened, it yields to pressure in any direction without breaking, and when the pressure is removed retains the form imparted. If dried at a moderate heat and then crumbled by pressure, it may be again kneaded, and resume its plasticity ; but if baked at a red heat, it acquires a hardness beyond that acquired by mere drying, and if crumbled after baking, can never again become plastic by incorporation with water.

Clay unmixed contracts in drying, exfoliates, and falls to pieces. Sand corrects this, and when introduced within given proportions does not impair the elasticity. Natural clays have almost always more or less lime, magnesia, iron, and salt, which complicate the conditions, as they act as fluxes and confer color upon the ware. Iron alone gives a red color ; iron and lime, cream-brown. The presence of magnesia in addition to the others gives a brownish yellow. The presence of carbonates is sometimes indicated by holes in the ware, produced by carbonic acid, which escapes in the form of gas. Another effect of the lime is to combine with the alumina and prevent its contraction. At a more intense heat the ingredients assume a nearly vitreous condition, and the oxide of iron assumes a bluish or greenish color. The salt is also decomposed, and its base assists the lime. The magnesia may combine with sulphuric acid derived from pyrites in the clay or sulphur in the coal, and is seen in efflorescence on the inside of the kiln.

The Egyptian modes of working the clay, and turning, baking, and polishing the jars, are shown in the tombs of Beni Hassan and Thebes. The clay was kneaded by the feet ; formed into clots of a proper size by hand, and placed on the wheel, which was of very simple construction and turned by hand. The handles, as with us, were separately made and subsequently attached. The required ornament was traced on them while soft ; they were then dried or baked by the escaping heat from the ovens.

The accompanying cut is from a tomb at Beni Hassan, time of Osirtasen or thereabout, 1706 B. C. The aim of the artist was to depict the successive manipulations. Four of the figures are represented working at separate wheels. One forms the inside and lip of the cup as it revolves with the table, holding his thumb dexterously inside against the modified resisting pressure of the left hand. The next man is forming the outside and cutting the cup off at its base, which is not at the bottom of the lump. This is now done by a wire. The third represents another stage of the process, the cup being removed and held aloft in the hand. The fourth man dabs on a new lump of clay, and this completes the series. Cups in various places indicate the character of the manufacture in progress. In the next place, we see a man forming a circular slab of clay. The next is raking the fire. Then follows a man handing a cup to another, who places it on the grate above the opening in the furnace-top, where it is baked. The next man carries off the baked cups in baskets supported on the yoke, which was universally used for carrying.

The date of these paintings entirely upsets the statements of Pliny, who attributes the invention of the potter's wheel to Choræbus the Athenian, or Anacharisis the Scythian. These paintings were made and the tombs closed on the mortal dust of their occupants 200 years before Cecrops.

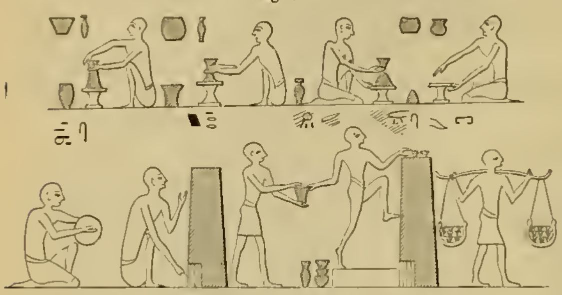
On the walls of the tombs of ancient Egypt are painted Ptah the Creator and Neph the Divine Spirit sitting at the potter's wheel turning clay to form men. See PORCELAIN.

> " As when, before his wheel
> Seated, the potter twirls it with both hands," etc
> HOMER, *Iliad*, XIII. 5.

The pottery of Samos was famous in the time of Homer.

Vases of many beautiful shapes, with single and double handles and very gorgeously colored, are shown in the magnificent French work, " Description de l'Egypte, par les Ordres de sa Majesté l'Empereur Napoleon le Grand " The work is in the Congressional Library in Washington, and the illustrations are on Plate 92, Vol. II., in the portion of the volume treating of the Antiquities of Thebes.

Fig. 3924.



Egyptian Pottery (from Beni Hassan).

The Egyptian pottery in the Metropolitan Museum, New York, includes a specimen asserted to be the oldest piece of glazed pottery with fixable date extant; it is an elongated bead, covered with glass glaze, and assigued to the period of Amon'm'he III., fifth king of the XIIth Dynasty, at a date of about 2020 B. C. This vitreous enamel, almost choking the finer lines of the model, is seen in blue and other colors on many of the little sacred images derived from tombs, and on many of the bead necklaces and ornaments accompanying mummies in the same collection.

" On the clay tablets which we have found at Nineveh, and which are now to be counted by thousands, there are explanatory treatises on almost every subject under the sun: the art of writing, grammars, and dictionaries, notation, weights, and measures, divisions of time, chronology, astronomy, geography, history, mythology, geology, botany, etc. In fact, we have now at our disposal a perfect cyclopædia of Assyrian science." — SIR HENRY RAWLINSON, 1853.

> " Offspring of clay and furnace bright,
> The choicest pottery clear and light,
> Boasts, as its birthplace, of the towers
> Which Neptune's and Minerva's powers
> From ills and dangers shield;
> Which beat back war's barbaric wave
> When Mede and Persian found a grave
> On Marathon's undying field."
> CAITIAS; quoted by ATHENÆUS, A. D. 220.

The chronicler of the " Deipnosophists" goes on to say: —

" And indeed the pottery of Attica is deservedly praised. But Eubulus says: ' Cnidian pots, Sicilian platters, and Megarian jars.' "

Perhaps no other art has done so much as the ceramic to preserve to us the appearance and habits of the peoples of the past. What with domestic, decorative, and funereal urns and lachrymatories, there are but few nations, it would seem, but have left traces to help us to some conception of their tastes and their capacities. The Metropolitan Museum of New York has a great collection, made by General Di Cesnola, United States Consul at Cyprus See the following works: Marryat's " History of Pottery and Porcelain," London, 1857; Burty's " Chefs-d'Œuvre of the Industrial Arts," Appleton & Co., 1869; " Life of Josiah Wedgwood," London, 1865.

The earthenware of the Greeks and Romans was unglazed, but they covered their pottery with wax, tallow, bitumen, and perhaps other articles, to render them impervious to water, wine, etc. The Romans used molds for ornamenting clay vessels and for making figures of idols, or of limbs, plants, etc., for votive offerings. The Peruvians use tallow, which is spread on while the ware is hot, and becomes partially carbonized The Etruscan ware has a similar appearance. In Italy and Spain, ancient and modern, wine-jars are rubbed with wax to render them impervious to liquids

The art of making glazed pottery originated with the Chinese, and passed from thence to India, and from thence successively to Arabia, Spain, Italy, Holland.

In the Alhambra of Granada some of the rooms are ornamented with glazed tiles. The tomb of Sultan Mahommed Khoda-Bendeh, at Sultanieh in Persia, was built in the thirteenth century, and has green enameled tiles on the outside and blue within. The painted mosque of Gour, in India, built in 1475, derives its name from the number of glazed tiles with which it is ornamented The Caravanserai of Mayar, near Ispahan, built by the mother of Shah Abbas, about 1550, has a covering of green glazed tiles on the front of the principal gateway. See TILE.

The material of which the Peruvian pottery was made was a colored earth and blackish clay, well tempered evidently, but apparently without glaze. Singular designs were embodied in their religious and sepulchral vases, which were destined to receive the *chicha* on sacrifice days. The long throat formed the handle, and a second opening admitted or demitted the air when emptying or filling. They were made double, treble, or quadruple; were engraved, painted, and ornamented in relief.

Of all the Polynesians, the Feejees alone had the art of making pottery. They did not have the wheel, but the women artificers made graceful and beautiful forms. Their tools were a small flat stone to form the inside, and a spatula for the outer surface. With these tools they made articles almost as perfect as lathe-formed ware.

Dr. Livingstone admired the skill in making pottery evinced by the tribes encountered in his " Expedition to the Zambesi."

The town of Delft, in Holland, became celebrated for the manufacture of earthenware, which is held to have been equal in quality to its Italian progenitor, but inferior in its ornamentation, apparently vying with China in its peculiar and almost grotesque modes of representing natural objects. See PORCELAIN.

The potteries of Lambeth, London, were started by men from Holland, about 1640.

The potteries of Staffordshire soon took the preëminence.

John Wedgwood was born at Burslem, England, in 1730, and after a variety of experiences such as would sadden and kill an average man, started a pottery on his own account, where he improved the productions of his art. In his second manufactory he established the white stone-ware, and in the third the cream-colored ware which gave him so much celebrity. He also originated a *terra-cotta* which could be made to resemble porphyry, granite, Egyptian pebble, and other stones of the siliceous or crystalline kind; a black porcelainous biscuit called basaltes; a white and cane-colored porcelain biscuit, smooth and wax-like; and another white porcelainous biscuit, which receives color from metallic oxides like glass on enamel, in fusion.

This property renders it applicable to the production of cameos, and all subjects required to be shown in bas-relief, as the ground can be made of any color, while the raised figures are those of the purest white He likewise invented a porcelain biscuit nearly as hard as agate, which will resist the action of almost all corrosive substances, and is consequently well adapted for mortars in the chemist's laboratory.

While honoring the names of those who have distinguished themselves in making pottery an art, we must remember Charles Avisseau (born, 1796) the potter of Tours, the city celebrated for the great victory gained by Charles Martel over the Saracens, October 10, 732, — a victory which, under God, determined the language, religion, and the form of civilization of Europe. Palissy had died three centuries before, the secret of his process dying with him, and Avisseau set about rediscovering the lost art. He succeeded in firing the wares without their undergoing any change and without the use of white glaze. He also composed a series of colors, all fusible at the same temperature, and also a gold enamel. He refused offers to devote his talents to the national establishment of Sèvres, preferring to maintain his independence and devote himself to a life of experiments and labor at his humble home in Tours.

The materials chiefly used in the North Staffordshire potteries are a light brown clay from Poole in Dorsetshire, and white clay from Cornwall, to which pulverized flint or granite is frequently added. The clays are derived from decomposed granite, and are prepared by mixing them in a *plunger* containing a large wheel, by which they are, with the addition of water, converted into a mass of the consistency of cream. This is run off into small reservoirs, termed *arks*, whence it is pumped up and passed through a series of sieves, by which it is reduced to *slip*. This is forced, under a pressure of 80 pounds to the square inch, into *chambers*, shallow pans over which are placed linen covers, in which the slip is received, permitting the escape of the expelled moisture and leaving it of a doughy consistency. It is then passed through a *pug*, a chamber having a spiral revolving blade, where it is hardened and compressed, and after being formed into large square cakes is placed in a dark cellar, where it undergoes the process of fermentation.

From these blocks are formed *stilts* and *spurs*, used for supporting pieces of pottery and porcelain in the drying-stoves. The blocks are placed in a rectangular chamber having a piston by which the clay is forced out through apertures of square, round, triangular, or other form adapted to the machine employed in the succeeding process. The flat pieces are called *backs*; the others, *shapes*. These are cut by a guillotine-like instrument into proper lengths, and then stamped by means of leaden dies in a press, by which a large number are formed at each impression.

The *stilts* or *spurs* are generally of triangular form, and have sharp projecting points. They are now placed in oval *saggars*, made of marl, which are inserted in a furnace and exposed to an intense heat for forty hours.

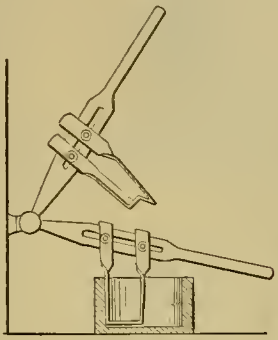
Common door-knobs, furniture casters, telegraph insulators, and similar articles are turned in the usual manner, while lock furniture of colored porcelain is stamped in dies from the dry clay-dust; these are then baked and dipped in glaze, which is afterward melted in ovens.

Pot′ter-y and Clay. See also under the following heads: —

Arch-brick.
Bags.
Bat-printing.
Batter.
Batting-block.
Biscuit.
Bisque.
Blowing-pot.
Blunging.
Bossing.
Bottger-ware.
Brick.
Brick-clamp.
Brick-dryer.
Brick-kiln.
Brick-machine.
Brick-mold.
Brick-press.
Brown-ware.
Bung.
Casting clay-ware.
Chimney-pot.
China.
Churn.
Clamp.
Clapper.
Clay-mill.
Clay-pipe.
Clay-pulverizer.
Clay-screening machine.
Clinker.
Cockle.
Cockspur.
Compass-brick.
Concave-brick.
Concrete-pipe.
Crazing.
Crockery-ware.
Crucible.
Crucible-mold.
Crucible-oven.
Cutter.
Delft.
Dod.
Draining-pipe.
Dressing-bench.
Earthen-pipe.
Earthenware.
Email-ombrant.
Enamel-kiln.
Encaustic tile.
Faience.
Fat-lute.
Fire-brick.
Flint-mill.
Float-stone.
Fusible porcelain.
Gaged brick.
Gilding porcelain.
Glaze.
Glaze-kiln.
Glost-oven.
Green-house.
Grinding-vat.
Ground-laying
Hack.
Hack-barrow.
Hake.
Hardening-kiln.
Hard porcelain.
Hip-tile.
Hot-house.
Hovel.
Ironstone-china.
Jigger.
Kaolin.
Later.
Lath-brick.
Lawn.
Luster-ware.
Lute.
Majolica-ware.
Malm-brick.
Marle-stock.
Milling.
Molding.
Molding-tile.
Mosaic tile.
Oven.
Page.
Pallet.
Parian.
Pavior.
Pipe-molding.
Plunger.
Polished brick.
Porcelain.
Porcelain-gilding.
Porcelain-mill.
Porcelain-printing.
Potter's lathe.
Pottery.
Pottery-gage.
Pottery-kiln.
Pottery-molding.
Pottery-painting.
Pottery-printing.
Pottery-tissue.
Pressed brick.
Press-printing.
Pug-mill.
Refractory.
Re-pressing machine.
Saggar.
Setter.
Sèvres porcelain.
Slapping.
Slicing-machine.
Slip.
Slip-kiln.
Slop-molding.
Smearing
Spattle.
Splayer.
Stamper.
Stilt.
Stock-board.
Stone-ware.
Strickle.
Strike.
Tempering-wheel.
Tender-porcelain.
Terra-cotta.
Tessellated tile.
Tesseræ.
Thrower.
Throwing-engine.
Thwacking-frame.
Tile.
Tile. Encaustic
Tile-kiln.
Tile-laying plow.
Tile-machine.
Tournasin.
Triangle.
Turning.
Ventilating bricks.
Watch.
Wedging.
Wedgwood-ware.
Whirling-table.
Worming-pot.

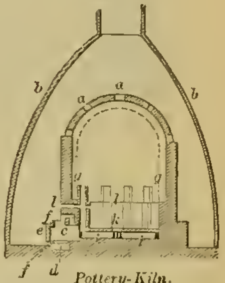
Pot′ter-y-gage. A shaper or templet for the inside of a vessel on the wheel. It is designed to finish the inside of stoneware smoothly and of a uniform size.

Fig. 3925.



Pottery-Gage.

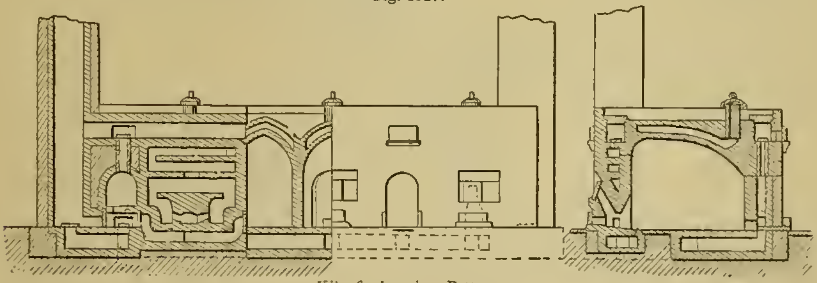
Fig. 3926.



Pottery-Kiln.

Pot′ter-y-kiln. The pottery-kiln, shown in section (Fig. 3926), consists of a cylinder of brick-work surrounded by iron bands and having a hemispherical top with apertures *a a* for the escape of smoke. It is surrounded by a cover *b*, which protects it from the cooling effects of air and rain, and has a chimney. Six or eight fireplaces are arranged equidistantly around the cylinder. *c* is the grate of one of these fireplaces; *d*, the ash-pit; *e*, the door; *f f*, draft-openings; between the furnace wall and the chimneys *g g* is an annular space about 15 inches wide, elevated about 3½ feet above the floor, below which are flues *i i* for the circulation of flame, all meeting at the center *k*. *l l* are sight-holes, enabling the workmen to see the interior of the kiln, that they may watch the action of the fire and regulate the draft accordingly.

Fig. 3927.

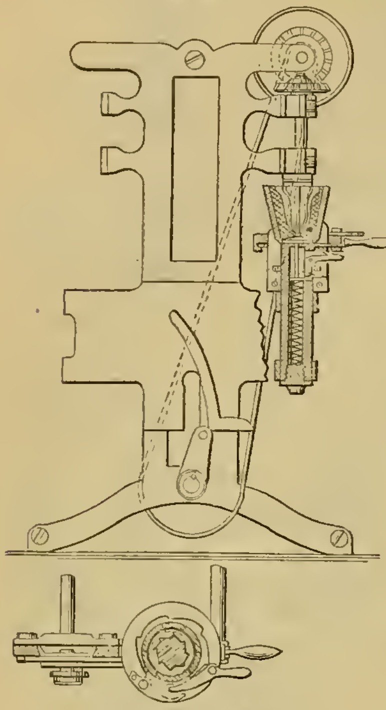


Kiln for burning Pottery.

In Fig. 3927, the gases and products of combustion pass off through the doorways or double walls and openings connected with the lower flue, a top flue connecting the space between them by means of tubes for carrying off the vapor of the green material, there being a double arch for heating the air on its way to the fireplace and returning it. A bottom flue also communicates with the kilns and smoke-stacks, to prevent the loss of heat and drawing up of moisture in the kiln. The views are a partial longitudinal section and elevation, and a transverse section.

Pot′ter-y-mold′ing. A machine for shaping articles of plastic clay. The flask is attached to a vertically sliding frame, and its charge is brought into contact with a revolving core. The flask is composed of a series of sections, which can be opened to remove the pot after molding. The bottom of the flask is also movable, and is pressed up to facilitate the removal of the molded pot.

Fig. 3928.



Pottery-Molding Machine.

Pot′ter-y-paint′ing. In this art enamel colors are used, such as will withstand the fire unchanged or will develop their colors under heat. Various metallic oxides are used for this purpose. See ENAMEL.

Painted porcelain is fired in a muffle-furnace.

Pot′ter-y-print′ing. (*Pottery.*) The device for the plate or other article is engraved on copper or otherwise, and an impression taken on a piece of unsized paper. This is wetted and placed over the plate, which is in the biscuit condition. The ink adheres to the plate when the paper is removed.

Another plan is to take an impression in oil only, and then dust the color on to the plate, to which it only adheres in the parts covered with oil.

The surface of the printed ware is covered with glaze, the ware placed in a *saggar* and burnt in a kiln.

Pot′ter-y-tis′sue. A kind of tissue-paper used to receive impressions of engravings for transference to *biscuit.* See PRESS-PRINTING.

The paper is made on the Fourdrinier machine in lengths sometimes equal to 1,200 yards.

Pot′ting. The cleansing of sugar by placing it while soft in inverted conical molds with a mass of saturated clay on top.

Placing new sugar in barrels to drain.

Pot′ting-cask. (*Sugar.*) A hogshead with holes in the bottom into which imperfectly crystallized sugar is dipped in order that the molasses may drain from it. In each hole is placed a crushed stalk of cane or plantain, which reaches to the top of the sugar. The molasses passes off through the spongy stalk, leaving the sugar comparatively dry and more perfectly crystallized.

Pot-wheel. A form of water-raising wheel. See NORIA.

Pouch. 1. A bag, usually leathern, for mail matter, money, or ammunition.

2. A cartridge-box.

Pou-de-soy; Pad′e-soy; Pod′de-soy. (*Fabric.*) A rich plain silk.

Pou-lon′. (*Fabric.*) A close woolen Thibetan stuff.

Poul′tice-boot. (*Menage.*) A large boot used for applying poultices to horses' legs. It is made of soft leather for the sides and a heavy sole-leather bottom.

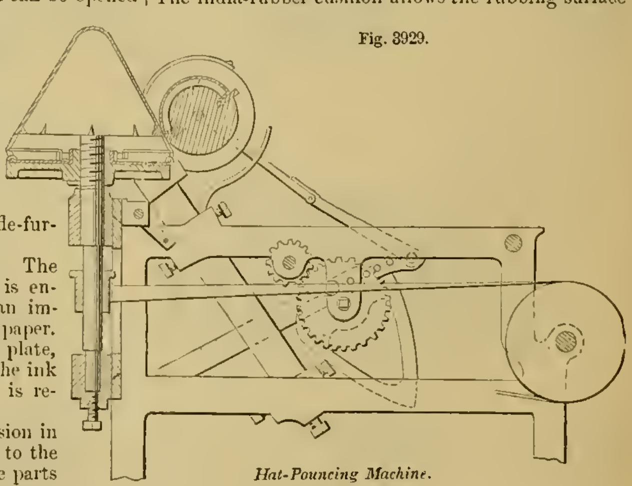
Poul′try-feed′er. A device to feed grain to fowls in quantity as used. It is upon the principle of the fountain-inkstand or the water-bottle for bird-cages, grain falling down into the trough as the latter is emptied.

Pounce. Pounded gum-sandarach and cuttle-fish bones. Used on freshly written manuscript instead of blotting-paper.

Pounce-pa′per. A tracing-paper prepared at Carlsruhe without oil.

Pounc′ing-ma-chine′. (*Hat-making.*) A machine for raising a nap upon hat-bodies by a grinding action. In Fig. 3929, the sand-paper or other rubbing surface has a rising or falling motion in an inclined direction, so as to act in a conical form; the *former* revolves on its axis and also traverses to and fro horizontally; it may also be raised and lowered. The india-rubber cushion allows the rubbing surface to yield and thus avoid the wearing of holes in the

Fig. 3929.



Hat-Pouncing Machine.

hat-body where inequalities exist. By turning a disk on its axis it rises and falls upon the screw-thread thereon, and so loosens or tightens the hat-body secured to the hooks in another disk; the latter resting upon and rising and falling with the first-named disk, but not turning with it.

Pound. 1. The avoirdupois pound of the United States equals 27.7015 cubic inches distilled water at 62° Fah., barometer at 30 inches, and the water weighed with brass weights in the air. This equals 7,000 grains, and is divided into 16 ounces, each ounce into 16 drams.

The troy pound has 5,760 grains, divided into 12 ounces, each ounce into 20 pennyweights, each pennyweight containing 24 grains.

The pound apothecary's weight is the same as the pound troy, but the ounces are divided into 8 drams, each dram into 3 scruples of 20 grains each.

One hundred and forty-four pounds avoirdupois equals 175 pounds troy or apothecary's weight.

The old Saxon pound sterling was a pound of silver troy weight.

2. (*Hydraulic Engineering.*) The level space of a canal between locks.

Pound'er. 1. The *beater* in a fulling-mill.

2. A *stamp* in an ore-mill.

3. The expression of a weight in shot, as 18-pounder, 24-pounder; usually written, 18-pdr., 24-pdr.

Pound'ing-ma-chine'. (*Metal.*) A stamping-mill. The term is usually applied to a powder-mill.

Pow'der. A finely comminuted substance. See GUNPOWDER; POLISHING-POWDER, etc.

Pow'der-blow'er. An instrument for blowing powder on to plants or into crevices infested by insects. See also FUMIGATOR.

Pow'der-chest. (*Nautical.*) A form of grenade consisting of a box charged with powder, old nails, etc., to be hurled at boarders.

Pow'der-flask. A pouch or metallic case for holding gunpowder, and having a charging nozzle at the end.

Pow'der-horn. A horn fitted to hold powder and used as a flask.

Pow'der-hose. (*Blasting.*) A tube of strong linen, about an inch in diameter, filled with powder, and used in firing military mines.

Pow'der-ing-mill. See GRINDING-MILL; SNUFF-MILL; ORE, etc. See list under MILL.

Pow'der-mill. Works in which the materials for gunpowder are prepared and compounded and the powder grained and faced. See GUNPOWDER.

Pow'der-mix'er. A pharmaceutical device for intimately mixing various powders. This is usually done on a small scale in a Wedgwood mortar, but in some cases a cylinder with spiral revolving beaters is employed.

Pow'der-prov'er. See BALLISTIC PENDULUM; EPROUVETTE.

Pow'der-room. (*Nautical.*) The apartment in a ship where powder is kept.

Pow'er. *Force* is the constant pressure. *Work* is the pressure multiplied by the distance through which the force is kept up. *Power* has reference to the *work* performed in a given time. *Duty* is the amount of work performed with a given consumption of material, say of coal, for instance. See DUTY.

Pow'er-ham'mer. A hammer in which the weight is raised by the power of machinery. There are several varieties, which differ in construction or mode of application.

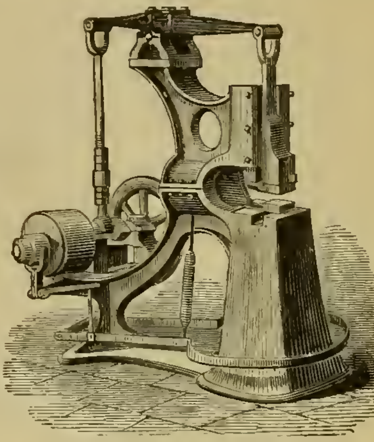
Steam-hammer.
Atmospheric hammer.
Monkey.
Pile-driver.
Dead-stroke hammer.
Tilt-hammer.
Revolving-hammer, etc.

See list under HAMMER.

Fig. 3930 may stand as an example of a form of power-hammer, made of various sizes from that of heavy forging to the small hammer for jewelers.

The power is communicated by a friction pulley. The belted pulley is loose on the shaft, and the friction pulley slides on a spline on the shaft. The operator bears down with his foot upon the treadle, which passes around the hammer; this brings the friction in contact with the belted pulley, which is running all the time, and rotates the shaft, on which is a crank; this, by means of a connecting rod and spring, works the hammer, giving a blow depending for its strength upon the force with which the friction pulley is pressed against the belted pulley.

Fig. 3930.



Palmer Power-Spring-Hammer.

Pow'er-loom. A loom driven and actuated by machinery; in contradistinction to a *hand*-loom.

It was invented by Dr. Edmund Cartwright. He patented it April 4, 1785. Steam was applied to his loom in 1807. He received a Parliamentary grant of £10,000 in 1808. He died in 1823, aged 80. See LOOM; WEAVING.

Poy. (*Nautical.*) A steering-pole.

Poy'al. (*Fabric.*) A striped stuff for covering benches and seats.

Poynt'ell. Paving formed of small lozenges or squares laid diagonally.

Poz'zu-o-la'na. A volcanic earth composed mainly of silica and alumina, and shipped from Pozzuoli. A portion analyzed by M. Berthier was constituted as follows: —

Silica	44.5	Soda	4
Alumina	15	Potash	1.4
Lime	8.8	Water	9.2
Magnesia	4.7		
Oxide of iron	12		99.6

Strabo says of this earth: —

> "Puteoli has become a place of extensive commerce, having artificially constructed harbors, which were much facilitated by the facile nature of the sand [degraded tufa], which contains much gypsum, and will cement and consolidate thoroughly. For mixing this sand with limestones they construct moles in the sea, thus forming bays along the open coast in which the largest transport-ships may safely ride."

It was obtained by the Romans near Baiæ, and is still exported largely from that part of Italy. Mixed with lime and water, it hardens anywhere, — in the air or under water. It is invaluable, and the permanency of the great sea-walls and other maritime structures of the Romans is largely due to its use. It is commonly known as *Roman cement.*

Many attempts have been made to form an artificial pozzuolana by combinations of sand, clay, lime, and iron. Ochreous clays are especially suitable.

General Treussart's system for making artificial pozzuolana is to reduce soft red bricks to powder, and mix them (2 parts) with lime that has been some time slaked (1 part); water to incorporate. See CEMENT.

The preparation of the natural material is by pounding or grinding and sifting, whereby it is reduced to powder, in which state it is beaten to a proper consistency with a due proportion of lime. Artificial pozzuolana is produced by pulverizing the clay, the psammite, or the arene, which is wetted, and then strewing a layer of it, about four tenths of an inch, on a plate of iron heated to a point between a cherry-red and forging-heat. It is left till it be raised to the same degree, for a space of time which varies for each kind of material, from five to twenty minutes. It must be continually stirred with a small rod, in order that the whole of the particles may be uniformly calcined.

Hydraulic limes which harden under water are dependent for their quality upon the presence of a certain amount of clay. In France the manufacture of artificial hydraulic lime is largely carried on. See LIME-KILN.

Pra'am. (*Vessel.*) *a.* A flat-bottomed lighter or barge, used in Holland and the Baltic.

b. A floating battery.

Prac'tice-butt. (*Ordnance.*) A target for practicing with guns.

Pra'hu. The war-vessel of the Malays. It is from 55 to 156 feet in length; carries 76 to 96 rowers, and from 40 to 60 fighting men. The guns are of brass, from 2 to 6 inches' bore, mounted on stock pieces, and from 4 to 10 in number. — ADM. SMYTH.

Prai'rie-plow. A large plow supported in front on wheels, and adapted to pare and overturn a very broad but shallow furrow-slice.

Its sharp share cuts at about half the depth of the sod's thickness, and such is found to be more effectual in killing the growth than in turning over the whole sod by cutting at a depth below the growing portions of the sod.

Pray'a. An embanked road or public walk.

Pray'ing-ma-chine'. We have never heard that any of our driving business men have made praying-machines for the Oriental market, although cast-iron gods, bronzed and varnished, have been made by the ton in Birmingham, England, and exported thence to heathen lands.

Praying-machines are in vogue in all the lands which acknowledge Thibet as their religious center. This includes India, Ceylon, Burmah, Siam, China, and Japan. Divided as it is from the mainland of the continent, and superior to China as Japan appears to be, there is much affinity between their forms of civilization and government, and in many details of their manners and religion.

In Thibet the art of praying has been brought to a high state of advancement. It is no longer difficult to utter long prayers, for the prayer written on a piece of paper or a leaf and fastened to a wheel is understood to be uttered once for every revolution of the wheel. The motion of the written is the mechanical equivalent of the vocal exercise. When before an idol, it is understood to be presented towards the god once during each revolution; and the women, who do most of the praying there, saunter into the temple, chat over the news and compare babies, meanwhile turning the wheel diligently. They go down from thence feeling justified and comfortable.

Anon comes one who is struggling in spirit with a great unfulfilled wish, and, flinging herself on the floor, turns the wheel with energy as she utters her prayer for a "bull child," or some other fervent desire of her heart.

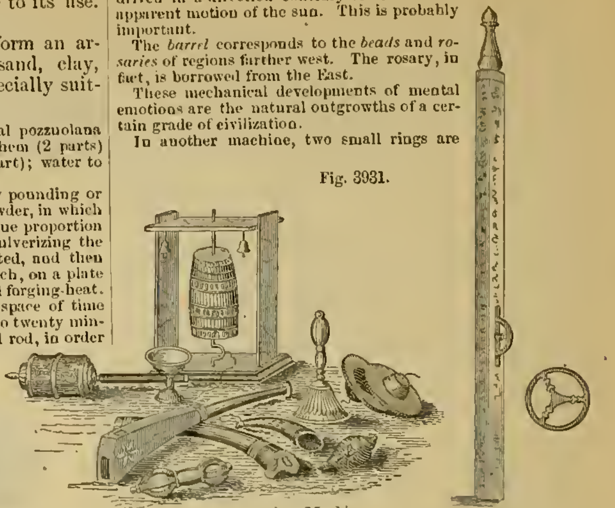
A praying-cylinder seen by Dr. Hooker at Simoobong in Sikkim consisted of a leathern cylinder placed upright in a frame; a projecting piece of iron struck a little bell at each revolution, the movement being caused by an elbowed axle and string. Within such cylinders are deposited written prayers, and whoever pulls the string properly is considered to have repeated his prayers as often as the bell rings. The machine is driven in a direction contrary to that of the apparent motion of the sun. This is probably important.

The *barrel* corresponds to the *beads* and *rosaries* of regions farther west. The rosary, in fact, is borrowed from the East.

These mechanical developments of mental emotions are the natural outgrowths of a certain grade of civilization.

In another machine, two small rings are placed on each spoke of the wheel, the jingling thereby produced being to attract the attention of the god. The greater the noise the greater the certainty of being attended to. The credit for prayers is in proportion to the energy of the action and the number of revolutions.

Fig. 3931.



Praying-Machines.

Some of these legends are to invoke the attention of Buddha to the condition of the souls of the departed, the metempsychosis being a form of purgatory; others are aphorisms which are understood to be devout expressions of patience.

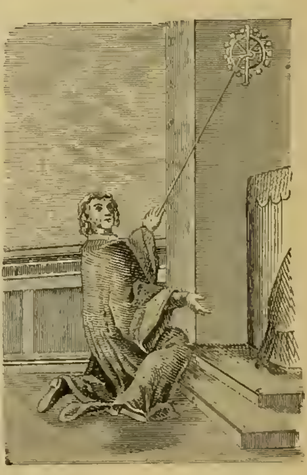
> "I would not harshly scorn, lest even there
> I spurned some elements of Christian prayer, —
> An aim, though erring, at a 'world ayont,' —
> Acknowledgment of good, — of man's futility,
> A sense of need and weakness; and, indeed,
> That very thing so many Christians want, —
> Humility."

These mechanical aids to prayer and substitutes for pilgrimage are to be found on roads in Thibet. You see pasteboard barrels, fixed on an axle and inscribed with choice prayers. The devout give the barrel a turn, and it revolves for a long time, according to the perfection of its workmanship, the force of the impulse, and the lubrication of the axle. The barrel prays for the persons, as one traveler remarks, "as long as gravitation and friction will permit. They sometimes fight for the privilege of turning the barrel" The poor fellows at the pool of Bethesda may have done the same in settling the question of precedence.

The words "Om Mani Padmi om" (*Hail to him of the Lotus and the Jewel*) are frequently painted on the cylinders of these machines and prayers placed within One noticed by Hooker, the naturalist, on a stream in Bhotan, was made to rotate on its axis by a spindle which passed through the floor of the building into the water, where it was terminated by a wheel. Such praying-cylinders are called *mani* by the Lamas

The Japanese praying-machine is somewhat similar. The proper subjects for prayer are displayed on the pillar, and the wheel in its recess is understood, during each revolution, to repeat the legend on the shaft. This reminds one of the warning, "Use not vain repetitions, as the heathen do."

Fig. 3932.



Sonnettes used in Churches (*Bonanni*, 1776)

Fig. 3932 is a representation from the "Description des Instrumens Harmoniques, en tous Genre, par le Pere Bonanni." Published at Rome, 1776. It is described as "Sonnettes used in churches," having a wheel with small bells on its periphery, and rung by a cord attached to the center of the wheel. Though somewhat indistinct in the original, it appears that the cord is attached to a wrist so as to revolve the wheel. It seems to have been adopted into Christian worship in Bretagne by a woman who renounced the worship of "The Star," but brought along the paraphernalia of the temple, intending to sanctify an esteemed and musical observance to the worship of a new object. So the jingling has proceeded for many centuries, from almond-eyed Cathay and old Zipango to the Bretons and Basques by the ocean of Atlantis.

Pray'ing-mill. A little water-wheel to keep a written prayer moving. Abbé Huc ("Travels in Tartary," 1844–46) refers to what he calls "a kind of *praying-mill*," known to the Tartars as a *chu-kor* or *turning-prayer*. He says: —

> "It is common enough to see them fixed in the bed of a running stream, as they are then set in motion by the water, and go on praying night and day, to the special benefit of the person who has placed them there. The Tartars also suspend them over their domestic hearths, that they may be set in motion by the current of cool air from the opening in the tent, and so twirl for the peace and prosperity of the family. Another machine which the Buddhists make use of to simplify their devotional activity is that of a large barrel turning on an axis. It is made of thick pasteboard, fabricated of innumerable sheets of paper pasted on one another, and upon which are written in Thibetan characters the prayers most in fashion. . . . . The devout can then eat, drink, and sleep at their ease, while the complaisant machine does all their praying for them."

He also relates a fight between two Lamas over a praying-mill which had been set in motion by one, and then stopped and again set in motion by the other. See PRAYING-MACHINE.

Preen. 1. A clothier's forked tool.

2. A bodkin.

Pre-pon'der-ance. (*Ordnance.*) The excess of weight of the part in rear of the trunnions over that in front. It is measured by the weight which requires to be hung to the muzzle to bring the gun to a horizontal line when suspended freely on its trunnions.

The preponderance of a gun is usually $\frac{1}{20}$ of its weight.

Pres'er-va'tion of Food. Various methods may be employed for preventing the fermentation and putrefaction of animal and vegetable substances and maintaining their usefulness as foods.

Cold. Putrefaction is entirely prevented or arrested at temperatures below the freezing-point, and animal substances may be thus preserved for indefinite periods without change. The mammoths found in masses of ice in Siberia were unchanged after the lapse of untold ages.

This method is largely employed during winter in cold climates and on a smaller scale in the keeping or transportation of flesh, game, etc., during the warm season.

Desiccation. This method is applied to both animal and vegetable substances. It is effected by exposing them, after having been sliced or cut into small pieces, to the sun in warm dry weather or to a current of warm dry air at a temperature not exceeding 140° Fah. If this be exceeded, flesh becomes hard and insipid. Vegetables prepared in this way are afterward compressed into a small bulk.

Buccaning consists in drying and smoking meat cut into thin slices. From this practice the West India Buccaneers of the seventeenth century are said to have derived their name.

Jerked beef is prepared by dipping thinly sliced meat into water and afterward drying it in the sun. This is sometimes pounded into a mass and packed in jars.

Pemmican is prepared from buffalo meat, sliced and dried in the sun or before the fire, pounded and mixed with melted fat, to which flavoring herbs or berries are sometimes added.

Flesh not for food may also be preserved by *immersion in antiseptic liquids*, as alcohol, to which camphor, sal ammoniac, or common salt may be added. A weak solution of creosote, sulphurous acid, or of alum, with or without the addition of corrosive sublimate or arsenious acid, may also be employed to prevent putrefaction.

Pickling in vinegar containing $\frac{1}{400}$ of creosote will preserve meat unchanged for a considerable time even during warm weather. The most efficacious mode of applying antiseptics is to inject them into the blood-vessels of an animal when recently killed. Such is Gannal's process, in which a solution of sulphate of alumina or preferably chloride of aluminium is injected into the carotid artery of a slaughtered animal as soon as the flow of blood has ceased, the extremities of the jugular veins having been previously tied. If the meat is to be kept for more than a few weeks, it should be washed with a mixed solution of chloride of aluminium and common salt and packed in air-tight barrels, or it may be kept in ordinary barrels simply packed with dry salt.

Robin employed some of the volatile hydrocarbons, as ether, in a capsule or sponge placed within a case containing the substance to be treated, the vapor preventing corruption. Fish may be preserved for some time in sugar, either alone or with saltpeter or common salt; treated in this way, they retain their natural flavor to a greater degree than in the ordinary salting process; if afterward dried, they may be kept for an indefinite period.

Smoking. This is usually employed in conjunction with salt. The meat, having been previously immersed in or thoroughly rubbed with salt, to which a proportion of sugar and saltpeter is usually added, is suspended over a smoldering wood-fire which burns slowly but emits a large quantity of smoke. Green hickory is preferable for smoking, wood of the pine family imparting a disagreeable flavor to the meat. In some cases the twigs or branches of aromatic plants are added to the fuel; juniper is used for smoking the celebrated Westphalia hams. Corn-cobs are frequently used.

Exclusion of air. In 1808, M. Appert invented a process for preserving provisions by parboiling, and inclosing them in earthenware-vessels from which the air was excluded. This as subsequently improved by Donkin and Gamble forms the basis upon which the more recent processes of preserving foods by canning are founded.

In that patented by Donkin the meat is first parboiled or somewhat more, freed from the bones, and then placed, either alone or with vegetables, in tin canisters which are filled with prepared gravy or juices; a tin cover with a small aperture is soldered over the open end of the can, which is then placed in boiling water or in a salt solution heated slightly above the boiling-point of water, thus expelling the air from the interior. When this is effected the aperture is closed with solder while the contents are yet hot. On cooling, the ends of the can assume an inwardly concave form, on account of the contraction of the contents. The success of the process is tested by exposing the cans for some time to a heat above 100° Fah., when, if incipient putrefaction had set in previous to the commencement of the process or it has been improperly conducted, the generated gases will cause the ends of the can to bulge outwardly.

Bevan's process, patented 1842, consists in exhausting the air from the cans previous to heating them, and in providing a supply of gelatine which is caused to flow in and fill the vacuum as the air is withdrawn, thus enabling the food to be cooked in a vacuum at a much lower temperature.

Potting. By this method air is excluded from animal substances previously cooked, by placing them in jars and covering them with a layer of lard, butter, or oil.

Pickling. This term is applied indifferently to the preservation of meats or vegetables in brine or vinegar. Brine is generally used for keeping meat, and vinegar for vegetables. This process forms an important part of household economy, and on a large scale constitutes a prominent source of national wealth.

Cabbage, sliced and packed in salt, undergoes a slight fermentation forming sauerkraut, an article of diet largely used in Northern Europe. Potatoes, turnips, and other roots, as well as apples and cabbages, are prevented from decaying by storage in moderately cool, dry situations.

Fruits are preserved by desiccation or by being treated with sugar, and either dried or retained in the sirup. The former are known as *dry* and the latter as *liquid confections;* they are usually boiled in the sirup.

Marmalades, *jams*, and *pastes* are prepared by beating up the pulp of fruits with liquefied sugar or honey. *Conserves* are beaten up with dry sugar.

Some fruits, as grapes, may be kept a long time by merely being loosely packed in sawdust; others are treated with alcoholic spirits and sugar.

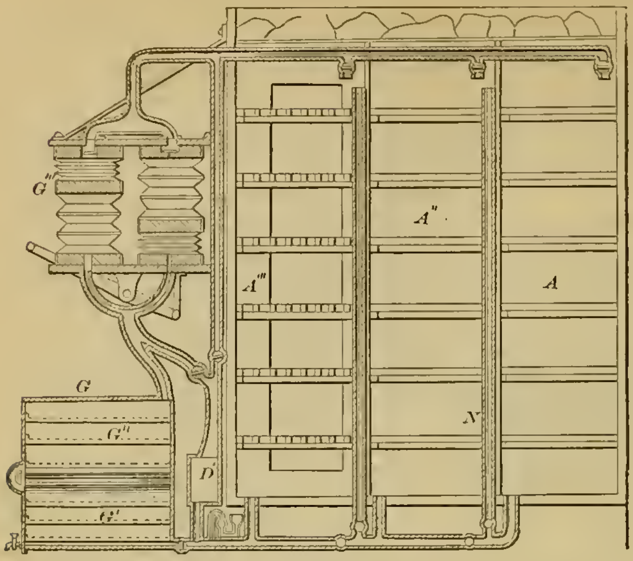
Milk may be preserved by reducing it by boiling to half its natural bulk, and beating it up with the yolk of eggs in the proportion of 8½ to 10½ quarts of milk; the whole is then heated for half an hour and frequently skimmed, strained, and again heated for two hours in a water-bath. See MILK, CONDENSED, page 1438.

A preferable method, generally pursued in the preparation of condensed milk, is to evaporate it at a gentle heat and add sugar. Milk thus prepared contains about 25 per cent of water, 29 per cent of cane, and 16 per cent of milk-sugar. Evaporation may be continued until the milk is entirely solidified.

Cream may be preserved by boiling down five measures to four, cooling and skimming, and then placing in closely stopped bottles, which are kept in a water-bath at a boiling heat for half an hour.

Pre-serv'a-to-ry. An apparatus for preserving substances to be used as foods, etc. In the example (Fig. 3933), the articles are placed within the chambers *A A''*, etc., connected with a combustion-chamber *D'*, by which the air is desiccated and its oxygen partially removed; it is afterward passed through

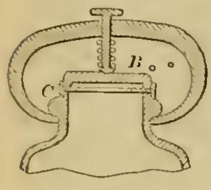
Fig. 3933.



Preservatory.

the deoxygenating-chamber *G G′*, containing a compound which has an affinity for that gas, and which combines with that remaining after desiccation. The air, both before and after deoxygenation, is caused to circulate through the various parts of the apparatus by means of the bellows *G‴*.

Fig. 3934.



Preserve-Jar.

Pre-serve′-jar. A jar the mouth of which may be hermetically closed, both to insure the better preservation of the fruit and to prevent evaporation. Various devices have been contrived for effecting this object. In the example, a flanged packing-ring *C* accurately fits the mouth of the bottle; over this and within the flange is placed the cap *B*, which is forced tightly down upon an india-rubber gasket by the pressure of a screw so as to exclude the air. See FRUIT-JAR.

Pre-serv′ing Wood. See WOOD, PRESERVATION OF.

Press. See under the following heads: —

Anti-friction press.
Arming-press.
Autographic press.
Baling-press.
Beater-press.
Bibble-press.
Blocking-press.
Bonnet-press
Bramah-press.
Brick-press
Bundling press.
Button-press.
Canceling-press.
Cane-press.
Cardboard-press.
Casting-press.
Centripetal-press.
Cheese-press.
Cider-press.
Cigar-press.
Cloth-press.
Coining-press.
Color-printing press.
Concrete-press.
Copperplate-press.
Copying-press.
Cork-press
Corundum-press.
Cotton-press
Crimp-press
Cutting-press.
Cylinder-press.
Cylindrical printing-press.
Domestic press.
Double-cylinder press.
Drop-press
Drum-press.
Dry-press.
Embossing-press.
Filtering-press.
Finishing-press.
Flat-press.
Flour-packer
Fly-press.
Foot-press.
Fruit-press.
Gauffering-press.
Glass-blower's press.
Gluing-press.
Gulleting-press.
Gunpowder-press.
Hand-stamp.
Hat-press.
Hay-press.
Hop-press.
Hot-press.
Hydraulic press.
Hydrostatic press.
Lard-press.
Level-press.
Lever-press.
Lithographic press.
Oil-press.
Packing-press.
Pad-crimp press.
Paper hot-press.
Pawl-press.
Peat-machine.
Peat-press
Perfecting-press.
Photo-relief press.
Portable-press.
Printing-press.
Proving-press.
Railway-press.
Re-pressing press.
Revolving-press.
Rolling-press.
Rolling-cam press.
Screw-press.
Seal-press.
Sewing-press.
Sheet-metal press.
Stabbing-press
Stamping-press.
Standing-press.
Stanhope-press.
Stearine-press.
Sterhydraulic apparatus.
Striking-up press.
Sugar-press.
Swing press.
Tincture-press.
Tobacco-press.
Toggle-press.
Transferring-machine.
Upsetting-press.
Veneer-press.
Voluntary-press.
Water-press.
Web-press.
Wedge-press.
Wet-press.
Wheel-press.
Wine-press.
Wire-press.
Wool-press.

Press-cake. (*Gunpowder.*) Incorporated or mill cake ready to undergo granulation.

Presse-ar-tère′. (*Surgical.*) An instrument with a handle and a plate with two perforations; the latter to hold a ligature, which is passed round an artery, and draws it up against the plate, the cords of the ligature being secured to the stem.

Pressed Brick. Bricks placed one at a time, when nearly dry, into a metallic mold, in which they are forcibly compressed by the action of a lever or screw, which forces up the piston forming the bottom of the mold. This gives a smooth face to the brick, and leaves the arrises very sharp.

Pressed Glass. Glass brought to shape in a mold by a plunger.

A modification consists in blowing it within a mold so as to make it assume the form of the latter.

Pressed Loop. (*Harness.*) A leather loop, the top of which is pressed up with an ornamental stamp.

Press′er. 1. The bar in a knitting-machine which drives the barb of the needle into the groove of the shank in order to let off the loop.

2. A form of ironing-machine.

3. The foot-piece in a sewing-machine which rests upon the cloth to hold it steady while the needle penetrates and withdraws, and then rises to allow the cloth to be fed. A *presser-foot.*

4. (*Spinning.*) *a.* The pressure-roller of a drawing-frame.

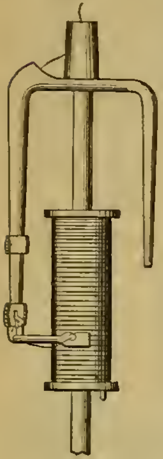
b. The spring-finger of a bobbin-frame.

Press′er-bar. (*Knitting-machine.*) A bar which presses upon the barb of the hook, so as to close it against the shank of the needle. By this means the loop in the hook is held therein while the loop previously made is brought over the closed needle and the loop within it.

Press'er-fly'er. (*Spinning.*) *a.* That form of machine in which the arm of the flyer is pressed against the bobbin by a spring.

b. One which has a spring arm pressing upon the bobbin upon which it delivers the yarn. See FLYER.

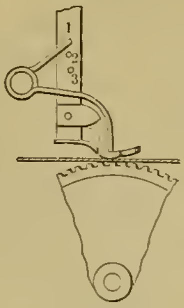
Fig. 3935.



Presser-Flyer.

Press'er-foot. (*Sewing-machine.*) A foot-plate which presses upon the goods and holds them against the rough face of the feed.

Fig. 3936.



Presser-Foot.

Press'er-frame. (*Spinning.*) One furnished with *presser-flyers.*

Presse-u-rêthre'. (*Surgical.*) A clamp for the penis to draw the parietes of the urethra together and prevent the discharge of urine. *Jugum-penis.*

Press'ing-bag. The horsehair cloth bag in which flaxseed or stearic acid is pressed.

Press'ing-board. 1. An ironing-board upon which seams are pressed.

2. (*Bookbinding.*) A board placed between a layer of books when piled in the *standing-press.*

Press'ing-plate. A follower-board in an oil-press; board and bags of the material alternate.

Press'ing-roll'er. (*Paper.*) *a.* A wire-gauze roller which takes up the moisture from the felted pulp in paper-making.

b. The roller which presses the sheet of damp paper to remove moisture.

Press-keys. Brass keys to hold tightly the strings in a sewing-press.

Press-pin. The iron lever of a screw-press.

Press-print'ing. (*Porcelain.*) One of the modes of printing porcelain. The other is BAT-PRINTING (which see).

In press-printing the engraving is coarse, the lines being very heavy, so as to hold a sufficiency of ink. The impression is taken on *porcelain-tissue* paper; the marginal paper of the pattern is then cut away and the impression dabbed against the *biscuit.* It is then rubbed with soapy flannel and finally with a roll of flannel. By damping and rubbing, the paper is then removed, leaving the oily ink adhering to the biscuit. The oil being driven off in a *hardening-kiln,* the ware is ready for glazing. *Press-printing* is applied to biscuit; *bat-printing,* to the glazed ware.

Press-stone. (*Printing.*) The bed of the press.

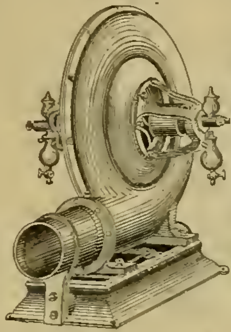
Press'ure-blow'er. One in which the air is driven by a positive pressure by pistons rotary or otherwise, in contradistinction to one in which the air is projected by fans working to produce a centrifugal action of the air by the speed of movement of radial vanes. See BLOWER. See also Fig. 2589.

Press'ure-en'gine. A water-pressure engine. See HYDRAULIC ENGINE.

Press'ure-fil'ter. A filtering-chamber placed in a pipe under a head of water.

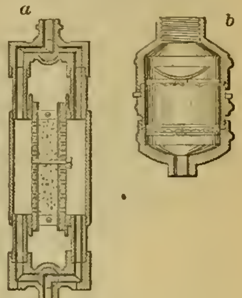
In Fig. 3938, *a* has two casings with perforated plates on the inside and a body of sand confined between the plates, together with a system of pipes and three-way cocks, whereby the water may be conducted first in one direction and then in another through the sand.

Fig. 3937.



Sturtevant Pressure-Blower.

Fig. 3938.



Pressure-Filter.

In Fig. 3938, *b*, the chambers are separated from each other by two partitions, consisting of wire-cloth and filtering material, supported by cross-bars; the upper partition supports a cup which is intended to break the force of the current of water.

Press'ure-forg'ing. A method of forging and swaging metals by hydraulic pressure. At the State Railway Works, Vienna, two presses capable of giving respectively 1,500 and 600 tons pressure are employed. Heated ingots of Bessemer steel, weighing 2,030 pounds, are placed under a hammer-like head attached to the piston and gradually squeezed into the form of bars, being shifted and turned as required when the piston is raised. The bar is then cut into lengths by a chisel attached to a press. The masses thus cut off are swaged to the desired form in molds by suitable dies attached to the piston. There is no jar or vibration in this machine, as in the steam hammer, and it is very expeditious in its operation, rendering it well adapted for complicated forgings, such as locomotive cross-heads, boiler-heads, steam-domes, etc., and also for spokes. See also FORGING-PRESS.

Press'ure-frame. (*Photography.*) Often called *printing-frame* and sometimes *press.* A strong shallow open frame of wood surrounding a square of thick plate-glass which rests upon a rabbet. When a positive "print" on sensitive paper is to be made from a photographic negative, the latter is laid with the collodion side upward upon the plate-glass front above described. A sheet of sensitized chloride of silver paper is then pressed into close contact with the negative, by a number of strong springs attached to hinged pieces which lock across the back of the frame, acting upon a movable wooden back separated from the sheet by suitable soft packing. When such a frame is turned up with its plate-glass side toward the sun, the light passing through the negative darkens the paper behind, so as to produce the positive picture or "print." The wooden back upon which the springs act is divided into two parts, which are hinged together. By means of this expedient, it is possible to examine from time to time the progress made in printing, one half the back being raised while the other holds the paper firmly in place upon the negative, and to stop that operation when the shadows are sufficiently dark.

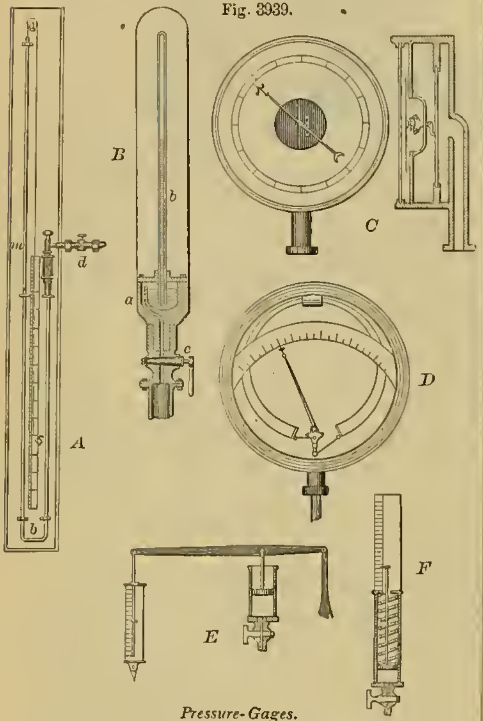
Press′ure-gage. 1. (*Steam-engine.*) An apparatus or attachment for indicating the pressure of steam in a boiler.

It assumes various forms.

a. A *safety-valve* is in one sense a *steam*-gage, as it indicates the attainment of a certain pressure. See SAFETY-VALVE.

b. A plug of fusible metal, compounded so as to melt at a certain temperature and inserted in the side of the boiler, is a *pressure-gage*, as it melts and allows the steam to escape under the circumstances designated. See ALLOY; FUSIBLE METAL; HIGH-PRESSURE ALARM.

Fig. 3939.



Pressure-Gages.

c. The mercurial steam-pressure gage (*A*) is a bent tube leading into the steam-generator at the end *d* and open to the air at the other end. A body of quicksilver occupies the bend *b*, and is elevated in the outer leg *m* of the tube by the pressure of steam on the mercury in the inner leg. A graduated plate shows the range within the pressures for which the generator is calculated. When the column in the outer leg stands thirty inches higher than that in the inner leg, it shows a pressure of two atmospheres, and so on. For great pressures it requires a long leg or that the column be loaded.

If the siphon-tube be of glass, the indicated pressure may be easily read; but to avoid fracture the tube is frequently made of iron, and the level of the mercury is indicated by a float.

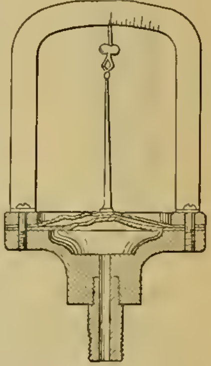
As the mercury in the long leg *m* rises, it will raise the float, the counterpoise of which *s* will descend and indicate upon the scale the excess of pressure of steam over the pressure of the atmosphere. Each two inches of the vertical column of mercury is equal to about one pound effective pressure in the boiler.

In high-pressure boilers, the great hight of the column of mercury would prove inconvenient, and therefore another form (*B*) is adopted.

a is a cistern of mercury, and *b* a glass tube whose lower end is open and plunged in the mercury. The tube contains air at ordinary pressure. When the stopcock *c* is opened, the steam from the boiler enters by the duct *d* and presses upon the surface of the mercury in the cistern, raising it in the tube and compressing the air. When the air is condensed to half its volume, its pressure is doubled; when it occupies only one third the space, its pressure is threefold, and so on.

d. In the Magdeburg pressure-gage (*C*) the fluid is admitted by a tube to the rear of an elastic diaphragm, whose motions actuate a toothed sector engaging a pinion on the spindle of the pointer, which indicates the pressure on a graduated arc. The action is analogous to that of the aneroid barometer. The diaphragm is generally corrugated in steam-pressure gages. See STEAM-GAGE.

Fig. 3940.



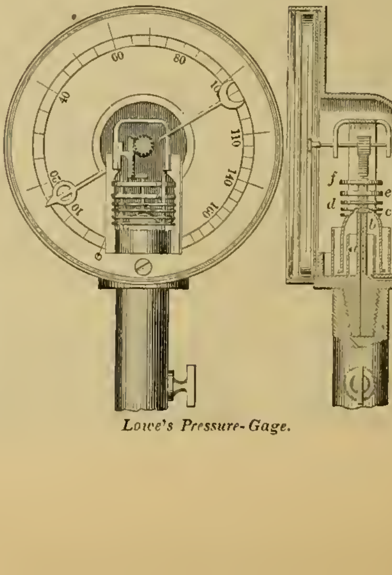
Corrugated Diaphragm Pressure-Gage.

In Fig. 3940, the corrugated disk is made more sensitive or capable of greater action on one side of its axial line than on the opposite side, by giving a varied or unequal construction to the corrugations. The capacity for expansion being greater on one side than the other, the index-finger, which is axial in the normal state, is tipped by the rising of the diaphragm, and its inclination is registered on the graduated bar.

e. Bourdon's aneroid-gage (*D*) is a bent tube which is closed at its ends and held by its midlength, at which the fluid is admitted. The pressure of steam or other fluid has a tendency to straighten the tube, whose ends are connected to a sector-rack, which operates an indicator in the manner just described.

f. In the *piston-gage* the steam acts upon the surface of a disk within a cylinder. The piston-rod is connected with a weighted lever (*E*) or a spring (*F*), which acts against the steam-pressure, the amount

Fig. 3941.



Lowe's Pressure-Gage.

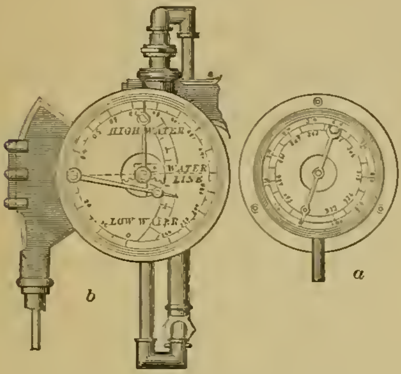
of which is indicated in the usual way. This is the principle of Watt's indicator.

Lowe's steam-gage consists of a tube *a* having a small hole through which steam is admitted to the interior of the receiver *b*, raising it into contact with the annular weight *c*, which is thus caused to rise, becoming successively loaded with the upper weights *d e f*, etc., as the steam-pressure increases. A rod passing centrally through the weights carries a rack which gears with a pinion on the axis of the indicator of the dial.

A series of cylinders, one within the other, may replace the annular weights, rendering the whole more compact.

One form of Ashcroft's well-known gage has two graduated circles, one representing the pressure and the other the temperature.

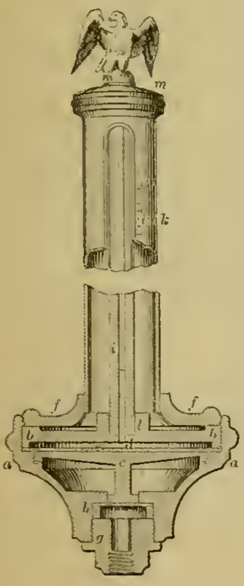
Fig. 3942.



a, *Ashcroft's Steam-Gage.*
b, *Graeber's Steam and Water Alarm-Gage.*

Shaw's pressure-gage (Fig. 3943) consists of a brass cup *a* containing an iron disk *b* recessed on its lower side to form a mercury chamber. *c* is a double-headed piston having its upper and larger head covered by a gum diaphragm *d*, and receiving the pressure of the mercury, which passes into the chamber *c* when pressure is applied to the small head of the piston *c*. *f* is a screw-cap, making a tight joint and preventing escape of mercury into the lower part of the cup *a*. *g* is a nut having an orifice for the steam connection, and *h* a perforated gasket, making an air and steam tight joint. The lower and smaller head of the piston *c* receives the steam pressure, and forces the mercury into the chamber *a* through a small perforation in the disk *b*, whence it rises into the glass tube *i* to a hight indicated by the graduated register *k*. A gum ring or cushion *l* receives the conical end of the tube *i*, which is firmly pressed upon it by screwing down the cap *m*. See also STEAM-GAGE.

Fig 3943.

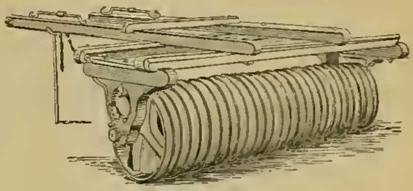


Differential Piston Pressure-Gage.

2. (*Nautical.*) A deep-sea pressure-gage is one which is constructed for measuring depths by the amount of compression to which the contained fluid is subject when submerged to great sea depths.

Press-wheel Roll'er. One constructed of a series of wheels which combine to form a rolling ridge and hollow face, and avoid clogging, or the necessity for a scraper to clean the roller. They are arranged upon self-lubricating axles, with hard-metal removable bushes attached to the iron outside brackets. The weight of a roller, seven feet by two feet, is one ton.

Fig. 3944.



Cylindrical Press-Wheel Roller.

Press-work. 1. (*Joinery.*) Cabinet work of a number of successive veneers crossing grain, and united by glue, heat, and pressure.

2. (*Printing.*) The printing of a form.

Pre-vent'er. (*Nautical.*) An additional rope, spar, chain, or bolt, as a support, stay, or substitute. A supplementary or auxiliary rope to support a spar, stay, etc., in a gale or in action.

A *preventer-bolt* is driven at the lower end of the *preventer*-plates to assist the strain of the chain-bolts.

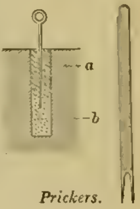
Preventer-plates are placed below the links of the chains.

Preyne; Prin. A technical term in some trades for a pin or needle.

Prick. (*Nautical.*) To trace a ship's course on a chart.

Prick'er. 1. (*Blasting.*) A priming-needle. A pointed copper wire with a ring head. It is forced into the charge *b*, and the tamping *a* is pounded around it. The pricker is then withdrawn, leaving an opening into which a little fine powder is poured to make a connection from the fuse to the charge.

Fig. 3945.



Prickers.

2. (*Gunnery.*) A sharp wire introduced at the vent to puncture the bag which holds the charge, in order that the priming may touch the powder.

3. (*Nautical.*) A small instrument having an enlarged head and a curved tapering point. It is similar to the fid and marline spike, but is used for smaller work.

4. A long slender iron rod used for probing or sounding the depth of a bog or quicksand.

5. (*Saddlery.*) *a.* A toothed roller for marking or stabbing holes for sewing leather, etc.

b. A tool (*c*) used to mark stitch-holes so as to render them uniform in distance.

Prick'ing-up. (*Plastering.*) The first coat of plaster on lath; the surface is scratched to form a key for the next coat. See PLASTERING.

Prick'ing-wheel. (*Saddlery.*) A traveling tool which marks the number of stitches to the inch. A *stitch-wheel.*

Prick-post. (*Building.*) A post framed intermediately between two principal ones.

Prick-punch. (*Forging.*) A pointed instrument used by smiths to mark their centers.

Prick-wheel. (*Saddlery.*) A tool used to prick off the work for the harness-stitcher, the points being made to produce a certain number of marks.

Priest's Cap. (*Fortification.*) An outwork with three salient and two entering angles.

Prill. (*Mining.*) The better portions of ore from which inferior pieces (*dradge*) have been spalled by the cobbing-hammer.

Prill'ion. (*Mining.*) Tin extracted from the slag.

Pri'ma. (*Printing.*) The first form of a sheet.

Prime. 1. (*Gearing.*) A number which is only divisible by itself or unity. Numbers *prime* to each other have no common factor except 1.

In wheel work, it is usual in any wheel and pinion that act on each other to use numbers of teeth which are *prime* to each other, so that each tooth of the pinion may encounter every tooth of the wheel in turn.

2. (*Steam.*) To carry over water with the steam.

3. To put powder in the pan of a fire-arm, or lay a train of powder to a charge.

4. (*Printing.*) A mark over a reference letter (*a'*, *b''*, etc.) to distinguish it from letters (*a*, *b*, etc.) not so marked.

Prime-con-duct'or. (*Electricity.*) The metallic conductor opposed to the glass plate or cylinder of an electrical machine. It is supported by a glass stem, and may be connected by chain with the object to be excited or with a Leyden jar or battery when the influence is accumulated.

Pri'mer. 1. (*Ordnance.*) *a.* A small, supplementary tube used with some descriptions of heavy, breech-loading ordnance. It is placed in the horizontal part of the vent before the vent-piece is placed in the gun, and communicates the flame from the ordinary tube to the cartridge.

b. A wafer, cap, or tube containing a compound which may be exploded by percussion or by friction; used for igniting the charge of powder in a cannon. Those generally used in the navy are made from quills which are nearly filled with fine-grained gunpowder, the upper part of the quill being split and turned over for containing a capsule of fulminate which is exploded by a sudden blow of the lock-hammer. Friction-primers (which see) are exclusively employed in the land service.

2. (*Blasting.*) *Tape primers* are used for firing charges at a distance. They are formed of long flexible strips of paper or fabric containing fulminate or other quick-burning compound, and are covered with a water-proof composition.

A detonating primer used in blasting with gun-cotton consists of a frusto-conical tube having its lower end filled with a detonating composition, above which is a layer of gun-cotton; the upper part of the tube is empty, and is covered with a paper cap; an ordinary fuse is inserted into this cavity and fired in the usual manner.

Prim'er. (*Printing.*) Two sizes of type are so called: *Great Primer*, the largest used in book-printing, measuring 51 ems to the foot; and *Long Primer*, a size intermediate between *Small Pica* and *Bourgeois*, measuring 89 ems to the foot.

Bourgeois, 102 ems to a foot.

Long Primer, 89 ems to a foot.

Small Pica, 83 ems to a foot.

Pica, 71 ems to a foot.

English, 64 ems to a foot.

Great Primer, 51 ems to a foot.

Prim'ing. 1. (*Painting.*) The first layer of paint, size, or other material laid upon a surface which is to be painted or glazed; as on a canvas, picture-frame, stuff, wall, vehicle, building, or other object.

The priming of the gilder on wood is composed of *white-stuff*, size, and whiting. See Gilding.

2. (*Fire-arms and Ordnance.*) The combustible which communicates fire to the charge.

3. (*Blasting.*) A train leading to a bursting-charge.

4. (*Steam.*) The carrying over of water with the steam into the cylinder.

Prim'ing-horn. (*Blasting.*) The powder-horn of the miner or quarryman.

Prim'ing-pow'der. 1. Detonating powder.

2. The train of powder connecting a fuse with a charge.

Prim'ing-tube. (*Ordnance.*) A tube to contain an inflammable composition, which occupies the vent of a gun whose charge is fired when the composition is ignited.

There are several kinds of priming-tubes, fired by *port-fire*, *lock*, or friction.

The tube is made of *quill*, *paper*, or *metal*, and is charged with mealed powder damped with methylated spirit, or by a detonating composition, such as chlorate of potash and antimony.

The tube is slightly smaller than the gun-vent, in the relative proportions of $\frac{2}{10}$ and $\frac{2}{9}$ of an inch, and a hollow is made down the middle of the composition, so that the fire may involve the whole length instantaneously.

The simplest form is that in which the tube is merely a holder for the priming, which is touched off by a port-fire. This is the *quill*, Dutch, or *common metal tube.*

Another variety has a cross-head or snipe to contain a detonating composition which is exploded by a hammer. This is the *cross-headed* or *detonating tube.*

A third variety is operated by friction, a roughened bar occupying the hollow in the composition, and exploding by friction the detonating composition in the head of the tube. The rough bar is jerked out by a lanyard. See Friction-primer.

Prim'ing-valve. A spring valve fitted to the end of a cylinder, to permit the escape of water without danger to the machinery from the shock of the piston against the incompressible fluid. This water collects partly from the condensation of steam within the cylinder, but is chiefly carried over from the boiler, either as *priming* or in a state of mechanical suspension with the steam.

Prim'ing-wire. (*Ordnance.*) A pointed wire to prick a cartridge when it is *home* and clear the way for the priming or loose powder. A flat-headed wire to clear the vent of any ignited particles. Fig. 3945.

Prince Ru'pert's Met'al. An alloy for cheap jewelry, etc.

A brass composed of copper, 75; zinc, 25. *Pinchbeck.*

Prince's Met'al. A jeweler's alloy of copper, 72; zinc, 28.

Prin-cet'tas. A worsted fabric, sometimes with a cotton warp.

Prin'ci-pal. 1. (*Carpentry.*) An important timber in a frame, as a *principal beam.*

A *principal rafter,* one of the heavy rafters which support the *purlins* and common rafters.

A *principal brace,* one immediately under the principal rafter.

A *principal post,* the corner post of a frame.

2. (*Music.*) A stop of an organ an octave higher than *open diapason* and in unison with *flute.* It is the first or medium stop which is tuned, all the other stops being tuned from it. See Stop.

Prin'ci-pal Raft'er. (*Carpentry.*) A rafter in the main truss upon which the purlins rest.

Print. 1. (*Fabric.*) A cotton cloth printed. *Calico.*

2. A mold sunk in metal from which an impression is taken by swaging. A *boss.* A *swage.*

3. (*Foundry.*) A projection on a pattern which leaves a space in the sand for the purpose of supporting a core in its right position and place. The space is entirely filled by the core, and its length is always that of the hole in the casting, and the print, or prints when two are used, which is commonly the case.

Print'ed Car'pet. A carpet dyed or printed in colors. By one process, the carpet, after weaving in undyed colors, is printed in the same manner as calico.

Another mode is to dye the yarns in bands or sections, which are adjusted and proportioned to their future position in the fabric.

Whytock's Brussels carpet (English) was designed to save woolen material by substituting a party-colored woolen yarn for the five yarns of various colors which usually accompany the linen warp in Brussels carpet (which see). The yarn is dyed of the requisite color at different places. The succession of colors is determined by a design-paper containing the pattern, ruled with squares, the lines being numbered along the top and down the length, and containing the entire figure of the pattern. The breadth of the band of color on the yarns and their due succession are determined thereby. The weaving is conducted in the manner adopted with velvet, without the complicated adjuncts incident to figure weaving.

Print'ed Ware. (*Pottery.*) Porcelain, queens-ware, etc., ornamented with printed figures or patterns; this is usually done previous to glazing the ware. An impression is taken on yellow unsized paper, previously dipped in soapy water, from an engraved copper plate to which the coloring matter has been applied; the pattern is then cut out from the sheet, laid printed side down on the plate or other article, and rubbed with a piece of flannel until the color is transferred; the article is then placed in water and the adhering paper removed, after which it is heated to expel the water and afterward glazed. In some cases the impression from the plate is taken in oil only, on a flexible sheet of glue called a *paper* or *bat,* and transferred to the article, which is then dusted over with the pulverized color in a dry state. The glue is cleaned by sponging and is ready for use again.

Print'er's Flow'er. (*Printing.*) A *tail-piece.* An ornament at the end of a printed book.

Print'er's Gage. *a.* A four-sided stick for measuring the work of a compositor. Each side of the stick is a gage for a particular type.

b. A rule cut to the length of a page, by which to *break* matter in *making up* pages.

c. A trial piece of *furniture* of proper size to regulate the distance between pages in imposing a form. The *furniture* is then cast or made up to such a size as, in conjunction with the chase-bars, to equal the *gage.*

Other gages are used in cutting and mitering rules, *setting* composing-sticks, etc.

Print'er's Roll'er. A soft elastic cylinder which imparts ink to a form.

The invention of the roller, simple as it seems, was so great a step in advance as almost to revolutionize the art of printing. Without the elastic inking-roller modern fast printing-presses would be impossible.

Previous to the invention of the roller, forms were inked by hand by *dabbing* with *balls* of soft leather on which ink was spread by rubbing together, one being held in each hand by the workman. The balls were stuffed with tow or cotton and attached to handles.

The first composition for rollers was glue and molasses. This is still in use. Other compounds are glue and glycerine, glue and honey, etc.

The glue is melted by steam heat to avoid burning, the molasses or other ingredients added; and the whole mass cooked until it arrives at a proper consistency, which is determined by cooling a small quantity. Donkin and Bacon's English Patent, 1813.

The roller is cast in a hollow cylindrical mold, a wooden core with metallic bearings being first placed centrally in the mold. See Inking-roll.

Print'er's Var'nish. Linseed or nut oil boiled and kindled till it acquires a certain consistence: to this black resin is added, ¾ to 1 pound to the quart of oil, stirred; 1¾ pound of dry brown soap added, stirred, boiled. May be diluted with oil of turpentine for use. See Lithographic Varnish, page 1333.

Print-hold'er. (*Photography.*) A small frame for suspension from a nail or supported at the back in the manner of an easel, adapted to hold and exhibit a photograph. See also Pressure-frame.

Print'ing. 1. *a.* The art of taking an impression from an inked form, plate, block, or stone.

Speaking generally, the art is at least forty centuries old. Ancient Assyrian and Egyptian seals exist, whose surfaces were blacked and then pressed upon bark, a leaf, or skin, delivering an impression either with white marks on a black ground or black on a white ground, according to the character of the engraving, whether the lines of the design were cut in or left salient.

The rude king who smeared his hand with red ocher or the soot from a burning lamp and then made the impression of the palm and digits beneath a grant of land, was a printer in his way in thus *putting his hand* to the document.

As a substitute for the *sign-manual,* kings of old stamped their names or pronomens upon their grants and orders. See Seal.

In the capitals of the great kingdom of Mesopotamia, which, in its day, was the most densely populated part of the earth, the impressions of the stamps and seals of the recorders and scribes are discovered in thousands. Tablets of clay were impressed by engraved cylinders and then baked, and have remained to this day. See Seal.

> "It is turned as clay to the seal." — *Job.*

This is not printing as we understand the word, but is closely allied; the ceramic works of the Assyrians, Egyptians, Phœnicians, Cyprians, and Etruscans have been, by their composition, proof against decay, and show the kindred arts of plastic molding, engraving, painting, and transferring, the latter being a mode of delivering upon an object an impression from a surface previously marked or inked with the design required to be repeated.

Some of the ancient stamps in the British Museum are of bronze, and have raised reversed letters, evidently intended to print on bark, leaves, papyrus, linen, or parchment. These stamps have handles. They were in use among the Romans before the Christian era.

The first notice that we find of printing pages is in the Chinese annals. Du Halde cites the following, from the pen of the celebrated Emperor Van Vong, who flourished 1120 years before Christ : —

> "As the stone Me [a word signifying ink in the Chinese language], which is used to blacken the engraved characters, can never become white ; so a heart blackened by vices will always retain its blackness."

From this it appears that printing from blocks was a very ancient art. Other Catholic missionaries besides Du Halde concur in supposing it to have been invented from 930 to 950 B. C.

The Chinese process is described by Sir J. F. Davis, and it is probable that it has remained substantially the same for a score of centuries.

> The block commonly used by the Chinese is pear-tree wood It is finely planed and squared to the dimensions of two pages. The surface is then rubbed over with a paste or size, occasionally made from boiled rice, which renders it quite smooth. The future pages, which have been transcribed on thin transparent paper, are delivered to the block-cutter, who sticks them face down to the block by the sizing just mentioned. The thinness of the paper permits the writing to show through perfectly. The paper being rubbed off, a clear impression of the ink remains on the wood. The workman then cuts away all that part of the block not covered by ink, leaving the characters in relief. The pages are then ready to print.
>
> The first four books of Kung-fu-tze were printed, according to Klaproth, upon page blocks in the province of Szut-schuen, between 890 and 925 A. D., and the description of the technical manipulation of the Chinese press might have been read in Western countries as early as 1310 in Raschid-eddin's Persian History of Cathay.
>
> No press is used in printing, but the workman holds in his right hand a stick with a brush at each end. With one brush he applies ink to the page, then lays on a sheet of thin paper, like tissue-paper, and runs the dry brush over it, so as to make the impression. The paper is printed on one side only, and the blank side is turned inward, leaving the fold on the outside of the pages. A Chinese book thus has the appearance of an uncut volume.
>
> This plan was used in Europe in the thirteenth century for printing playing-cards and the works known as *block-books*, each page being an engraved block, like those of the Chinese.
>
> In the year 1041, a Chinese blacksmith named Pi-Ching invented a method of printing from plates formed from movable types of burnt clay, called *ho-pan*, that name being still used to designate the plates in use at the Imperial printing-office. The types of Pi-Ching were of the thickness of a Chinese coin, and each had a word on its face. A plate of iron was covered with fusible mastic, and the letters were laid upon it in lines running from the top downward. The plate was then heated and the types were forced into the mastic, being *planed down* to a level surface by pressure. When the edition was printed, the mastic was again heated and the types removed.
>
> The vast number of characters used in the Chinese language, which is not phonetic and has a symbol for each word, renders it doubtful whether there is any advantage in using movable types over engraved blocks. The printing-office established by American missionaries in China has 6,000 different characters in its font of type. The types now in use in China are of similar form to our own.
>
> The works of Gotama, under the title of "Verbal Instructions," are published by the Chinese government in four languages, — Thibetan, Mongol, Mantchou, and Chinese, — from the Imperial press at Pekin, in 800 large volumes. The name of this founder of Buddhism was Arddha Chiddi. He was born about 1700 B. C., at Capila, near Nepaul. This religion now embraces Ceylon, Tartary, Thibet, China, Japan, and Burmah. He changed his name to *Gotama*, "one who kills the senses," in allusion to the sublimation of the soul by physical mortifications.

It appears that the Venetians introduced block-printing into Europe, and wood-engraving and printing had long been in use in the time of Charles V., when playing-cards were thus made. The printing from blocks is said to have been practiced at Ravenna in 1289, and among the Germans in 1300. In 1441 it had attained the dignity of special legislation ; the Venetian card-makers, taking their impressions by means of a burnisher, obtained protection against the introduction of "stamped cards."

The most important of the *block-books* was the "Biblia Pauperum," or poor man's Bible, which was a book of from 40 to 50 pages, with scenes and incidents from the Bible. It was a great favorite for four or five centuries, existing at first in the manuscript form ; it was printed from blocks in 1440, and remained as a block-book long after the invention of separate-type printing by Guttenberg. The book had several authors, but its first compilation is ascribed to Bonaventura, the chief of the Franciscans, in 1260.

John Guttenberg (called Geinsfleisch, from the name of his house) was born in 1400 at Mentz. In company with Faust and others he printed several works with *wooden types* and *wooden blocks*. These were the "Alexandri Galli Doctrinale" and "Petri Hispani Traetatus," in 1442 ; and subsequently the "Tabula Alphabetica," "Catholicon," "Donati Grammatica," and the "Confessionalia," between the years 1444 and 1450. In the years 1450 – 55, the Bible of 637 leaves was printed by Guttenberg and Faust with *cut metal types*. Guttenberg died in 1468, in high honor for his genius and perseverance. Faust, after dissolving partnership (1455) with Guttenberg, became allied with Schoeffer ; and they published in 1457 the "Codex Psalmorum" with metallic types, — the most ancient book with a date and inscription.

Guttenberg took other partners, and published the "Catholicon Jo. de Janua" in 1460. Guttenberg used none but *wooden* or *cut metallic* types till the year 1462.

Faust gave his daughter in marriage to Schoeffer, the former servant of Guttenberg and himself, and the inventor of *cast metallic type*.

The most ample testimony in favor of Schoeffer is given by Jo. Frid. Faustus, of Aschaffenburg, from papers preserved in his family : —

> "Peter Schoeffer of Gernsheim, perceiving his master Faust's design, and being himself ardently desirous to improve the art, found out (by the good providence of God) the method of cutting (*incidendi*) the characters in a *matrix*, that the letters might easily be singly *cast*, instead of being *cut*. He privately *cut matrices* for the whole alphabet ; and when he showed his master the letters cast from those matrices, Faust was so pleased with the contrivance that he promised Peter to give him his only daughter Christina in marriage, a promise which he soon after performed But there were as many difficulties at first with these letters as there had been before with *wooden* ones, the metal being too soft to support the force of the impression ; but this defect was soon remedied by mixing the metal with a substance which sufficiently hardened it."

Service with Guttenberg was the means of directing Schoeffer's attention in this line, but it must be admitted that the invention of the latter was by very far the greatest of the series, leaving nothing for future generations but to improve the details of the process.

The first book printed with *cast types* was "Durandi Rationale," in 1459 ; they seem, however, to have had only *one size* of *cast* letters, all the larger characters which occur being *cut types*, as it plainly appears by an inspection of the book. Faust and Schoeffer continued to print a considerable number of works till 1466. They took more impressions on *vellum* than on *paper* in their earliest works, which was the case with their Bibles and Tully's Offices. This was soon inverted ; for when *paper* was introduced, they took but few impressions on *vellum*, which were more for curiosities than for general use. How long Faust lived is uncertain ; but, in 1471, we find that Schoeffer was in partnership with Conrad Henlif and a kinsman of his master Faust. Faust and Schoeffer printed the

"Codex Psalmorum" (with *cut* types), in 1457, now in Imperial Library, Vienna.

"Durandi Rationale," 1459, Earl of Pembroke's Library, England.

"Catholicon Januensis," 1460, Royal Library, France.

Livy printed "Du Fresnoy," 1460.

First Bible completed, 1460.

Latin Bible, 1462; Royal Library, France.

Greek characters first used, 1465.

"Cicero de Officiis," 1465.

Tully's Offices, 1465-66, Bodleian and other libraries.

Roman characters at Rome, 1467.

Caxton sets up a press at London, 1471.

"De Civitate Dei." 1473.

Æsop's Fables, by Caxton, first book with numbered pages, 1474.

Aldus cast the Greek alphabet and printed a Greek book, 1476.

Aldus introduced italics, 1476.

"The Pentateuch" in Hebrew, 1482.

Homer in folio, by Demetrius of Florence, 1488.

The "Complutensian Polyglot" of Cardinal Ximenes, in 1517.

The exact conformity of different copies of the book taken by Faustus for sale in Paris gave rise to the report of his being in league with Satan, and was the origin of the popular story of his attendant demon.

The Mentz printers, in order that the art might not be divulged, administered an oath of secrecy to all whom they employed; this appears to have been strictly adhered to until the year 1462, at which period the city was sacked and plundered by Archbishop Adolphus of Nassau; its former rights and franchises were also abolished. Amid the consternation occasioned by this extraordinary event, the workmen of the Mentz press, considering their oath of fidelity no longer binding, spread themselves in different directions. By this circumstance the hitherto great mystery was rapidly carried through a considerable portion of Europe; and the places which received it early, after some time commenced a contention for the merit of the discovery.

Laurentius Zanssen, surnamed Koster, was born in Haarlem about 1370, and died 1440. His claim to be the inventor of separate wooden types rests upon the testimony of Adrian Young, rector of the Latin School of Haarlem about 1570. It is said that he tied with string his form of separate wooden types. It is more probable, from some existing specimens, that he sometimes cut blocks of a few words or lines to print portions of a page or add inscriptions to cuts.

A claim has also been put in for John Mentilius of Strasburg.

Janson of France, an engraver of coins and medals, about 1458, seems to have observed the process and subsequently practiced it in Venice, where he published the "Decor Puellarum" and "Gloria Mulierum," in 1471. He determined the form and proportions of the present Roman character.

It may be mentioned that, as at first practiced in Europe, sheets were printed on but one side and the backs of the pages pasted together. At first, also, spaces were left for the illuminated capital letters, which were put in by hand.

The art was carried to France in 1469; to Italy, in 1465; to Spain, in 1477; to England by Caxton, in 1474.

Italy soon took the lead, and long kept it, Venice being the headquarters. In the editions published in the sixteenth century, one half were Italian, and one half of these were Venetian; one seventeenth were English.

In Venice, during the Turkish war of 1563, newspapers first made their appearance. The "Gazette de France" was commenced in 1631. Newspapers were fairly established in England after the decapitation of Charles I.

The forms of the old printers were generally either large or small folios, or at least quartos; the lesser sizes were not in use. The leaves were without running-title, direction-word, number of pages, or divisions into paragraphs. The character itself was a rude old Gothic mixed with Secretary, designed on purpose to imitate the handwriting of those times. The words were printed so close to one another that it was difficult and tedious to be read even by those who were used to manuscripts and to this method, and often lead the inattentive reader into mistakes. Their orthography was various and often arbitrary, disregarding method. They had very frequent abbreviations, which in time grew so numerous and difficult to be understood, that there was a necessity for writing a book to teach the manner of reading them. Their periods were distinguished by no other points than the double or single one, that is, the colon and full-point; but they a little after introduced an oblique stroke, thus /, which answered the purpose of our comma. They used no capital letters to begin a sentence, or for proper names of men or places. They left blanks for the places of titles, initial letters, and other ornaments, in order to have them supplied by the illuminators, whose ingenious art, though in vogue before and at that time, did not long survive the masterly improvements made by the printers in this branch of their art. The name of the printer, place of his residence, etc., etc., were either wholly neglected or put at the end of the book, not without some pious ejaculation or doxology. The date was likewise omitted or involved in some cramped circumstantial period, or else printed either at full length or by numerical letters, and sometimes partly one and partly the other; thus, one Thousand CCCC and lxxxiii, etc.; but all of them at the end of the book. There was no variety of characters, no intermixture of Roman and italic; these are of later invention; but their pages were continued in a Gothic letter of the same size throughout. They printed but few copies at once, for 200 or 300 were then esteemed a large edition.

Catchwords at the foot of pages were first used at Venice by Vindeline de Spori. They have but lately been abolished.

Signatures to sheets were used by Zorat in Milan in 1470.

The first press in America was in Mexico. The "Manual for Adults" was printed on it in 1550 by Juan Cromberger, who was probably the first printer in America. The second press was at Lima, in 1586. The press at Cambridge, Massachusetts, was established in January, 1639, by Stephen Daye. It still exists as the "University Press," and at that establishment this Dictionary has the honor to be set up. The Faculty of Harvard College was censor till 1662, when "licensers of the press" were appointed. In 1755 the press was free. A Psalter in the English and Indian languages was printed at the "University Press" in 1709.

A printing-press was established in New London, Conn., in 1709; the first printing-press in Turkey was brought from Paris by Mohammed Effendi, in 1721; the first press in Annapolis, Md., was in 1726; Williamsburg, Va., 1729; Charleston, S. C., 1730; Newport, R. I., 1732; Halifax, N. S., 1751; Newbern, N. C., 1755; Portsmouth, N. H., 1756; Savannah, Ga., 1763; Quebec, Canada, 1764. The first press west of the Alleghany range was in Cincinnati, 1793. The first press west of the Mississippi, in St. Louis, 1808.

Stereotyping was invented by William Ged of Edinburgh, in 1725; inking-rollers, by Nicholson; *composition* inking-rollers, by Donkin and Bacon of London, in 1813.

The Roman alphabet is used for the body of printed matter in English books and newspapers, though hundreds of types differing from the Roman are used for special purposes, as the titles of books and in displayed advertisements. See LETTER; FONT.

The compositor at work on ordinary printed matter has a pair of cases for his Roman letter and another pair, or a double case, for italic. (See CASE.) In picking up the letters he works without reference to the face of the type, but is guided entirely by the *nicks*, assuming always that his case is not *foul*, that is, does not have letters in the wrong boxes.

In putting the type in his *stick*, he places it so that the nicked end shall be down and away from him. Each letter is held by the thumb of the left hand until another letter or space is placed beside it. In reading from type the letters are of course inverted.

At the end of the line, if the words do not fill the stick they are made to do so by wider spacing, or the ordinary spaces are replaced by thinner ones, so that another word or syllable can go in. This is called justifying.

When the stick is filled, the matter is lifted out on to a galley for proving. When the proof has been read, the type is *made up* into pages or columns, *locked up* in a *chase*, and is then *ready for the press*, or for *stereotyping* or *electrotyping*.

When the edition has been printed the type is said to be *dead*, and is ready for distribution. A compositor will *distribute matter* from three to four times as fast as he can *set* it.

Electrotype or stereotype plates are used instead of type when the edition is so large that wear of type would amount to more than the cost of plates, when it is desired to preserve the plates for a future edition, and sometimes for other reasons. Among

Cost of One Ream and of 100 Sheets of Paper, Weight per Ream and Cost per Pound being given, from 12 to 150 pounds per Ream, and at from 16 to 35 Cents per Pound.

[The upper figure in each square gives the cost per ream (480 sheets), and the lower figure per 100 sheets. The last column gives the price per half-cent, to assist in calculating the fractions.]

Lbs. per Ream.	16c.	17c.	18c.	19c.	20c.	21c.	22c.	23c.	24c.	25c.	26c.	27c.	28c.	29c.	30c.	31c.	32c.	33c.	34c.	35c.	½c.
12	1.92 .40	2.04 .43	2.16 .45	2.28 .48	2.40 .50	2.52 .53	2.64 .55	2.76 .58	2.88 .60	3.00 .63	3.12 .66	3.24 .68	3.36 .70	3.48 .75	3.60 .76	3.72 .78	3.84 .80	3.96 .83	4.08 .86	4.20 .88	.06 .01
14	2.24 .47	2.38 .50	2.52 .53	2.66 .55	2.80 .58	2.94 .61	3.08 .65	3.22 .67	3.36 .70	3.50 .73	3.64 .76	3.78 .79	3.92 .82	4.06 .85	4.20 .88	4.34 .90	4.48 .93	4.62 .96	4.76 .99	4.90 1.02	.07 .01
16	2.56 .53	2.72 .57	2.88 .60	3.04 .63	3.20 .67	3.36 .70	3.52 .73	3.68 .77	3.84 .80	4.00 .83	4.16 .87	4.32 .90	4.48 .93	4.64 .97	4.80 1.00	4.96 1.03	5.12 1.06	5.28 1.10	5.44 1.13	5.60 1.17	.08 .02
18	2.88 .60	3.06 .64	3.24 .68	3.42 .71	3.60 .75	3.78 .78	3.96 .83	4.14 .86	4.32 .90	4.51 .94	4.68 .98	4.86 1.01	5.04 1.05	5.22 1.09	5.40 1.13	5.58 1.16	5.76 1.20	5.94 1.24	6.12 1.28	6.30 1.31	.09 .02
20	3.20 .67	3.40 .71	3.60 .75	3.80 .79	4.00 .83	4.20 .88	4.40 .92	4.60 .96	4.80 1.00	5.00 1.04	5.20 1.08	5.40 1.13	5.60 1.17	5.80 1.21	6.00 1.25	6.20 1.30	6.40 1.33	6.60 1.38	6.80 1.42	7.00 1.46	.10 .02
22	3.52 .73	3.74 .78	3.96 .83	4.18 .87	4.40 .93	4.62 .97	4.84 1.02	5.06 1.06	5.28 1.10	5.50 1.15	5.72 1.20	5.94 1.24	6.16 1.28	6.38 1.33	6.60 1.38	6.82 1.42	7.04 1.47	7.26 1.51	7.48 1.56	7.70 1.60	.11 .02
24	3.84 .80	4.08 .85	4.32 .90	4.56 .95	4.80 1.00	5.04 1.05	5.28 1.10	5.52 1.15	5.76 1.20	6.00 1.25	6.24 1.30	6.48 1.35	6.72 1.40	6.96 1.45	7.20 1.50	7.44 1.55	7.68 1.60	7.92 1.65	8.16 1.70	8.40 1.75	.12 .03
26	4.16 .87	4.42 .92	4.68 .97	4.94 1.03	5.20 1.08	5.46 1.14	5.72 1.19	5.98 1.25	6.24 1.30	6.50 1.35	6.76 1.41	7.02 1.46	7.28 1.52	7.54 1.58	7.80 1.63	8.06 1.68	8.32 1.73	8.58 1.78	8.84 1.84	9.10 1.90	.13 .03
28	4.48 .93	4.76 .99	5.04 1.05	5.32 1.11	5.60 1.17	5.88 1.23	6.16 1.28	6.44 1.34	6.72 1.40	7.00 1.46	7.28 1.52	7.56 1.58	7.84 1.63	8.12 1.69	8.40 1.75	8.68 1.81	8.96 1.87	9.24 1.93	9.52 1.98	9.80 2.04	.14 .03
30	4.80 1.00	5.10 1.07	5.40 1.13	5.70 1.19	6.00 1.25	6.30 1.31	6.60 1.37	6.90 1.44	7.20 1.51	7.50 1.56	7.80 1.63	8.10 1.69	8.40 1.75	8.70 1.81	9.00 1.88	9.30 1.94	9.60 2.00	9.90 2.06	10.20 2.13	10.50 2.19	.15 .03
32	5.12 1.07	5.44 1.13	5.76 1.20	6.08 1.27	6.40 1.33	6.72 1.40	7.04 1.47	7.36 1.53	7.68 1.60	8.00 1.67	8.32 1.73	8.64 1.80	8.96 1.87	9.28 1.93	9.60 2.00	9.92 2.07	10.24 2.13	10.56 2.20	10.88 2.27	11.20 2.33	.16 .03
34	5.44 1.14	5.78 1.20	6.12 1.28	6.46 1.35	6.80 1.42	7.14 1.49	7.48 1.56	7.82 1.63	8.16 1.70	8.50 1.77	8.84 1.84	9.18 1.91	9.52 1.98	9.86 2.05	10.20 2.13	10.54 2.20	10.88 2.27	11.22 2.34	11.56 2.41	11.90 2.48	.17 .04
35	5.60 1.17	5.95 1.24	6.30 1.31	6.65 1.39	7.00 1.46	7.35 1.53	7.70 1.60	8.05 1.68	8.40 1.75	8.75 1.82	9.10 1.90	9.45 1.97	9.80 2.04	10.15 2.12	10.50 2.19	10.85 2.26	11.20 2.33	11.55 2.41	11.90 2.48	12.25 2.55	.18 .04
36	5.76 1.20	6.12 1.28	6.48 1.35	6.84 1.43	7.20 1.50	7.56 1.58	7.92 1.65	8.28 1.73	8.64 1.80	9.00 1.88	9.36 1.95	9.72 2.03	10.08 2.10	10.44 2.18	10.80 2.25	11.16 2.33	11.52 2.40	11.88 2.48	12.24 2.55	12.60 2.63	.18 .04
38	6.08 1.27	6.46 1.35	6.84 1.43	7.22 1.50	7.60 1.58	7.98 1.66	8.36 1.74	8.74 1.83	9.12 1.90	9.50 1.98	9.88 2.06	10.26 2.14	10.64 2.22	11.02 2.29	11.40 2.38	11.78 2.45	12.16 2.53	12.54 2.61	12.92 2.69	13.30 2.77	.19 .04
40	6.40 1.33	6.80 1.42	7.20 1.50	7.60 1.58	8.00 1.67	8.40 1.75	8.80 1.83	9.20 1.92	9.60 2.00	10.00 2.08	10.40 2.17	10.80 2.25	11.20 2.33	11.60 2.42	12.00 2.50	12.40 2.58	12.80 2.67	13.20 2.75	13.60 2.83	14.00 2.92	.20 .04
42	6.72 1.40	7.14 1.49	7.56 1.58	7.98 1.66	8.40 1.75	8.82 1.84	9.21 1.93	9.66 2.01	10.08 2.10	10.50 2.19	10.92 2.28	11.34 2.36	11.76 2.45	12.18 2.54	12.60 2.63	13.02 2.71	13.44 2.80	13.86 2.89	14.28 2.97	14.70 3.06	.21 .04
44	7.04 1.47	7.48 1.56	7.92 1.65	8.36 1.74	8.80 1.83	9.24 1.92	9.68 2.02	10.12 2.11	10.56 2.20	11.00 2.29	11.44 2.38	11.88 2.48	12.32 2.57	12.76 2.66	13.20 2.75	13.64 2.84	14.08 2.93	14.52 3.03	14.96 3.12	15.40 3.21	.22 .05
45	7.20 1.50	7.65 1.59	8.10 1.69	8.55 1.78	9.00 1.88	9.45 1.97	9.90 2.06	10.35 2.16	10.80 2.25	11.25 2.34	11.70 2.44	12.15 2.53	12.60 2.63	13.05 2.72	13.50 2.81	13.95 2.91	14.40 3.00	14.85 3.09	15.30 3.19	15.75 3.28	.23 .05
46	7.36 1.53	7.82 1.63	8.28 1.73	8.74 1.82	9.20 1.92	9.66 2.01	10.12 2.11	10.58 2.20	11.04 2.30	11.50 2.40	11.96 2.49	12.42 2.59	12.88 2.68	13.34 2.79	13.80 2.88	14.26 2.97	14.72 3.07	15.18 3.16	15.64 3.26	16.10 3.35	.23 .05
48	7.68 1.60	8.16 1.70	8.64 1.80	9.12 1.90	9.60 2.00	10.08 2.10	10.56 2.20	11.04 2.30	11.52 2.40	12.00 2.50	12.48 2.60	12.96 2.70	13.44 2.80	13.92 2.90	14.40 3.00	4.88 3.10	15.36 3.20	15.84 3.30	16.32 3.40	16.80 3.50	.24 .05
50	8.00 1.67	8.50 1.77	9.00 1.88	9.50 1.98	10.00 2.08	10.50 2.19	11.00 2.29	11.50 2.40	12.00 2.50	12.50 2.60	14.00 2.71	13.50 2.81	14.00 2.92	14.50 3.02	15.00 3.13	15.50 3.23	16.00 3.33	16.50 3.44	17.00 3.54	17.50 3.65	.25 .05
52	8.32 1.73	8.84 1.84	9.36 1.95	9.88 2.06	10.40 2.17	10.92 2.28	11.44 2.38	11.96 2.49	12.48 2.60	13.00 2.71	13.52 2.82	14.04 2.93	14.56 3.03	15.08 3.14	15.60 3.25	16.12 3.36	16.64 3.47	17.16 3.57	17.68 3.68	18.20 3.79	.26 .05
54	8.64 1.80	9.18 1.91	9.72 2.03	10.26 2.14	10.80 2.25	11.34 2.36	11.88 2.48	12.42 2.59	12.96 2.70	13.50 2.81	14.04 2.93	14.58 3.04	15.12 3.15	15.66 3.26	16.20 3.37	16.74 3.49	17.28 3.60	17.82 3.71	18.36 3.83	18.90 3.94	.27 .06
55	8.80 1.83	9.35 1.95	9.90 2.06	10.45 2.18	11.00 2.29	11.55 2.41	12.10 2.52	12.65 2.63	13.20 2.75	13.75 2.87	14.30 2.98	14.85 3.09	15.40 3.21	15.95 3.32	16.50 3.44	17.05 3.55	17.60 3.67	18.15 3.78	18.70 3.90	19.25 4.01	.28 .06
56	8.96 1.87	9.52 1.99	10.08 2.10	10.64 2.22	11.20 2.33	11.76 2.45	12.32 2.57	12.88 2.68	13.44 2.80	14.00 2.92	14.56 3.03	15.12 3.15	15.68 3.27	16.24 3.38	16.80 3.45	17.36 3.62	17.92 3.73	18.48 3.85	19.04 3.97	19.60 4.08	.28 .06
58	9.28 1.93	9.86 2.05	10.44 2.18	11.02 2.30	11.60 2.42	12.18 2.54	12.76 2.66	13.34 2.78	13.92 2.90	14.50 3.02	15.08 3.14	15.66 3.26	16.24 3.38	16.82 3.50	17.40 3.63	17.98 3.75	18.56 3.87	19.14 3.99	19.72 4.11	20.30 4.23	.29 .06
60	9.60 2.00	10.20 2.13	10.80 2.25	11.40 2.38	12.00 2.50	12.60 2.63	13.20 2.75	13.80 2.88	14.40 3.00	15.00 3.13	15.60 3.25	16.20 3.38	16.80 3.50	17.40 3.63	18.00 3.75	18.60 3.88	19.20 4.00	19.80 4.13	20.40 4.25	21.00 4.38	.30 .06
65	10.40 2.17	11.05 2.30	11.70 2.44	12.35 2.58	13.00 2.71	13.65 2.84	14.30 2.98	14.95 3.12	15.60 3.25	16.25 3.39	16.90 3.52	17.55 3.66	18.20 3.79	18.85 3.93	19.50 4.06	20.15 4.20	20.80 4.33	21.45 4.47	22.10 4.60	22.75 4.74	.33 .07
70	11.20 2.33	11.90 2.48	12.60 2.63	13.30 2.77	14.00 2.92	14.70 3.06	15.40 3.21	16.10 3.35	16.80 3.50	17.50 3.65	18.20 3.80	18.90 3.94	19.60 4.08	20.30 4.23	21.00 4.38	21.70 4.52	22.40 4.67	23.10 4.82	23.80 4.96	24.50 5.10	.35 .07
75	12.00 2.50	12.75 2.66	13.50 2.81	14.25 2.96	15.00 3.13	15.75 3.28	16.50 3.44	17.25 3.59	18.00 3.75	18.75 3.91	19.50 4.06	20.25 4.22	21.00 4.38	21.75 4.53	22.50 4.69	23.25 4.84	24.00 5.00	24.75 5.16	25.50 5.31	26.25 5.47	.38 .08
80	12.80 2.67	13.60 2.83	14.40 3.00	15.20 3.17	16.00 3.33	16.80 3.45	17.60 3.67	18.40 3.83	19.20 4.00	20.00 4.17	20.80 4.33	21.60 4.45	22.40 4.67	23.20 4.83	24.00 5.00	24.80 5.17	25.60 5.33	26.40 5.45	27.20 5.67	28.00 5.83	.40 .08
85	13.60 2.83	14.45 3.01	15.30 3.19	16.15 3.37	17.00 3.50	17.85 3.72	18.70 3.90	19.55 4.07	20.40 4.25	21.25 4.43	22.10 4.60	22.95 4.78	23.80 4.96	24.65 5.14	25.50 5.31	26.35 5.50	27.20 5.67	28.05 5.83	28.90 6.01	29.75 6.19	.43 .09
90	14.40 3.00	15.30 3.19	16.20 3.38	17.10 3.56	18.00 3.76	18.90 3.94	19.80 4.13	20.70 4.31	21.60 4.50	22.50 4.69	23.40 4.88	24.30 5.06	25.20 5.25	26.10 5.44	27.00 5.63	27.90 5.81	28.80 6.00	29.70 6.19	30.60 6.38	31.50 6.56	.45 .09
95	15.20 3.17	16.15 3.37	17.10 3.56	18.05 3.76	19.00 3.96	19.95 4.16	20.90 4.35	21.85 4.55	22.80 4.75	23.75 4.95	24.70 5.15	25.65 5.34	26.60 5.54	27.55 5.74	28.50 5.94	29.45 6.14	30.40 6.33	31.35 6.53	32.30 6.73	33.25 6.93	.48 .10
100	16.00 3.33	17.00 3.54	18.00 3.75	19.00 3.96	20.00 4.17	21.00 4.38	22.00 4.58	23.00 4.79	24.00 5.00	25.00 5.21	26.00 5.42	27.00 5.63	28.00 5.83	29.00 6.04	30.00 6.25	31.00 6.46	32.00 6.67	33.00 6.88	34.00 7.08	35.00 7.29	.50 .10
110	17.60 3.67	18.70 3.90	19.80 4.13	20.90 4.35	22.00 4.58	23.10 4.81	24.20 5.04	25.30 5.27	26.40 5.50	27.50 5.73	28.60 5.96	29.70 6.19	30.80 6.42	31.90 6.65	33.00 6.88	34.10 7.10	35.20 7.33	36.30 7.56	37.40 7.79	38.50 8.02	.55 .12
120	19.20 4.00	20.40 4.25	21.60 4.50	22.80 4.75	24.00 5.00	25.20 5.25	26.40 5.50	27.60 5.75	28.80 6.00	30.00 6.25	31.20 6.50	32.40 6.75	33.60 7.00	34.80 7.25	36.00 7.50	37.20 7.75	38.40 8.00	39.60 8.25	40.80 8.50	42.00 8.75	.60 .13
130	20.80 4.33	22.10 4.60	23.40 4.88	24.70 5.15	26.00 5.42	27.30 5.69	28.60 5.96	29.90 6.23	31.20 6.50	32.50 6.77	33.80 7.04	35.10 7.31	36.40 7.58	37.70 7.85	39.00 8.12	40.30 8.40	41.60 8.67	42.90 8.94	44.20 9.21	45.50 9.48	.65 .14
140	22.40 4.67	23.50 4.96	25.20 5.25	26.60 5.54	28.00 5.83	29.40 6.13	30.80 6.42	32.20 6.71	33.40 7.00	35.00 7.29	36.40 7.58	37.80 7.88	39.20 8.17	40.60 8.46	42.00 8.75	43.40 9.04	44.80 9.33	46.20 9.63	47.60 9.92	49.00 10.21	.70 .15
150	24.00 5.00	25.50 5.31	27.00 5.63	28.50 5.94	30.00 6.25	31.50 6.56	33.00 6.88	34.50 7.19	36.00 7.50	37.50 7.81	39.00 8.13	40.50 8.44	42.00 8.75	43.50 9.06	45.00 9.38	46.50 9.69	48.00 10.00	49.50 10.31	51.00 10.63	52.50 10.94	.75 .16
	18c.	17c.	18c.	19c.	20c.	21c.	22c.	23c.	24c.	25c.	26c.	27c.	28c.	29c.	30c.	31c.	32c.	33c.	34c.	35c.	½c.

book-printers it is often said that an edition of 5,000 copies will warrant the expense of stereotyping, and less than that number will not pay for publication.

b. (*Plate-printing.*) Taking impressions from engraved plates. See COPPERPLATE-PRINTING.

c. (*Stone.*) See LITHOGRAPHY; LITHOGRAPHIC PRESS; PHOTOLITHOGRAPHY.

d. (*Fabric.*) See CALICO-PRINTING.

e. (*Embossed.*) See PRINTING FOR THE BLIND.

f. (*Color.*) See CHROMATIC PRINTING; CHROMOLITHOGRAPHY.

An American invention has been made public for producing pictorial effects by the use of movable metallic types, cast like ordinary printing types, and bearing upon their faces different devices, which, by their combination, produce the desired effect. The types are each $^{1}{}_{32}$ of an inch square, their surfaces either plain, black, or lined in various directions and degrees of fineness. It is probably rather more ingenious than useful, and approximates the appearance of a canvas pattern for needlework.

Fasol's *stigmatypy* consists in using only the full-point of different sizes cast upon the same body The variations in shade and the whole effect is produced, as in ordinary stipple engraving, according to the proximity of the points.

g. Printing in gold is done in one of two ways: —

1. The impression is taken in a mixture of varnish, burnt umber, and gold size. Upon this gold-leaf is laid and lightly pressed. When sufficiently dry, the superfluous gold is rubbed, leaving the gilded letters.

Bronze-powder is used for inferior printing

2. Whittaker's method The stereotype-plate is placed on a hot metal block on the bed of the press The gold-leaf is laid on the face of the metallic page. The paper or vellum is placed on the tympan, having been previously sifted over with dried glair of egg and resin The tympan is turned down and the pressure maintained a little longer than usual.

2. (*Photography.*) The obtaining of *positive* prints from the exposure of sensitized paper beneath a photographic *negative* to the sun's rays. First performed by Fox Talbot. See PHOTOGRAPHY.

Quantity of Paper required for 1,000 *Copies of a Book, and the Number of Pages to Forms of various Sizes.*

Forms.	PAPER.		4to Pages.	8vo Pages.	12mo Pages.	18mo Pages.	32mo Pages.
	R'ms.	Q'res.					
1	1	2	8	16	24	36	64
2	2	4	16	32	48	72	128
3	3	6	24	48	72	108	192
4	4	8	32	64	96	144	256
5	5	10	40	80	120	180	320
6	6	12	48	96	144	216	384
7	7	14	56	112	168	252	448
8	8	16	64	128	192	288	512
9	9	18	72	144	216	324	576
10	11		80	160	240	360	640
11	12	2	88	176	264	396	701
12	13	4	96	192	288	432	768
13	14	6	104	208	312	468	832
14	15	8	112	224	336	504	896
15	16	10	120	240	360	540	960
16	17	12	128	256	384	576	1024
17	18	14	136	272	408	612	
18	19	16	144	288	432	648	
19	20	18	152	304	456	684	
20	22		160	320	480	720	
21	23	2	168	336	504	756	
22	24	4	176	352	528	792	
23	25	6	184	368	552	828	
24	26	8	192	384	576	864	
25	27	10	200	400	600	900	
26	28	12	208	416	624	936	
27	29	14	216	432	648	972	
28	30	16	224	448	672	1008	
29	31	18	232	464	696	1044	
30	33		240	480	720		
31	34	2	248	496	744		
32	35	4	256	512	768		
33	36	6	264	528	792		
34	37	8	272	544	816		
35	38	10	280	560	840		
36	39	12	288	576	864		
37	40	14	296	592	888		
38	41	16	304	608	912		
39	42	18	312	624	936		
40	44		320	640	960		
41	45	2	328	656	984		
42	46	4	336	672	1008		
43	47	6	344	688			
44	48	8	352	704			
45	49	10	360	720			
46	50	12	368	736			
47	51	14	376	752			
48	52	16	384	768			
49	53	18	392	784			
50	55		400	800			

Official Classification of the Class of Printing.

KINDS OF PRINTING.

Albertype.
Anastatic.
Aquatint.
Autography.
Autotypograpby.
Bas-relief.
Block.
Bronze
Calico (fabric).
Ceramic.
Chemitypy.
Chromatic.
Chromolithographic.
Electro-magnetic.
Embossed typography (blind).
Embossing (color).
Flock.
Fugitive.
Galvanoglypty.
Galvanography.
Glass.
Globular surface.
Heliochromy.
Heliotypy.
Hieroglyphic.
Intaglio.
Letterpress.
Lithographic.
Marbling.
Mezzotinto
Music.
Nature.
Offset.
Paneiconography.
Paper-hanging.
Phonotypography.
Photogalvanographic.
Photographic.
Photo-relief.
Phototypography.
Photozincography.
Plate.
Spool.
Stigmatypic.
Telotype.
Thermography.
Transfer.
Warp.
Xylographic.
Yarn.
Zincography.

SURFACES.

Anaglyptograph.
Chromatic type.
Convex type surfaces.
Dies.
Ectypography.
Electrotypes.
Engraved cylinders.
Engraved plates
Etched.
Galvanoplastic.
Glyphography.
Graphotype.
Logotypes.
Movable types.
Metallic (by chemicals and electricity).
Perforated plates.
Photoglyptic.
Phraseotypes.
Rubber stereotypes.
Rubber type.
Sectional plates.
Stereotypes.
Stone.
Stone cylinder.
Tapered type.
Wood carvings.
Zinc cylinders.

PRESSES.

Oscillating.

Oscillating bed and platen.
Oscillating bed, stationary platen.
Oscillating platen, stationary bed.

Reciprocating.

Addressing-machines.
Block.
Branding-stamps.
Card-presses.
Copying-presses.
Embossing-presses.
Fluidic impression.
Lever-press.
Perfecting.
Perforating-stamps.
Reciprocating bed and platen.
Reciprocating platen, stationary bed.
Stationary platen and reciprocating bed.
Type-writing.

Rotary.

Copying-press.
Many-impression cylinders, horizontal form.
Many-type cylinders, common axis.
Numbering-machines.
Paging-machine.
Perforating.
Prismatic form, rotating impression-cylinder.
Reciprocating cylinder and reciprocating bed.
Reciprocating cylinder, stationary bed.
Revolving type-cylinder.
Rotating cylinder, reciprocating bed.
Rotating cylinder, rotating bed.
Segmental cylinder and bed.
Segmental cylinder (type on flat side).
Single type-cylinder, double feed.
Single type-cylinders, many-impression cylinders.
Stop-cylinder.
Vertical type-cylinder, radially arranged impression-cylinders.
Vibrating cylinder, reciprocating bed.

Adjuncts.

- Blankets.
- Bodkins.
- Chases.
- Composing-sticks.
- Copy-holders.
- Damping.
- Delivering.
- Drop-rollers.
- Feeding.
- Fly-frames.
- Folding-machines.
- Friskets.
- Galley-rests.
- Galleys.
- Grippers.
- Imposing-stone.
- Inking
  - Ball.
  - Pelts.
  - Roller.
- Lapping.
- Leads.
- Mallet.
- Mitering-machines.
- Offsetting-blankets.
- Palette-knife.
- Quads, quadrats.
- Quoins.
- Registering.
- Reglets.
- Rule-cutters.
- Rules.
- Scrapers.
- Shooting-stick.
- Slugs.
- Spaces.
- Stereotype-plate holders.
- Sticks (side, head, and foot).
- Tympans.
- Type-cases.
- Type-casting.
- Type composing and distributing.
- Type-cutting.
- Type-gage.
- Type-rubbing.

See under the following heads: —

- Accented letters.
- Addressing-machine.
- Agate.
- Alley
- Anastatic printing.
- Antique.
- Apostrophe.
- Ascending-letter.
- Backing.
- Bank.
- Bank-note.
- Bat-printing.
- Beard.
- Bed.
- Bevel.
- Bite.
- Blackleading-machine.
- Blanket.
- Block.
- Block-printing.
- Board-rack.
- Bodkin.
- Body.
- Book.
- Bourgeois.
- Box.
- Brace.
- Bracket.
- Brass rule.
- Brayer.
- Breve.
- Brevier.
- Cahier.
- Calico-printing.
- Canon.
- Card-press.
- Caret.
- Carriage.
- Case.
- Ceramic printing.
- Chase.
- Chromatic printing.
- Clay-process.
- Color-printing.
- Column-rule.
- Composing-frame.
- Composing-machine.
- Composing-stand.
- Composing stick.
- Condensed letter.
- Copper-faced type.
- Copperplate press.
- Copy-holder.
- Crochet-type.
- Crotchet.
- Cutting-line.
- Cylinder printing-press.
- Dabber.
- Damping-machine.
- Dead matter.
- Descending letter.
- Diamond.
- Dipping-pan.
- Dip-roller.
- Distributing-machine.
- Distributing-roller.
- Double-cylinder press.
- Double letter.
- Drum.
- Ductor.
- Duodecimo (12mo).
- Eighteenmo (18mo).
- Elastic type.
- Electrotype.
- Em.
- Embossed typography.
- Emerald.
- English.
- Extended letter.
- Face.
- Feeding-apparatus.
- Floating-plate.
- Fly.
- Fly-board.
- Folio.
- Font.
- Foot-stick.
- Form.
- Forties.
- Forty-eights (48's).
- Frame.
- Frisket.
- Furniture.
- Gage paper-cutter.
- Gage. Printer's
- Galley.
- Galley-roller.
- Gallows.
- Gold-printing.
- Gold-size.
- Great primer.
- Grippers.
- Guide.
- Guillotine-cutter.
- Gutta-percha plate.
- Gutter.
- Gutter-snipe.
- Hair-line.
- Hat-tip press.
- Head-stick.
- Horn-book.
- Horse.
- Imposing.
- Imposing-stone.
- Inferior letter.
- Ink-cylinder.
- Ink-fountain.
- Inking-trough.
- Ink-roller.
- Ink-slice.
- Inner form.
- Inset.
- Italic.
- Kern.
- Lead.
- Lead-cutter.
- Leader.
- Lean face.
- Letter.
- Letter-board.
- Letter-case.
- Letterpress-printing.
- Ligature.
- Lithographic press.
- Live matter.
- Logotype.
- Long primer.
- Lower case.
- Mailing-machine.
- Manifold writing-book.
- Matrix.
- Matter.
- Medium.
- Metal furniture.
- Minion.
- Minionette.
- Miter-box.
- Mitering-machine.
- Music-printing.
- Music-type.
- Nature-printing.
- Newspaper folding-machine.
- Nippers.
- Nonpareil.
- Numbering-machine.
- Octavo (8vo).
- Offcut.
- Oil-cloth printing.
- Outer form.
- Overlay.
- Page-gage
- Paging-machine.
- Paragon.
- Paste-points.
- Pearl.
- Peel.
- Perfecting-press.
- Photo-mechanical printing.
- Pica.
- Pie.
- Pigment-printing.
- Planer.
- Platen
- Plate-printing machine.
- Pompet.
- Porcelain.
- Porcelain-printing.
- Postage-stamp.
- Poster.
- Pottery-printing.
- Press-printing.
- Primer.
- Printing for the blind.
- Printing-frame.
- Printing in colors.
- Printing in gold.
- Printing-ink.
- Printing-machine.
- Printing. Pictorial
- Printing-press.
- Printing-roller.
- Printing-telegraph.
- Printing-wheel.
- Printing-yarn
- Proof.
- Quadrat (quad).
- Quarto (4to).
- Quoin.
- Raising.
- Register.
- Register-point.
- Reglet.
- Revise.
- Ribbon for hand-stamps.
- Roller-mold.
- Roller-printing.
- Rounce.
- Ruby.
- Rule.
- Scraper.
- Script.
- Setting-rule.
- Shooting stick.
- Signature.
- Slip
- Small pica.
- Sorts.
- Space.
- Space-line.
- Space-rule.
- Stereotyping.
- Stereotyping-machine.
- Stick.
- Superior.
- Supply-roller.
- Surface-printing.
- Tape.
- Thirty-twos (32's).
- Ticket-printing.
- Topical coloring.
- Transfer-printing.
- Turtle.
- Twelvemo (12mo).
- Twenty-fours (24's).
- Tympan.
- Type.
- Type-distributing machine.
- Type-setting machine.
- Type-writing machine.
- Underlay.
- Vibrating roller.
- Wetting-machine.
- White-line.
- Yarn-printing machine.

Print′ing-bod′y. (*Pottery.*) A piece of ware prepared for being printed.

Print′ing for the Blind. This is a French invention. For it we are indebted to Valentine Haüy, who, in 1784, produced works in relief letters at Paris. He took the idea from a map in relief, the invention of a German. He adopted a form substantially similar to the Roman letters. The Academy of Sciences reported in its favor, a school was established, exhibitions took place before Louis XVI. For want of energy the institution languished until Dr. Guillié took charge in 1814.

The first book in relief in the English language was printed by Dr. Gall of Edinburgh, in 1827.

The Bible was printed in Glasgow by Alston, 1848, in raised Roman characters, upper case. It was comprised in nineteen volumes.

Gall's alphabet, Edinburgh, 1826, was a modified Roman, but in the process of simplification attained a certain resemblance to some old characters, among which may be cited the Punic, Oscan, and Greek. He published a book in this character in 1826, and the Gospel of St. John in 1829-34. Gall is regarded as the principal promoter of the art in Britain. He afterward modified the character of his type, and published a number of other books of the New Testament.

The systems of arbitrary characters, or, in other words, the alphabets adapted for the use of those having the faculty of sight, are not necessarily the best adapted for those who depend upon the sensation of touch. Much fruitless labor has been expended upon the matter, and this has been partly owing to the lack of due consultation with the persons who were to benefit by the result. The Illyrian or Sclavonic alphabet was early adopted, owing to its square form, which seemed to render the character easy to distinguish by the touch. The modification of the Roman character adopted by Haüy was modified by Guillié, and since his time various alphabets have been introduced, which have isolated the pupils of various institutions from each other, as no pupil could read any of the publications of another institution without mastering the other alphabet.

The system of punctured letters, invented by a blind man, Louis Braille, consists of dots whose differing numbers and arrangement indicate the respective letters. The number of dots varies from 1 to 6, and the variations readily admit of the letters, accented vowels, diphthongs, punctuation marks, numerals, etc.

Other arbitrary systems are those of Lucas, Frere, Moon, and Carton. Lucas's, claimed to be the least difficult to learn of the English systems, and peculiarly adapted for those who are deficient in delicacy of touch, uses many abbreviations of words and syllables, and is bulky, thirty-six volumes being required to contain the Scriptures, which, in the Boston alphabet, fill but eight.

Frere's is a phonetic system; in this the Scriptures are embraced in fifteen volumes.

Moon's system, the invention of a blind man, is based on those of Lucas and Frere, resembling the latter in the lines being alternately read from left to right and from right to left, from a supposed motive of convenience. The letters are each formed of one or two lines only, by using nine forms turned in different directions. Few abbreviations are employed.

Carton's system resembles Braille's, the dots being arranged to more nearly resemble Roman letters.

Alston's system consists of a slight modification of the Roman characters.

In America, the system of Mr. J. B. Friedlander has been to some extent employed. The alphabet is Roman capitals of the form known as block-letter. The only existing dictionary of the English language in raised letters is printed in this character.

Dr. Howe of Boston, superintendent for many years of the Perkins Institution for the Blind, is the author of the modified lower case Roman alphabet used in the United States. It has, perhaps, no equal among all the European systems, and the Jury Report of the English Exposition of 1851 give it a decided preference over all other systems known to the jury.

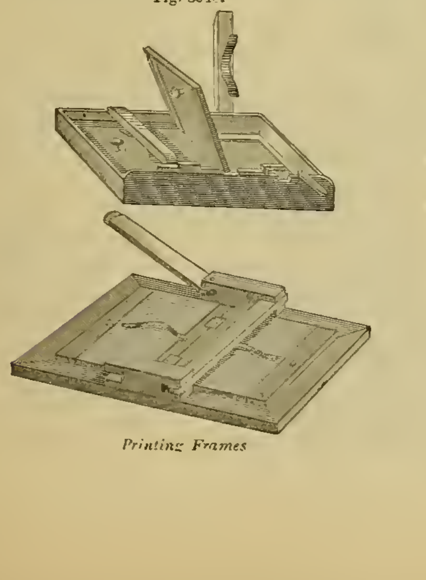
An alphabetic system having lower case with capitals is also employed in France.

Foucault's *printing-frame for the Blind* (French) was exhibited in 1849 and 1851 at the European Expositions, and is substantially as follows: —

The letters of the alphabet executed in relief are fixed on the upper ends of metallic rods made to slide longitudinally in tubes. They are placed on the same plane, in the form of a fan, and at the bottom of each is a small letter agreeing with that on the upper end. The lower ends of all the rods converge toward the same spot, and deliver their impressions as called in action at the place where the paper is presented. The paper is fed along between each impression, such as to enable the next impression to be delivered in the proper succession for the sense of the writing. At the end of a line the paper is shifted upward, and back to the commencement of another line. Foucault, though blind, was successful in business and mechanical enterprises, and was a zealous friend of his afflicted fellow-men.

Johnston's *printing apparatus for the blind* (United States patent, February 19, 1857) differs from the preceding in the mode of operating. The letters are arranged on the ends of cylindrical plungers moving vertically in tubes arranged near the margin of a disk, which is capable of rotation on a vertical axis. Each plunger has a letter in relief for the fingers of the blind, and acts in correspondence with a similar letter, which is to be impressed on the paper. The blind person feels round the disk until he finds the right letter. He then presses the letter and revolves the disk till he hears a click, when a pressure is brought upon the letter at the spot where the paper is presented. Each letter is brought to the same opening to give its impression, and the paper receives two movements, as in Foucault's; one between each letter for the spacing, and another at right angles to the former for the distance between lines. See Writing-frame.

Fig. 3946.



Printing Frames

Print'ing-frame. (*Photography.*) Also known as a *pressure-frame.* A quadrangular shallow box in which sensitized paper is placed beneath a negative and exposed to the direct rays of the sky or of the sun. Large printing-frames have always a pane of plate-glass in front to support the negative; the latter being laid thereon, and the sensitized paper on the negative. The back is closed, the contact being maintained by buttons and springs. The frame is then inverted, exposing the glass to the light. The back is made in two sections, hinged together, so as to allow examination of the print during exposure without shifting it.

Print'ing-ink. A compound of linseed-oil and lamp or ivory black. The oil is boiled, the lampblack and sometimes rosin and other ingredients added, and the compound ground. The recipes are various.

Print'ing-ma-chine'. See Printing-press; Calico-printing; Copperplate-printing, etc.

Print'ing-pa'per. Printing-paper includes news, book, and copperplate paper. It is usually bibulous, the oily and viscid ink not being subject to run upon the wet paper. Copperplate-paper is of the quality of *drawing*-paper, minus the sizing. See Paper.

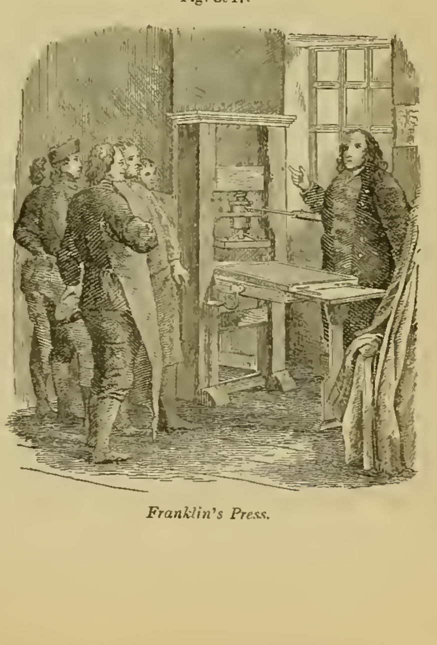
Print'ing-press. A machine to take an impression on paper or parchment from type, electrotype, or stereotype forms, steel or copper plates, lithographic stones, etc.

Presses for book or newspaper printing are broadly divided into *platen* and *cylinder* machines, and the latter again into such as have a flat type-bed reciprocating at the same speed as the surface speed of cylinder, and those which carry the type or printing plates on a revolving cylinder. See list on page 1793.

The first printing-press was a common screw-press with a bed, standards, a beam, a screw, and a movable platen. A contrivance for running the form in and out was afterward added.

Blaew of Amsterdam made a number of improvements in 1620, which entitle him to the rank of the

Fig. 3947.

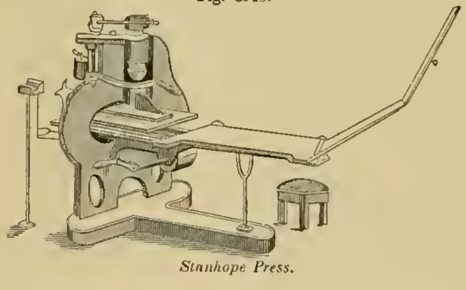


Franklin's Press.

first great improver of the printing-press. His press had a traveling bed, a platen depressed by a screw which was moved by a lever, and by a spring to raise the screw and platen after the delivery of the impression. The condition of the press in the time of the most illustrious printer on record is shown by the annexed cut, which is taken from the original press used by Franklin in London, and now in the museum of the United States Patent-Office. It is still the "Blaew" press, with minor modifications. It operates on the screw principle, the horizontal sweep of the handle rotating the screw which traverses through a nut in the cross-beam above, raising or lowering the platen, the center of whose upper surface has a cup which rests against the lower end of the screw-head; the four corners of the platen being fastened by thongs to the screw-head, so as to give it a certain independence of adjustment, to enable it to fit against the face of the form, that is, to assume parallelism therewith. The form rests on the bed and is secured in position by temper screws. The bed runs in and out on a track; a rack on the under side of the bed being engaged by a pinion on the shaft beneath, which is rotated by a hand-crank. The platen is only large enough to cover one half the bed, and in printing a newspaper it was necessary to screw down the platen on each page, running the bed forward or back between *pulls*.

This may be taken as a sample of the press in use until the advent, late in the eighteenth century, of Lord Stanhope's improved press, which so long maintained its position and has so familiar an appearance. The oscillating hand operates a toggle to force down the platen upon the paper on the form, and the platen is raised again by a spring when the force is withdrawn. The bed travels on ways, and the frisket is hinged and is so jointed as to lie back in an elevated position when raised for the purpose of withdrawing the sheet, inking the type, and placing a sheet thereon.

Fig. 3948.

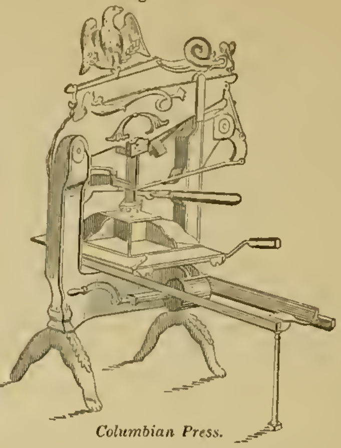


Stanhope Press.

The Columbian hand-press was invented by George Clymer of Philadelphia, who completed his invention about 1817. The Columbian press was considered superior to Stanhope's. The power is applied to the platen by a compound lever, consisting of three simple levers of the second order. This press is interesting as being the first important American addition to the art of printing.

Peter Smith's hand-press soon succeeded the Columbian as an American invention, and, in 1829, the Washington press was patented by Samuel Rust. This press has been modified in various ways, and is now the only hand-press much used in the United States for printing large sheets. The pressure is applied by a compound lever acting on a toggle-joint, and the platen is lifted by springs on each side.

Fig. 3949

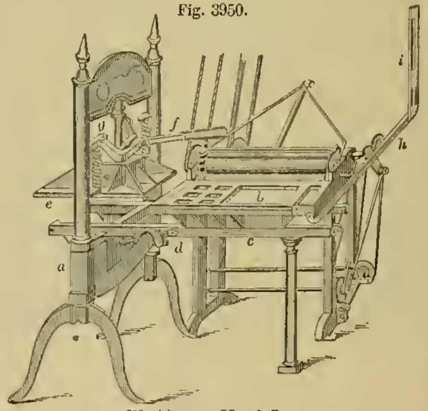


Columbian Press.

In Fig. 3950, *a* is the frame of the press, cast in sections; *b* is the bed, which slides on track *c*, and is run in and out by turning crank *d*, which has a belt attached to its pulley or *rounce*; *e* is the platen, *f* the handle or bar (sometimes called *devil's tail*), and *g* the toggle. Tympan *h* and frisket *i* are held up by the nature of their hinges, which allow only a certain amount of swing.

An automatic inking action, shown in the cut, was some time since introduced into hand-presses, whereby the inking-roller is operated by a weight raised by the *pull* of the pressman in delivering an impression. The descent of the weight draws the roller over the type and returns it to the inking-table while the pressman is placing another sheet upon the *tympan* and folding down the *frisket*.

Fig. 3950.



Washington Hand-Press.

The parts of a hand-press are: —

Bar; the lever by which pressure is applied.
Base; the cross-bar below the track.
Bed; a heavy casting with smooth face, which supports the *form*
Belt; a leathern strap attached to the drum, moving the bed back and forth under the platen.
Cap; a heavy cross-bar connecting the *cheeks* or *standards*.
Carriage; the bottom of the bed resting on the *track*.
Cheeks; the uprights at each side of the platen.
Drum; the pulley on the rounce.
Frame; the *cheeks*, *head*, and *base*.
Frisket; a light frame pivoted to the tympan.
Gallows; an upright to support the tympan.
Girdle; the belt.
Head; the cap.
Hook; a substitute for the gallows.

Lever; the *bar* or *devil's tail.*

Platen; a casting with smooth under face parallel with the bed.

Press-cloth; a blanket inside the tympan to regulate impression

Rounce; the winch which moves the bed.

Spindles; bolts parallel with the cheeks to hold the platen in parallelism with the bed.

Springs; to lift the platen.

Standards; the cheeks.

Toggle; the compound lever through which pressure is applied.

Track; the bars on which the bed slides.

Tympan; a frame covered with linen pivoted to the bed, so as to turn down over the form.

Tympan-drawer; a frame just fitting the tympan. The press-cloth comes between the tympan and drawer.

Wedge; a double inclined plane above the platen to regulate impression.

Power-presses. Nicholson obtained a patent in England, 1790, for a cylinder printing-machine which is believed to be the first on record. It was not brought into effective use, but some of the ideas were quite original, and were adopted by subsequent inventors. The main features are as follows: —

> "The types, being rubbed or scraped narrower toward the foot, were to be fixed radially upon a cylinder. This cylinder, with its type, was to revolve in gear with another cylinder covered with soft leather (the impression-cylinder), and the type received its ink from another cylinder, to which the inking apparatus was applied. The paper was impressed by passing between the type and impression cylinders" — HANSARD.

König, a German, constructed a printing-machine for Mr. Walter of the London "Times," in 1814; the issue of the 28th of November of that year, being printed on König's press, was the first newspaper printed by machinery driven by steam-power. The rate was 1,100 impressions per hour; this was afterward increased to 1,800. In this machine ordinary type was used; the form was flat, and passed beneath a large cylinder which delivered the impression.

The paper was held to its cylinder by tapes; the form was reciprocated beneath the inking apparatus and the paper-cylinder alternately. To double the rate, a paper-cylinder was to be placed on each side of the inking apparatus. The ink was placed in a trough and ejected upon the upper of a series of rollers, passed downward in the series; and here first occurred the distributing-roller with end motion.

König designed to combine two single machines to form a perfecting-press, but did not succeed.

Donkin and Bacon's machine, 1813, was built for the University of Cambridge, England. Several forms were attached on the sides of a prism, and were presented consecutively to the inking-cylinder and paper-cylinder. In this machine were first used the composition inking-rollers of glue and molasses.

In 1815, Cowper obtained a patent for curved electrotype-plates to be affixed to a cylinder. The greater portion of the cylinder formed a distributing surface for the ink; the remainder was occupied by the stereotype-plate.

Applegath and Cowper's single machine went back again to the flat reciprocating bed. This machine was the first to have diagonal distributing-rollers to spread the ink smoothly by sliding on the reciprocating inking-table.

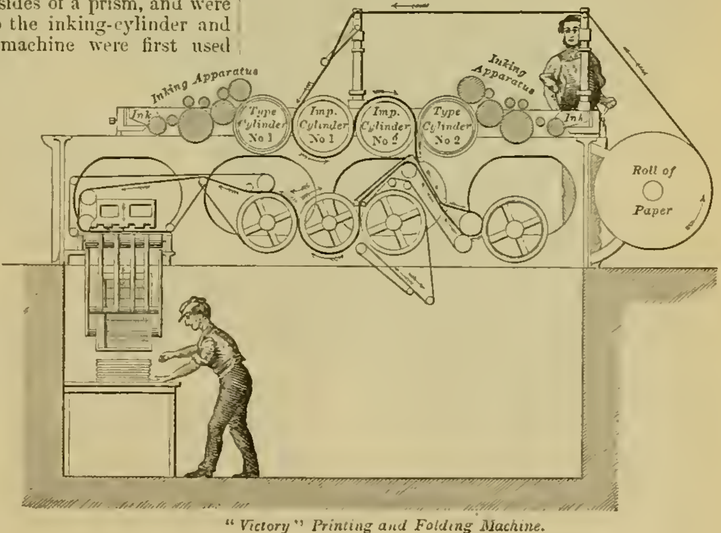
Applegath and Cowper's four-cylinder machine, 1827, superseded König's in the "Times" office, and printed at the rate of 5,000 per hour, on one side. It had four printing-cylinders, one form of type on a flat bed, and the paper-cylinders were alternately raised and depressed so that two were printed during the passage one way and the other two on the return passage. A pair of inking-rollers between the paper-cylinders obtained their ink from the table.

Applegath's machine, 1848, was long used upon the "Times." It introduced one novelty: placing the whole series of cylinders on end. On the vertical type-cylinder the type was arranged in upright columns, forming flat polygonal sides to the drum. Arranged around it were eight sets of inking apparatus, alternating with eight impression-cylinders, and the paper, fed from eight *banks*, was delivered upon as many tables. The paper fed from each feed-board was carried by tapes and rollers, and, passed on edge to the type and impression cylinders, was carried off, thrown over flatwise, and laid by boys upon the pile on the table. The number of sheets per hour worked upon this machine rose from 8,000, in 1848, to 12,000, printed on one side.

The Hoe type-revolving printing-machine is made with two to ten printing-cylinders arranged in planetary form around the periphery of the larger type-carrying cylinder. The type is secured in *turtles*, or the stereotype is bent to the curve of the cylinder. The circumference of the central cylinder has a series of binary systems, the elements of which are an inking apparatus and an impression apparatus, the paper being fed to the latter and carried away therefrom by tapes to a flyer, which delivers it on to a table. It has as many banks as feed or impression cylinders. See CYLINDER-PRESS.

There are numerous modifications of the flat-bed and type-revolving machines for more or less rapid work; perfecting, or for one side only; for fine wood-cut work, for book work, or job work; with continuously revolving cylinders, or stop cylinders, which pause while the bed returns; with inking-rollers varying in numbers with the kind of work required; and with many other variations in size for posters, hand-bills, and cards.

Fig. 3951.



"Victory" Printing and Folding Machine.

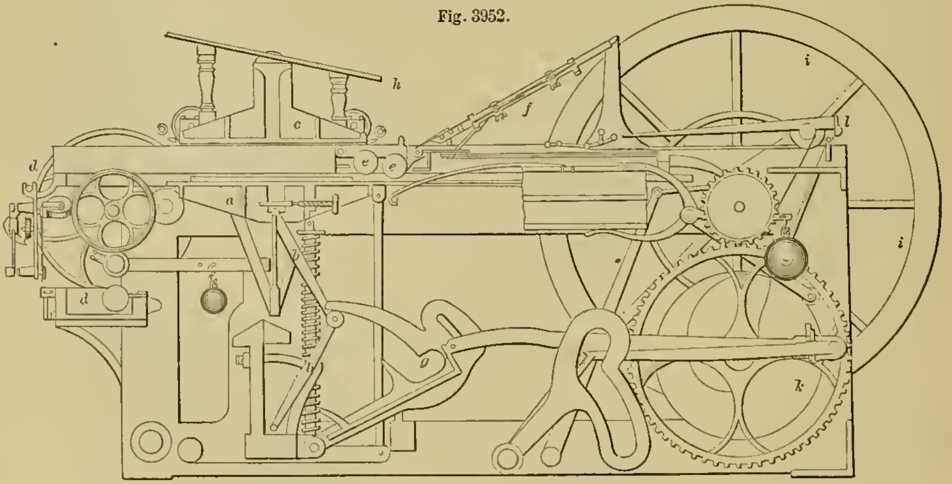
The "Victory" printing and folding machine is illustrated in the plate opposite. The roll of paper is placed on brackets at the end of the machine; the paper is led over two wetting-boxes, then, being damped, is led over two hot copper cylinders and entered between the first printing and impression cylinder; when it is printed on one side, it enters between the second pair of cylinders, which print the paper on the second side; it then travels on tapes to the cutting and folding cylinders. The *first* fold is given by a blunt knife fixed transversely across the peripheries of the wheels, and forces the paper into the gripper of a second cylinder, which carries the doubled paper half a revolution; a serrated steel knife is then forced through the intervening web of paper into a groove, thereby cutting the first perfect printed sheet from the web; a second blunt knife forces the doubled paper into the grippers of the third folding-cylinder; the newspaper thus twice folded is carried round by the grippers to a vibrating frame, entering each alternate sheet to a pair of cross folding-rollers, when it is forced by means of a steel knife, raising the middle of the paper between the tapes which traverse up each side of the delivery end of a frame, carrying each alternate sheet to the second pair of rollers, when the second cross folding-knife comes sharply down and forces the middle of the paper in between the two rollers under which the delivering apparatus works. This delivery consists of a frame which swings backward and forward like a pendulum, the papers traveling down between the tapes while it is going one way, and being thrown out as it comes back, falling like flakes on to the top of the accumulating heap on the table, where they are piled regularly one over the other. This machine is especially adapted to damp, print, cut, fold, and deliver an eight or a four page newspaper. It prints and folds 9,000 perfect copies of an eight-page paper of fifty inches square, or 18,000 copies of a four-page paper per *hour*. It also prints, folds, and pastes at the back a twenty-four-page paper, like the "Christian Union," of New York, this at the speed of 7,000 per hour. The space required for the working of this machine is eighteen feet long, ten feet wide, eight feet high to the top of the delivery frame. With the lower delivery, as shown in Fig. 3951, a pit underneath the machine is required. The plate shows the upper delivery. In working, it only requires one pressman, and one boy for taking away the papers; and as it folds the papers at the same time that they are printed, it saves the cost and expense of working separate folding-machines, which have always been used until the "Victory" combined machine for printing and folding was invented. See also Perfecting-press; Web-press.

Fig. 3951 shows the "Victory" with lower delivery.

Fig. 3952 is a longitudinal vertical section of an Adams flat-bed press. *a* is the bed of the press, which is raised by straightening the toggles *b b*; *c* is the platen; *d* is the ink-fountain and ink-distributing apparatus. The inking-rollers *e e* pass twice over the form, and are attached to the frame of tympan *f*. The segment *g* serves to straighten the toggles and cause the impression. *h* is the feed-board; *i*, the drive-pulley; and *k*, a gear-wheel with pitman-rod to *g*. *l* is the fly.

The first power-printing machine in the United States was the invention of Daniel Treadwell, of Boston, in the year 1822. Two of these machines were set up in New York City, one in the printing-house of the "American Bible Society," and another in that of the "American Tract Society." The former was driven by a steam-engine and the latter by two mules working in the upper story, the animals having been hoisted by means of tackle. This machine was a flat-bed press, and was long a favorite; it was used by Gales and Seaton in Washington in their printing for the United States government. The platen was moved to the form, and not the form to the platen, as with the Adams, which is shown in Fig. 3952.

Fig. 3952.



Adams Press.

The Adams power-press was introduced in 1830, but has since been much improved, and still stands very high with book-printers. Its movement is based on that of the hand-press, and gives a perfectly flat impression by lifting the bed of the press and its form against a stationary platen. Sheets are fed to the press by hand, and taken away by tapes and a fly. One thousand impressions per hour is a fair speed for a large Adams press on book forms.

Single-cylinder presses have a flat bed which is geared to reciprocate at an even speed with a revolving cylinder. Sheets of paper are fed to the cylinder, which carries a prepared tympan. The inked form runs along with the sheet until it is printed, when the form is retracted and inked again.

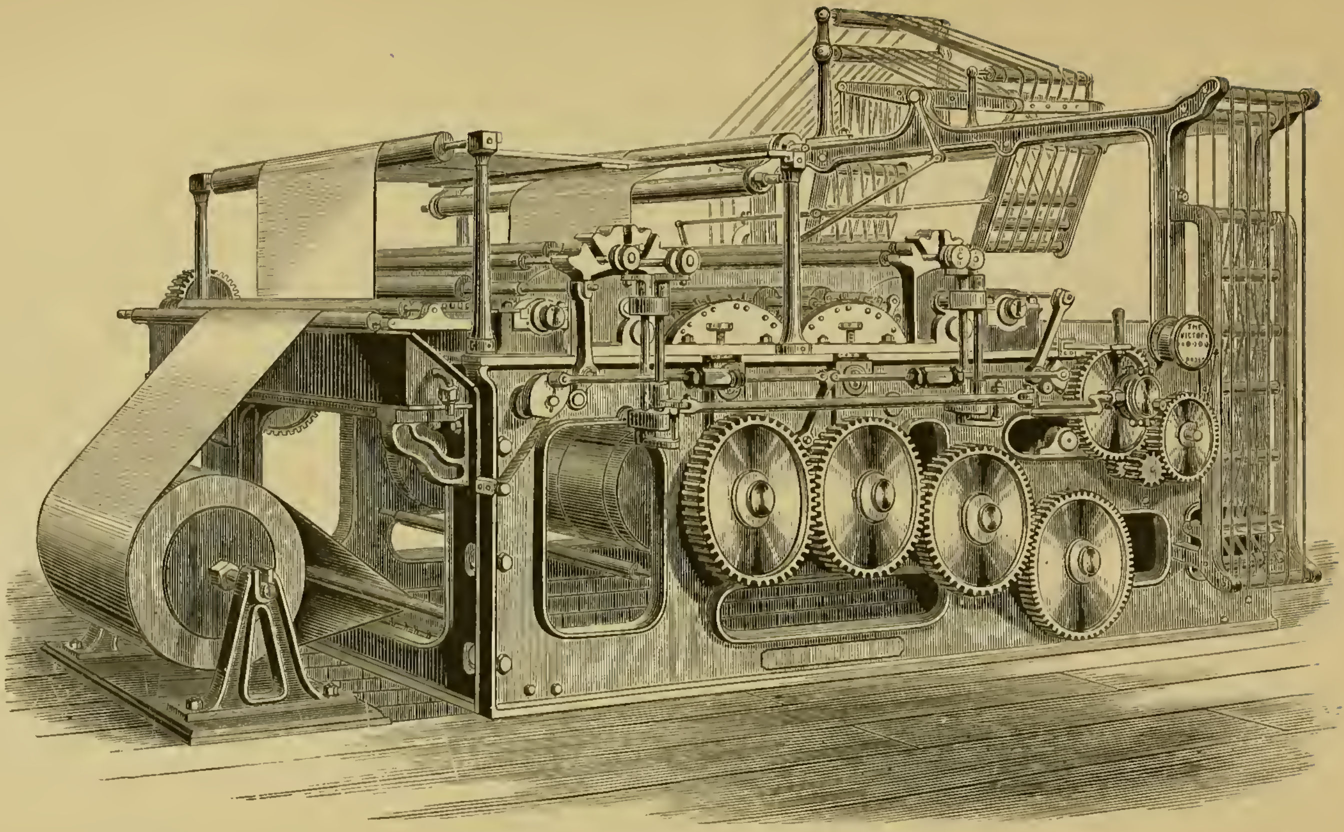


PLATE XLIII.

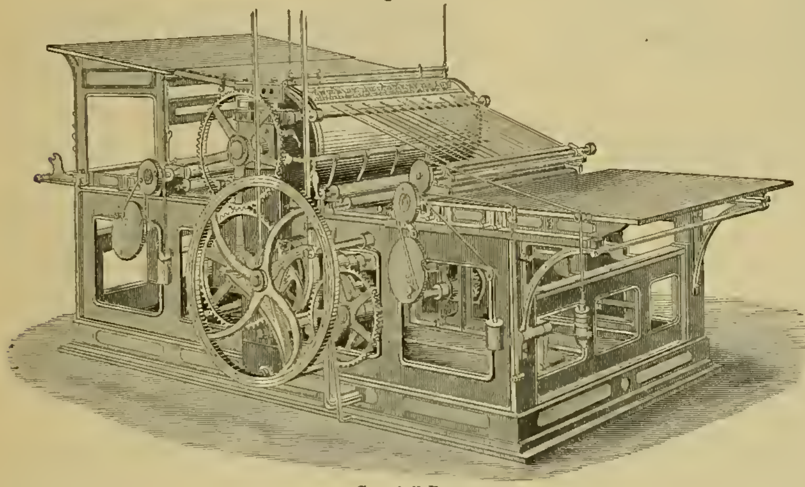
THE VICTORY PRINTING AND FOLDING MACHINE.

See page 1798

A segment of the cylinder is removed to allow of a backward movement of the bed, and in some machines the cylinder stops after a partial revolution. See CYLINDER-PRESS.

Fig. 3953 is a single-cylinder press of the Campbell pattern. It is controlled in its operation entirely by the sheet, so that it is impossible to print the sheet out of register. When a sheet is fed badly it is thrown out unsoiled, and it will continue to be thrown out so until it is properly fed. If pointing is necessary in fine register, the points are operated by electricity, in which case it is impossible to print out of register on it. This result is obtained through an exhaust-apparatus that operates a bolt attached to a diaphragm, which locks up the impression. The registering is operated by a small valve, through the agency of points making a circuit through the point-holes in the sheet, it being necessary that both should be through before the impression is thrown on to point the sheet. When the press fails to point, the former is hooked up and the fountains are thrown out of gear. Color is taken for each successive sheet only. Another peculiarity is a double fountain, having two sets of inking apparatus which distribute the ink on the form in two strata; these, like two wedges, overlap to form a single stratum of uniform thickness throughout. There is one inking apparatus on each side of the cylinder. As many as fourteen distributing and inking rollers may be used with this press.

Fig 3953.



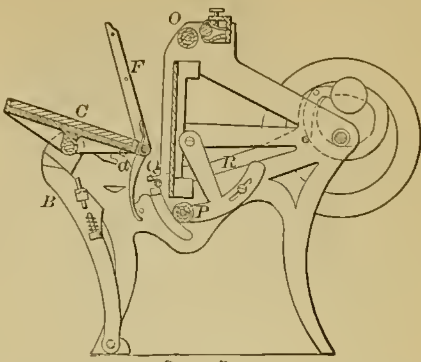
Campbell Press.

A large number of small job-presses have been built by American mechanics, and are capable of doing excellent work at very high speed. Among these may be mentioned the *Gordon*, *Globe*, *Liberty*, *Universal*, *Cincinnati*, and others, adapted to print sheets to the size of foolscap or larger. Three sizes are in common use, known by the size of the sheet they will print, as $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{1}{2}$ medium presses.

Fig. 3954 shows a press of this character. *C* is the platen, which pivots in the shaft *B*, and is thrown into parallelism with bed *Q*, by the curved projection *a*. The rolls are carried by arms *R*, and receive ink from the distributing cylinders *O*, *P*, above and below the type form.

In the Gordon press (Fig. 3955, upper one), the form is secured in a chase which is clamped to the bed *b* of the press. This bed rocks on a pivot at *c*, and comes into parallelism with the platen *p* when the impression is about to be given. The platen rocks on the main shaft *d*, which is propelled by pitman and intermediate gearing from the treadle *i*. The arm *m s* is the roller-carrier, which swings on a pivot *r*, and carries the rollers *n n* alternately over the form and the revolving disk *t*, which distributes the ink; *g* is a counterweight to balance the swinging bed and attachments, and operates the movable fingers by a spring bar *a*. A feed-board *v* rests on top of the frame of the press. The platen is moved by set-screws, and is covered by the usual blanket.

Fig. 3954.



Denny Press.

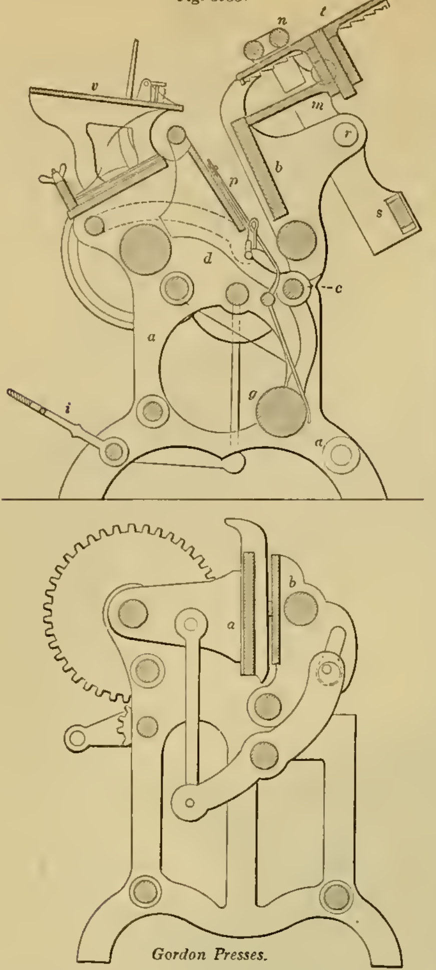
Gordon's press (Fig. 3955, lower one), patented March 3, 1874, has a rocking platen and bed, bound together by a compound toggle-lever, which holds them in locked position during the impression, as seen in the figure. By straightening the toggle-lever, the bed and platen are rocked back out of parallelism, the form on bed *a* is rolled, and a fresh sheet fed to platen *b*.

Bryson's inking apparatus for printing-presses, patented June 30, 1874, relates to a means for inking the types from one fountain in opposite directions, so that there is an equalization, one set of form-rollers commencing when charged at the front edge of the form and inking toward the back, and the other commencing at the back and inking toward the front of the form, so as to secure equality in the distribution of the ink, with but few rollers.

Leboyer's press uses a sheet of porous paper introduced between the type and the card, as a substitute for fluid ink and the roller.

Hydraulic presses have been adapted to the printing of bank-notes and steel and copperplate engravings, but their operation is necessarily slow. See

Fig. 3955.



Gordon Presses.

Copperplate-press ; Lithographic Press ; Ticket-printing Press, etc. See also Perfecting-press ; Web-press ; Cylinder-press.

A valuable compendium of patents on printing-presses may be found in Ringwalt's "Encyclopædia of Printing," pp. 236 – 248.

2. (*Plate-printing.*) See Copperplate Printing-press.

Print'ing-tel'e-graph. An electro-magnetic telegraph which automatically records transmitted messages. The term is, however, generally applied only to those which record in the common alphabet, so that the message may be understood by an ordinary reader.

The first of this kind with which we are acquainted was invented in 1837 by the late Alfred Vail, well known for his connection with the early progress of the Morse instrument in this country.

The operation of this depended on the synchronous vibration of two pendulums, one at each station, by which the corresponding letters on the two type-wheels at the transmitting and receiving stations were simultaneously brought into vertical position, that at the receiving station being thrust upward so as to print on a slip of paper when the appropriate letter at the transmitting station came upward and completed the circuit. As only one letter was advanced at each beat of the pendulum, and it would of course frequently happen that nearly a complete revolution of each type-wheel would be required in order to bring into proper position the next letter to be transmitted, the rate of transmission was exceedingly slow. Accordingly, the apparatus, though ingenious, never came into practical use.

In 1840, Mr. Alexander Bain, the ingenious inventor of the electro-chemical telegraph known by his name, invented a printing-telegraph in which type-wheels at each station were caused to rotate at exactly equal speeds by means of clock-work mechanism driven by springs.

The circuit was completed by means of a pin, which could be inserted in any one of a number of holes arranged around a dial-plate and corresponding to the series of Arabic numerals. While the circuit was complete, the operative mechanism was prevented from working by means of pallets on an upright cranked shaft engaging with a pivoted bar controlled by a governor. The circuit was broken by removing the pin from the hole in which it previously was and inserting it in that corresponding to the figure next to be transmitted; this, by releasing a pivoted electro-magnet having a detent arm, allowed the spring actuating the mechanism to act, causing a governor to operate, releasing the detent bar from the pallets and permitting the crank-shaft to rotate until the appropriate figure on the type-wheel could be acted on by a lever connected therewith, which took place when the pin inserted in the dial came in contact with a fixed hand thereon, when the circuit was again completed and the mechanism stopped; at this moment the figure was pushed into contact with a roll of paper, to which a movement at once rotary and upward was imparted by the clock-work. The message was thus imprinted upon the roll in a spiral line.

House's printing-telegraph, patented in 1848, to date from April 18, 1846, has been extensively used in the United States.

It consists of a composing-machine and a printing-machine at each station, the former of which is included in, and the latter distinct from, the circuit.

The circuit commences in the battery of one station, passes along the line wire through the coil of an axial magnet to an insulated iron frame of the composing-machine of the next station, thence to a circuit-wheel revolving in this frame, enters a spring pressing on the edge of the circuit-wheel, and has a connection with the return wire, along which the electricity passes through another battery back to the station whence it came.

The composing-machine is arranged within a case on top of which the printing-apparatus is placed. Both are driven by a hand-crank carrying a fly-wheel and a pulley over which passes a band that turns the operative mechanism pertaining to each. An insulated iron frame immediately below the keys has within it a revolving shaft rotated by a band and pulley on one of its extremities; the shaft is partially inclosed within an iron cylinder, with which it is connected by a friction device, so that they may revolve together, or the shaft may have independent rotation. On the opposite end of the cylinder is a brass wheel, called the circuit or break wheel, 4 or 5 inches in diameter, and having 14 teeth and the same number of interspaces on its periphery.

The shaft and cylinder form a part of the circuit, one point of connection being where the shaft rests on the frame and the other with a spring which, when the apparatus is rotated, alternately strikes a tooth and drops into a space, thus closing and breaking the circuit.

The cylinder has two lines of teeth, 14 in each, spirally arranged along its opposite sides, which correspond with stops on the under surfaces of the keys, so that when one of the latter is pressed down the motion of the cylinder is arrested. Its continuous rotation causes the circuit to be rapidly broken or closed; but when one of the keys is depressed the cylinder is held in position, maintaining the circuit either open or closed, as it happened to be at the moment, and so continues until released from contact with the key or until another key is manipulated.

The electrical pulsations are transmitted to the printing-machine at the other station through a peculiarly constructed axial magnet, having a valve at its upper end, to which condensed air is admitted from a chamber into which it is compressed by an air-pump operated by the fly-wheel. The stem of the valve has a series of bell-shaped flanges, which make and unmake connection with a series of corresponding flanges within the magnet during the pulsation of the current, causing the air admitted to the valve to operate a piston arranged at right angles thereto, and which is connected with the lever of an escapement whose pallets engage pins on the upper surface of the printing-wheel. Each vibration of the valve thus advances the printing-wheel one letter. When a stop is made while the machine is in operation, when the circuit remains open or closed for more than one tenth of a second, an eccentric draws a shaft on which the paper strip is carried forward up against the type-wheel, which, by means of an interposed endless coloring band, impresses the letter then presented upon the paper. See Shaffner's "Telegraph Manual."

Hughes's telegraph, 1856, requires but a single current for each letter; the reception and transmission of messages simultaneously over the same wire and printing from the type-wheel while in motion are provided for by appropriate devices.

The most important of these are: 1. A *chariot* which revolves with a vertical shaft having the same velocity as the type-wheel, over the surface of a disk pierced with a number of perforations equal to the letters on the type-wheel, into which project the ends of a number of pins that are raised by the movement of keys arranged like those of a piano-forte. When the chariot passes over a pin thus raised, a connection is established with the line-wire and a current is transmitted to the next station While passing over an interspace the current is diverted through the disk to the earth.

2. On its way to the line-wire the current traverses the coils of an electro-magnet, beneath which is a permanent steel horseshoe magnet having its poles in contact with the soft iron cores of the electro-magnet. The magnetism induced in the coils when no current is passing causes them to attract and hold down an armature against the force of a spring. When connection is made, as above stated, with the local battery, the current, which is opposed to that of the steel magnet, weakens the effect induced by the latter in the coil sufficiently to permit the spring to withdraw the armature, through which an impulse is transmitted and the circuit again instantaneously broken.

The above arrangement renders the apparatus extremely sensitive.

When the armature rises, the shaft of the printing-wheel, which is in two parts, locking with each other, turns the wheel at the same moment that a cam movement is caused to press a strip upward against the type-wheel, which imprints the letters.

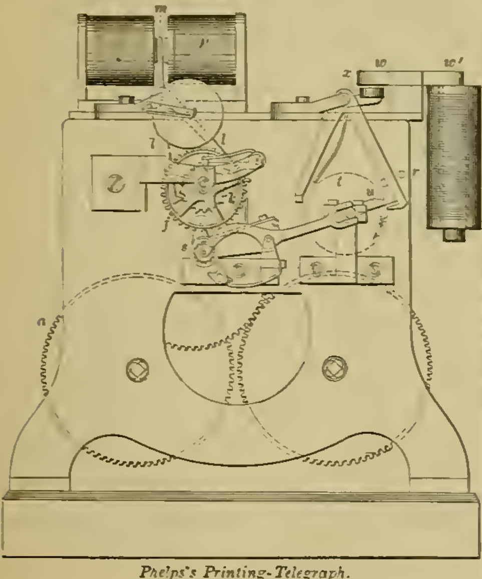
The chariot and type-shaft are readily adjusted to correspondence, if required, previous to the transmission of a message, and any slight inequalities in their motion are automatically adjusted by the machine itself.

Printing-telegraphs may be divided into two classes: those on the step-by-step principle, and those in which the type-wheel is continuously rotated by an independent motor, the circuit of the printing-hammer being closed when the letter is opposite to the printing-pad. The House, Hughes, and Phelps machines belong to the latter class, and those of Vail, Bain, and others to be cited, to the former. The most recent types of step-by-step printing-telegraphs are: —

a. Those having clock-work mechanism controlled by an electro-magnetic escapement.

b. The clock-work is dispensed with and a ratchet-wheel on the type-wheel shaft is actuated by a pawl attached to an armature.

Fig. 3956.



Phelps's Printing-Telegraph.

c. The type-wheel is mounted directly upon the shaft of an electric motor, the armature-wheel of which revolves between the poles of two electro-magnets.

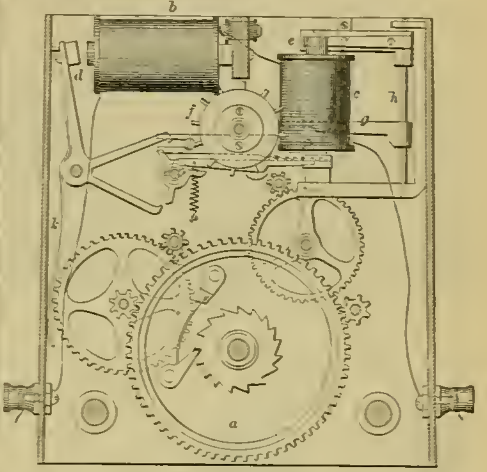
a. Phelps's printing-telegraph, November 4, 1873 (Fig. 3956).

The type-wheel *f*, driven by clock-work mechanism from the spring-barrel, is placed on a shaft concentric with the ratchet *k*, which is controlled by pallets of the escapement *l l* attached to the permanently magnetized armature *m* vibrated by alternating currents through the electro-magnets *o p*. The electro-magnet *r*, controlling the printing escapement, is in the same circuit, its core having an extension *w*, and, being surrounded by a non-magnetic material, it is not operated by the rapidly changing currents passing through *o p*, which work the type-wheel escapement; but when the key connected with any particular letter is struck, the circuit is closed, sufficient magnetism accumulates in the core *w'* to attract the armature *x*, releasing the arm *u* carrying the paper-roller *s*, and allowing a crank-pin on the shaft of the wheel *t*, turned by a train of mechanism from the spring-barrel *a*, to depress that arm of the lever and throw the feed-roller up against the type.

Anders's printing-telegraph (Fig. 3957).

The type-wheel and printing mechanism are driven by a spring acting on the shaft of the wheel *a*. As currents alternating in direction are passed through the electro-magnet *b* and polarized magnet *c*, the armature *d* of the former is attracted and held to its poles, while the armature *e* of the polarized magnet *c* is caused to vibrate laterally between the poles of this magnet, releasing one by one the teeth of the scape-wheel *f* on the type-wheel shaft from contact with a pallet on the arm *g* of the rock-shaft *h*, which is operated by the vibrations of the armature. An intermittent motion is thus imparted to the type-wheel, advancing it one letter at each electric pulsation; and when, by touching the proper key, these are suspended, the spring *k* draws back the armature *d*, the press mechanism is released, and an impression is taken, the type-wheel being now at rest.

Fig. 3957.

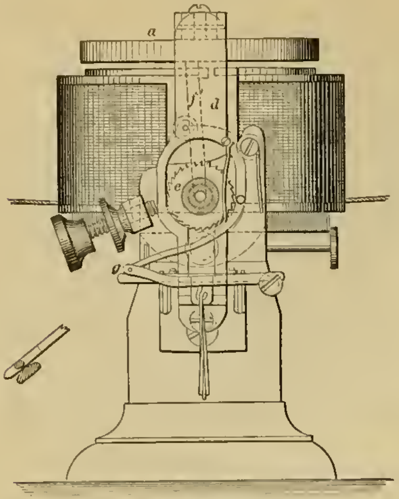


Anders's Printing-Telegraph.

b. Edison's printing-telegraph (Fig. 3958).

The printing and type wheels are actuated directly by the armature of the electro-magnet. The armature *a* is secured to a lever which swings on screw-centers and is connected to a bar *d*, carrying a pawl which engages a ratchet-wheel *e* fixed on the type-wheel shaft. The vibrations of the armature alternately raise and depress the lever, causing the pawl on the bar to advance the type-wheel one letter at each vibration. During the pulsations the motion of the armature is limited by a stop on a vibrating polarized bar, so that no impression is made; but when the current is reversed, the bar is attracted, releasing the stop, permitting a spring to act on the armature, which is carried up to the full limit of its motion, bringing a pad, connected with the lower part of the bar, against the paper strip which is pressed against the type-wheel. The full downward movement of the connected lever and bar actuates a dog at *g*, which advances the paper the required distance for each impression.

Fig. 3958.



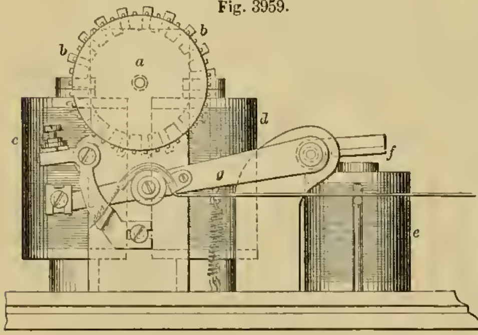
Edison's "Baby" Telegraph.

c. Van Hœvenbergh's printing-telegraph.

The type-wheel *a* is upon the same shaft with a wheel *b*, having radial armatures and revolved between the poles of two electro-magnets *c d*. *e* is one of two printing-magnets. A rotating circuit-changer opens and closes the circuit through each of these magnets alternately, the rapidity of the changes being proportioned to the speed with which the circuit-changer is revolved. The armatures of the wheel *b* are so adjusted that when the wheel is stopped by the cessation of a current, the armature next to be attracted shall be near its attracting core, so as to be operative in renewing the revolution.

To effect the printing, the current of an auxiliary battery is, by depressing a key, caused to pass through one of the magnets *e* which, attracting the armature *f*, lifts the printing-pad on the lever *g* into contact with the type-wheel.

Fig. 3959.



Van Hœvenbergh's Printing-Telegraph.

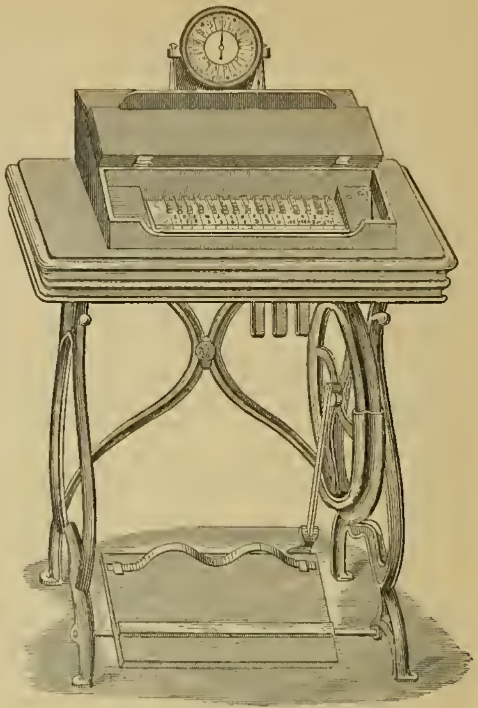
Fig. 3960 is George L. Anders's printing-telegraph stand. It has a key-board and a visible dial, being actuated by the ordinary step-by-step movement. When transmitting, the current is derived from a magneto-electric machine driven by a treadle.

Brett's printing-telegraph, invented about 1845, is thus described in an English work: —

"A small key-board has a row of ivory keys, marked with the letters of the alphabet and other characters. Connection is made by the wire to a machine at the other extremity of the line. This machine has a type-wheel having on its circumference letters and characters corresponding to those on the key-board. A given key on the key-board at the transmitting end being depressed, a clock-work is released, causing a barrel beneath the key-board to revolve until one pin in the spiral row on its surface catches against the lower end of the key depressed.

"A counterpart movement takes place in the printing-machine at the receiving end, the depression completing the electric circuit and releasing an escapement in the printing-machine at the receiving end, causing a type-wheel to revolve. This is inked by a little flannel roller, which is kept in gentle contact with it. Above the type-wheel a slip of paper is moved along by rollers when the machine is in action, and at the proper moment a hammer presses down the paper on the type that is uppermost, and an impression is delivered thereon."

Fig. 3960.



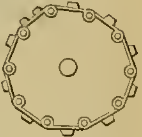
Anders's Printing-Telegraph Stand.

Such is a mere sketch of the devices employed in the Brett printing-telegraph, which was used in connection with the first submarine cable between England and France.

Print'ing-type. See TYPE.

Print'ing-wheel. One used in paging or numbering machines or in ticket-printing machines. It has letters or figures on its periphery. In the one illustrated, the sections containing salient letters are hinged together and the chain lapped around a core.

Fig. 3961.



Printing-Wheel.

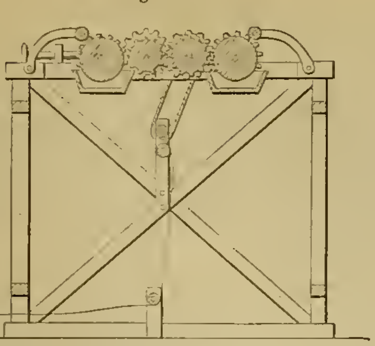
Print'ing Yarn. A machine for printing yarn for party-colored work. In the example, the yarn to be printed is run between two fluted rollers, one of which is adjustable by means of set-screws. These rollers are supplied with color by means of other rollers supplied from troughs properly arranged.

Pris-cil'las. (*Glass-blowing.*) A jaw-tool resembling a pinchers, used for pinching in the neck of a bottle, or of giving it some peculiar shape while it is revolved on the end of the *pontil* which rolls upon the arms of the glass-blower's chair. *Pucellas.*

Prise-bolts. (*Ordnance.*) The projecting bolts at the rear of a mortar-bed or garrison gun-carriage under which the handspikes are inserted for training and maneuvering the piece. They are formed by the prolongation of the assembling bolts.

Prism. The prism, geometrically speaking, is a solid having similar and parallel bases, its sides forming similar parallelograms. The bases may be of any

Fig. 3962.



Yarn-Printing Machine.

polygonal form, and from them the prism derives its specific name, as triangular, square, hexagonal, etc. The triangular form is employed in optics, and it is usual to call any transparent medium so arranged that the surfaces which receive and transmit light form an angle with each other, a prism.

The fact that a variety of colors are produced by the passage of sunbeams through a piece of glass thus shaped had undoubtedly been noticed before the time of Sir Isaac Newton, but he was first to discover the unequal refraction which the different colored rays composing the solar spectrum undergo in passing through the prism; to show that it might be separated into seven apparently distinct colors in the order of their refrangibility, commencing, when the prism is placed with an edge downward, with red, to which succeed orange, yellow, green, blue, indigo, and violet, the latter being uppermost; to measure the breadth in the spectrum of each of these colors, and to demonstrate their connection with the phenomenon of the rainbow.

His original experiments may be repeated by any one by means of a triangular prism; an ordinary chandelier-drop will answer, placed near a slit in the window-shutter of a darkened room, so that the rays passing through the slit may fall upon one of its sides at an angle. The decomposed beam may be received on a screen or an opposite wall: the adjustment necessary to obtain the best-defined spectrum is soon determined.

Subsequent researches have proved that there are really but three primary colors, red, yellow, and blue, which combine to produce the impression of whiteness, and that the others embraced in the Newtonian spectrum are really caused by the intermingling of rays which separately would produce the effect of red, yellow, and blue. It has also been found that there are invisible rays, less refrangible than the red, which have a greater heating power than any of the visible rays, and that there are others beyond the violet which produce a greater chemical effect than do the visible rays.

The length of the spectrum formed by similar prisms of various substances is found to vary considerably, or, in other words, some have a greater dispersive power than others. Upon this fact the construction of the achromatic lens is based. See ACHROMATIC LENS.

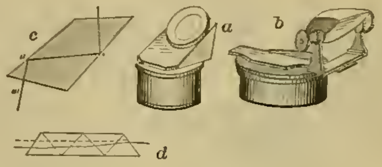
This dispersion varies in different kinds of glass, and is greater in some liquids, notably bisulphide of carbon, than in any species of glass; for this reason it has sometimes been employed, inclosed in glass, for prisms and lenses.

Prisms are employed as eye-pieces for some kinds of instruments, as the camera-lucida and the azimuth-compass, and are also used in connection with the microscope, serving to erect an inverted image (Nachet's, *a*, Fig. 3963), or as an illuminator and condenser (Amici's). The former is interposed between the two lenses forming the eye-piece; the inverted object formed by the field-glass passing through the lower eye-lens is transmitted to the upper surface of the prism, and after undergoing a series of reflections within the prism, emerges erect from its upper surface and is viewed through the upper lens.

Amici's (*b*) is placed near the object-end of the instrument, and serves to reflect and condense the light on an object upon the stage when it cannot be illuminated by the mirror; it is movable, so that the light may be thrown on the object at different angles, that it may be more perfectly examined.

Wenham's (*c*) is designed to divide the cone of rays proceeding from the objective, so that the magnified image may be viewed by both eyes. The prism is so placed in the tube that the pencil striking its lower surface undergoes little or no refraction. On reaching $'$, one half is transmitted directly to one eye, while the other half, after undergoing two reflections at $''$ and $'''$, is transmitted to the other eye; by this arrangement the rays passing through the left half of the objective are transmitted to the right eye, and those from the right half to the left eye.

Fig. 3963.



Prisms.

a, Nachet's erecting-prism.
b, Amici's illuminating-prism.
c, Wenham's binocular prism.
d, Arrangement of prisms in spectroscope eye-piece.

By placing two prisms in reverse positions, the light decomposed by one is recomposed by the other, so as to exhibit a white beam. When two or more are so arranged that the second receives the beam transmitted from the first and deflects it in the same direction, though the colors undergo no farther decomposition, the length of the spectrum, *i. e.* the dispersion, is increased, the space occupied by each color being proportionately lengthened. An arrangement *d* of this kind is called a train of prisms, and is used in the spectroscope.

In Sorby and Browning's spectroscopic eye-piece, which may be applied to any microscope, a train of five prisms (*d*), the inner, middle, and outer ones of which are of crown, and the two interposed ones of flint glass, are placed in a tube above the achromatic eye-glass; the rays entering the train, which have been separated by the greater dispersive power of the flint glass, emerge from the upper prism in a direction parallel to their original incidence. See SPECTROSCOPE.

It is customary, for convenience' sake, in modern practice to place the prism or prisms, when more than one is employed, in a vertical position, and to provide devices for intercepting the light so that a square spectrum may be formed

Besides being used for resolving white light into its elementary colors, the prism is, as well as the mirror, employed for polarizing light.

Through its instrumentality, by means of the spectroscope and the polariscope, we are enabled alike to determine the constitution of the fixed stars and to ascertain the chemical components of the minutest particles of organic matter, opening a field of scientific inquiry the boundaries of which cannot as yet be even imagined.

Nicol's prism is used as an adjunct to the microscope in examining the properties of polarized light. Its action depends on the doubly-refracting property of the material (Iceland spar) of which it is composed.

On viewing a small object, such as a black dot on a sheet of paper through a piece of Iceland spar or of selenite, two images will be seen; on turning the spar around, one of these images will appear to revolve about the other. The fixed image is called the ordinary, and the other the extraordinary image; the line joining them is always in the direction of the shorter diagonal of the crystal when its edges are of equal length and the angle between the ordinary and extraordinary ray is 6° 12′.

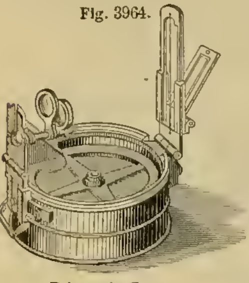
The action of this spar is to refract the light into two divergent pencils, forming the *ordinary* and *extraordinary* rays, the differences in the angle being 6° 12′ The crystal being bisected by a plane passing through its obtuse angles, and forming an angle with the principal axes of the crystal of 22°, the two surfaces being finely polished and brought together, one of the rays suffers total refraction and passes out at the side, while the other, being within the angle of refraction, passes on through the other section of the crystal. By this means one of the rays is eliminated, leaving the ordinary remainder ray a beam polarized in a single plane; the other, the eliminated ray, being polarized in the other plane, but removed The object is to obtain a single polarized ray.

It results that a ray polarized in this direction is alone capable of passing through the prism This enables the Nicol prism to be used as an *analyzer*

It is usual to cement the two sections with Canada balsam, the angle of refraction of which being less than that of the Iceland spar, does not interfere with elimination of the extraordinary ray. It would not be safe to say that the action is due to the Canada balsam, for the action would take place if the prism sections were merely laid together, but it would not do to cement with a material having the same index of refraction as the spar, as in this latter case the effect would be to re-make a solid crystal.

Pris-mat′ic Com′pass. An instrument for measuring horizontal angles by means of the magnetic meridian. It is principally employed in reconnoissance or in sketching the general features of a country. It resembles a CIRCUMFERENTOR (which see), but has a floating card attached to the needle graduated to 15′ of a degree. The graduations commence at the N. point, and are numbered around the circle up to 360°. A sight-vane is fixed perpendicularly, with a fine wire stretched across it, opposite to which is a prism. On applying the eye to the prism, and bisecting any object with the wire in the sight-vane, the division on the card coinciding with the thread and reflected to the eye of the observer will show the angle formed by the object with the meridian.

Fig. 3964.



Prismatic Compass.

Prism-mi-crom′e-ter. An instrument invented by the Abbé Rochon, in which the principle of double refraction is applied to micrometrical measurement. See DOUBLE-REFRACTION MICROMETER.

Prism-sphe-rom′e-ter. An instrument invented by Dr. Meyerstein of Göttingen, for ascertaining the curvature of a sphere or the deviation of the surface of any object from a plane. See Poggendorf Ann., Vol. 126, p. 589.

Pritch. An eel-spear with several prongs.

Pritch′el. (*Forging.*) The punch employed by horse-shoers for punching out or enlarging the nail-holes in a horseshoe. Also being temporarily inserted into a nail-hole in the shoe, it forms a means of handling the latter.

Pri′va-teer′. (*Vessel.*) A vessel belonging to private parties sailing with a license (letter of marque) from one belligerent party to prey upon the enemy's ships. The practice originated at the end of the sixteenth century in the war between Spain and the revolted Netherlands. Privateering is a sort of authorized piracy. Of late it has been difficult to ascertain the distinction between the two.

Priv′y. In almost all cities of the world, until a comparatively recent date, all kinds of filth were thrown into the public streets. This was forbidden in Paris by an ordinance in 1395. It was practiced till 1750 in Edinburgh. Three centuries since the royal residences of Spain were destitute of privies, while the circumnavigators found them among the Maories of New Zealand, the antipodes.

Laws ordering that every house in Paris should be furnished with a privy were passed in 1513, 1533, 1697, and 1700. A non-compliance was rendered penal. In other cities of France the same regulations were made.

Prize-bolt. (*Ordnance.*) A bolt projecting from a mortar-bed, under which a handspike is inserted in maneuvering. A *running-up bolt* or *traversing-bolt.*

Proa. (*Vessel.*) *a.* A narrow canoe, thirty feet long and three feet wide, used by the natives of the Ladrone Islands. The stem and stern are similar, the boat sailing either way. The lee side is flat, so that the canoe resembles half of a vessel divided vertically in the line of the keel. Extending to leeward is an outrigger, consisting of a frame at the end of which is a floating canoe-shaped timber, which prevents the crank and narrow canoe from upsetting.

b. A Malayan boat propelled by sails and oars.

Pro′bang. 1. (*Veterinary.*) An instrument for removing a root, apple, or other object which has lodged in the esophagus. When the piece so presses upon the trachea as to obstruct breathing, the case is critical, and the probang is used to force it down into the stomach or impale it, and thus afford means for extracting it.

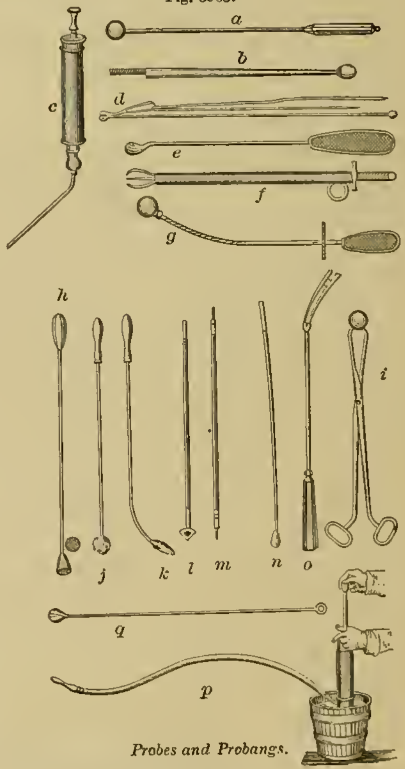
A tube of leather, even a black-snake cart-whip, may answer. Probangs are made hollow with stilettos, and have an enlarged head, so as not to pass the object. They are also used on hoven cattle to facilitate the escape of gas resulting from the fermentation of the food, or to relieve the stomach of a part of the food. In such a case it is a kind of trocar.

An enema apparatus (*p*, Fig. 3965), for injecting a diluent and withdrawing the fluid contents of the paunch, is the preferable instrument in distension by gas.

2. (*Surgical.*) A slender whalebone rod with a piece of sponge on one end, for pushing down into the stomach bodies which may have lodged in the esophagus. Sometimes the other end is provided with a silver basket on a hinge, by which bodies so lodged may be drawn out.

The sponge, acting as a *porte-mèche*, may be saturated with caustic or medicaments, which may thus be applied to the part affected.

Fig. 3965.



Probes and Probangs.

j k, probangs with ivory or sponge ends.
l m n, jointed probangs for the pocket.

o is Buck's sponge-holder, with jaws.

q is a *porte-mèche* to carry lint, a sponge, or other tent into a wound.

Probe. A surgical instrument, usually made of silver wire, having a rounded end, and introduced into wounds in exploring for balls, etc.

There are also probes to explore the uterine cavity, the *ducta lachrymalis*, etc. According to their use their nomenclature varies, as *bullet*, *uterine*, or *eye* probe. Some are provided with a groove running to their points, for the purpose of directing knives in making incisions, and are then called *director-probes*.

d is Tieman's probe, with eye for introducing lint into a wound.

e is a bullet-scoop.

f is Moses's bullet-extractor, with three prehensile claws.

g is Tieman's flexible seeking-probe.

h is a bur-head bullet-probe, which will receive a mark from lead in its path.

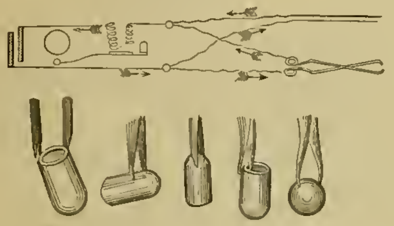
i is a bullet-forceps.

The porcelain probe for the discovery and removal of leaden balls lodged in the body was devised by Nélaton It has at its extremity a small *rugous* or wrinkled porcelain ball, which becomes blackened in contact with a leaden bullet.

Probes of iron were found in Pompeii, in the Via Consularis, in a dwelling, the supposed former residence of a surgeon. Spatulas, cautiug-irons, forceps, needles, catheters, and lancets in iron and copper or bronze, were also found there by Dr. Savenko of St. Petersburg, 1819.

The electrical probe of M. Trouvé consists of two pointed steel wires projecting about four inches from an ivory handle. They are surrounded near their points by a tube of vulcanite inclosed in a slotted tube of German silver, and may be moved slightly forward so as to project beyond this by means of a button to which they are connected, sliding in the slot. The other ends of the wire are connected with the terminals of a galvanic battery, forming an open circuit. The battery is formed of a zinc and carbon element, inclosed in a case of hardened india-rubber hermetically sealed, the exciting liquid being bisulphide of mercury. For use, the probe is pushed into the wound until a resistance is encountered which in the judgment of the operator may be the bullet. The points are then protruded and the instrument turned about, if necessary, until both points touch the object, when, if it be the bullet sought, the circuit is completed by metallic contact, actuating the armature of an electro-magnet and causing it to ring a bell.

Fig. 3966.



Trouvé's Electric Probe.

A pair of forceps for extracting the ball are similarly connected to the terminals of the battery. The figure shows the probe, terminals, electro-magnet, bell, positive and negative plates of the battery, forceps The lower figure illustrates the action of the points; when both points touch the ball the circuit is closed.

Probe-syr'inge. *c*, Fig. 3965, represents a syringe, the nozzle of which is no larger than an eye-probe. Used to throw injections into the nasal duct.

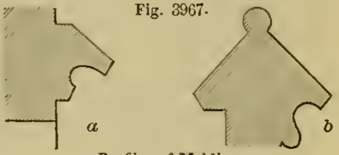
Pro-cel'las. (*Glass-making.*) A glass-maker's tool. See PUCELLAS.

Pro'che-am'e-ter. An instrument for registering the revolutions of a carriage-wheel. An ODOMETER (which see).

Pro'file. 1. (*Joinery.*) The outline of a series of moldings, or of any other parts, as shown by a section through them.

2. (*Engineering.*) A vertical section through a work or section of country to show the elevations and depressions.

Fig. 3967.



Profiles of Moldings.

a, Lintel. *b*, Wall coping.

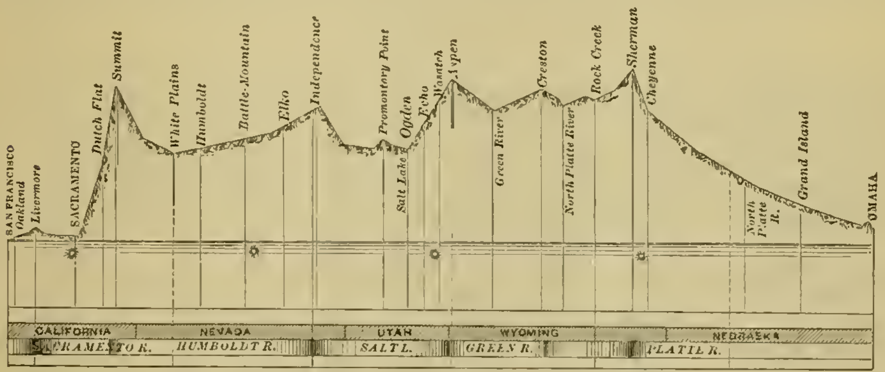
In *fortification*, it is perpendicular to the face of the work. See illustration of *Intrenchment.*

A *profile* is a light wooden frame set up to guide workmen in throwing up a parapet.

In *railroading*, a profile is a vertical section of the country traversed, showing the hills and hollows, and enabling the cuttings and embankments to be so adjusted that the earth of one will furnish material for the other.

The scale of vertical proportion of working drawings is generally ten times that of the horizontal.

Fig. 3968.



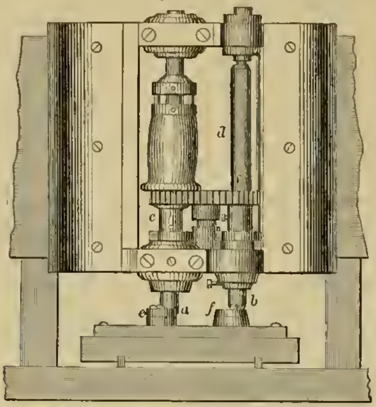
Profile of Pacific Railway (*Relation of Vertical to Horizontal Scale*, $\frac{1}{4000}$).

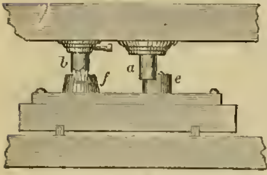
Pro'file-cut'ter. (*Wood-working.*) The cutting-knife, usually made up of sections which correspond to parts of a given pattern of molding, and by which molding is cut in a machine. See MOLDING; MOLDING-MACHINE.

Pro'file-pa'per. Paper ruled with horizontal and vertical lines for drawing profiles of railway surveys, fortifications, or other engineering works.

Pro'fil-ing-ma-chine'. One by which an object of a given contour or outline may be duplicated; or one by which a given profile may be given to a piece by adequate manipulation of the parts, in the absence of the pattern which forms an automatic guide for the tool. In the former case, the machine is used for duplicating templets, gages, and patterns, now so much used in making various machines, a great number to an exact size and proportion, to be afterward assembled. Locomotives, sewing-machines, fire-arms, watches, and many other articles are thus made. (See ASSEMBLING.) The machine shown in Fig. 3969 partakes of some of the characteristics of the CARVING-MACHINE (which see), and also of the LATHE FOR TURNING IRREGULAR FORMS (which see). In each case the principle of action is that of two corresponding mandrels moving in concert, one having a pin which traverses the outline of the object to be copied, and the other having a cutter which moves around the object to be cut in a path corresponding to that of the pin which is guided in contact with the edge of the pattern.

Fig. 3969.





Profiling-Machine.

In the instance illustrated, the pin *a* is on the mandrel *c*, and the cutter *b* on the mandrel *d*; these are geared together and rotated, the pin *a* being kept in contact with the pattern *e*, while the cutter is rotated in contact with the work *f* in and out and around as the contour of the pattern may govern the pin.

Pro-jec'tile. A missile, or package containing a number of missiles, projected from a gun by the expansive force of air, gas, or steam; commonly the gases generated by the ignition of gunpowder. See the following under their appropriate heads: —

Ammunition.
Angel-shot.
Arrow.
Ball-cartridge.
Barrel-shot.
Bar-shot.
Bolt.
Bomb.
Bomb for killing whales.
Bomb-lance.
Buckshot.
Bullet.
Canister-shot.
Cannon-ball.
Carcass.
Cartridge.
Case-shot.
Chain-shot.
Charge.
Crossbar-shot.
Double-headed shot.
Expanding-ball.
Explosive-ball.
Fire ball.
Grape-shot.
Grenade.
Gun-harpoon.
Hand-grenade.
Harpoon.
Incendiary-shell.
Langrel.
Light-ball.
Minie-ball.
Nail-ball.
Parachute light-ball.
Percussion-shell.
Rocket.
Rocket-harpoon.
Round-shot.
Sabot.
Sand-shot.
Segment-shell.
Shell.
Shot.
Shrapnel.
Slug.
Smoke-ball.
Spherical case-shot.
Sub-caliber projectile.
Tier-shot.
Torpedo.
Trundle-shot.

See also PRIMER, SABOT, FUZE, WADDING, PACKING, PERCUSSION-CAP, CHARGER, and the other accessories.

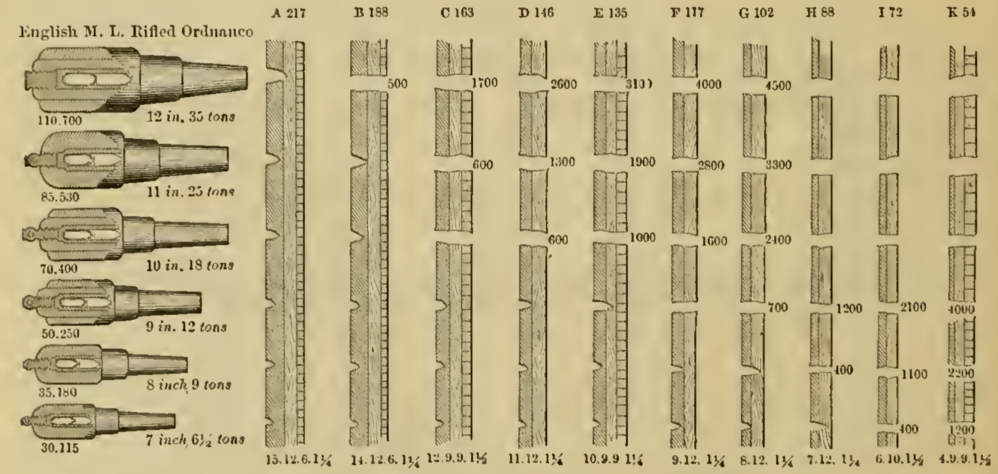
The number of projectiles used in the Crimean war, as compiled from official data, is as follows: French, 29,460,363; English, 15,000,000; Piedmontese, 50,000; Turks, 50,000; Naval forces (Allied), 35,000; Russian, 45,000,000. Total, 89,595,363.

Killed and wounded by these projectiles: French, 50,836; English, 21,038; Piedmontese, 183; Turks, 1,000; Naval forces (Allied), 2,000; Russian, 100,000 Total, 175,057.

One projectile in 512 did execution, upon the supposition that no two projectiles struck one person.

Fig. 3970 is a diagram showing the perforating and penetrating power, at various distances, of Palliser projectiles, fired from the service rifled muzzle-loading guns, with battering charges of pebble powder. Each target, representing in resisting power a certain class of vessel, is supposed to be at the normal distance of 200 yards from the gun, except where the range at which the projectile would perforate such a target is expressly stated Thus the diagram shows that a target consisting of a 14-inch plate, backed by 18 inches of timber, and a 1¼-inch iron skin, would be perforated at 500 yards by tho 12-inch 35-ton gun; whereas the Palliser projectiles fired from

Fig. 3970.



Penetration of Projectiles

the 11-inch 25-ton gun would only penetrate to a depth of 16 inches into the same target at 200 yards.

The weights of guns and force of impact are expressed in English tons of 2,240 pounds. The figures under each gun are respectively: —

Weight of powder. Diameter of bore.
Weight of ball. Weight of gun.

The figures opposite the holes through the targets are the distances in yards up to which the shot made a clean breach.

The power of resistance of each target is given immediately over it; thus A 217 means that it would require an energy of 217 foot tons per inch of the shot's circumference to perforate class A. All projectiles are assumed to strike perpendicularly to the face of the target.

The figures beneath the armor are the thicknesses of the plating, backing, and skin.

Pro-jec′tion. (*Drawing.*) The representation on a plane surface of the parts of an object.

The *gnomonic* projection. The eye is placed in the center of the sphere.

The *orthographic* projection. The eye is supposed to be at an infinite distance.

The *stenographic* projection. The eye is placed on the surface of the sphere.

The *isometric* projection. The projections of three equal lines parallel respectively to three rectangular axes are equal to one another.

The *perspective* projection. Represented on the perspective plan.

Pro-lap′sus-in′stru-ments. *a.* Instruments used to correct or prevent the falling of the womb. See Pessary; Abdominal Bandage, etc.

b. To prevent the falling of the anus; a trap-like appliance, consisting of a pelvic band to which is fastened a spring running down the spine and ending in an ivory pad resting on and supporting the anus. See also Suppository; Pile-supporter.

Pro-longe′. (*Ordnance.*) A rope used to drag a gun-carriage without the limber in maneuvering when it is required to move in a narrow track, or in retiring firing along a street or through a defile. It has a hook at one end and a ring at the other.

Pro-me′the-an. A device for striking light, consisting of matches tipped successively with melted sulphur and then with chlorate of potash to inflame them. They are dipped in a bottle of sulphuric acid. See Lighting-devices.

Prong. In a mechanical sense this is equivalent to a *tine*, a *claw*, a *tooth*, as the relation may require or suggest.

Prong-chuck. A burnishing chuck with a steel prong.

Proof. 1. (*Printing.*) A trial impression from a form for examination by the reader and comparison with the copy. (*First proof.*)

After correction a second proof is taken for the author. (*Clean proof.*)

The corrections and alterations having been attended to, a third proof (the *revise*) is had, to see that the alterations have been correctly made.

A *press-proof* is a final one to settle the margins, signatures, etc.

2. (*Engraving.*) *a.* An impression taken from a steel or copper plate in the course of its execution to determine its forwardness.

b. A *counter-proof* is an impression taken from a newly printed proof, to obtain a copy from an engraved plate similar to the latter and not in reverse.

c. An early impression of a completed plate before the printing of the regular edition.

3. (*Spirits.*) A mixture of equal weights of absolute alcohol and water. Its specific gravity is 0.917. The ordinary proof-spirit of commerce is 0.920 at 60° Fah.

The name is derived from the gunpowder-proof. Spirit was poured over gunpowder and the vapor inflamed. If it fired the gunpowder, it was *over* proof. If it damped the powder, so that the spirit burnt without igniting the powder, it was *under* proof. The weakest spirit capable of firing gunpowder was the proof-spirit of pharmacy, specific gravity 0.920.

4. (*Ordnance.*) The tests are by hydraulic pressure and by firing charges.

The proof charge is much heavier than the service charge, and is repeated, close examination being made for flaws and crevices.

The proof by water is under a heavy pressure; the bore being wiped dry, the surface is examined by a mirror to detect the exudation of moisture from crevices or honeycomb.

5. (*Small-arms.*) The barrels are loaded with a heavy charge, laid on a massive table in the proving-room, and fired by means of a train of powder, the balls being received in a sand-bank. This is repeated.

The proving of gun-barrels at Ilion is thus performed: forty barrels are loaded at a time, with 280 grains of powder and 500 grains of lead in each, and arranged in a small room, to be all discharged at once; they are placed in position, wedged, and held down by a heavy beam; a train of powder is then laid to all the touch-holes, the workmen leave the room, and all is ready; the double doors having been closed, the tester strikes with a hammer a small rod of iron protruding through the wooden partition: the rod is driven into a percussion-cap at the end of the train of powder, and the explosion of the charges in all the rifles immediately occurs. The value of this test is very great, the ordinary charge being 70 grains of lead. The barrels are afterward tested with 150 grains of powder, to see if they have been strained by the first test

Swords are proved by bending them and seeing if they resume their original shape, and by striking them flatwise over a curved block of hard wood.

6. (*Gunpowder.*) *a. Ordinary proof of powder*; one ounce with a 24-pound ball. The mean range of new, proved at any one time, must not be less than 250 yards; but none ranging below 225 yards is received.

Powder in magazines that does not range over 180 yards is held to be unserviceable.

Good powder averages from 280 to 300 yards; *small grain*, from 300 to 320 yards.

b. A proof of blasting-powder is, that two ounces being fired in an 8-inch mortar, elevated at an angle of 45°, shall throw a ball of 68 pounds to a distance of 240 feet.

Another test is, that two ounces of powder in the eprouvette gun (weight, 86½ pounds; bore, 27.6 inches long and 1¾ inches diameter) shall give a recoil of 20°.

7. (*Sugar-manufacture.*) The test by which a sugar-boiler judges of the condition of the condensed sirup.

The *preuve au filet*, or *string test*, consists in taking a drop of sirup between the finger and thumb and then separating. The condition required is that the sirup will allow itself to be drawn into an attenuated thread.

The *preuve au crochet*, or *hook test*, is when the thread breaks and curls up into a little hook. This is divided into the *crochet leger*, or *weak*, and the *crochet fort*, or *strong*, according to the energy of the action in forming the hook

The *preuve au soufflé*, or *bubble test*, is obtained by taking a portion of sirup in a perforated skimmer and blowing from below upward so as to make a bubble of sirup. The abundance and size of the bubble determine whether it be *soufflé leger* or *soufflé fort*. It indicates a condition fit for making candy.

The *preuve au caisse*, or *case proof*, is by dipping the wetted finger in sirup and then in cold water, taking up a *case*, or *sheath*, of sirup, whose behavior when rolled into a ball and thrown upon the floor determines the classification, as follows: *le petit caisse* is when the ball of sugar rolled from the finger is cracked open by throwing it on the ground; *le grand caisse* is when the ball flies to pieces under the same circumstances; *le caisse sur le doigt* is when the envelope of sugar on the finger refuses to roll, but breaks up as it is removed.

M. Payen has given precision to these tests by describing their respective temperatures and density:

Tests.	Temperature, Fah.	100 parts contain —	
		Sugar.	Wat'r.
Filet	228 2	85	15
Crochet leger	230.9	87	13
Crochet fort	233 6	88	12
Soufflé leger	240 8	90	10
Soufflé fort	249.8	92	8
Caisse petit	251 6	92.7	7.3
Caisse grand	263.3	95 7	4.3
Caisse sur le doigt	270.5	96.5	3.5

8. (*Proof of Strength.*) See DYNAMOMETER; TESTING-MACHINE.

9. Iron axles are proved by allowing them to fall from a certain hight upon two blocks of cast-iron, or by letting a weight fall upon them from a certain hight.

Proof-house. A house fitted up for *proving* barrels of fire-arms. They are extra heavily charged, laid on a bench, primed, and fired by a train of powder into a bank of sand. The average loss in England is four per cent on 600,000 barrels annually. A second proving takes place when the piece is ready for assembling.

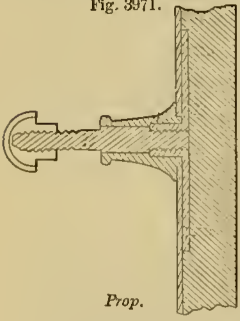
Proof-plug. A plug screwed temporarily into the breech of a gun-barrel to be proved.

Proof-sheet. (*Printing.*) An impression taken for the use of the corrector or author after all errors noted have been corrected.

Proof-staff. A metallic straight-edge by which a wooden staff is tested and corrected, *e. g.* the *red staff* used by millers to detect irregularities in the face of a millstone. The straight-edge, being reddened with ocher, is passed over the face of the millstone, and the elevated points become colored in consequence.

Proof-stick. (*Sugar-making.*) A stick with which a small quantity of sirup is lifted from the open pan or the vacuum-pan to judge, by the rapidity and character of its crystallization, the condition of the contents of the pan. See PROOF, 7.

Fig. 3971.



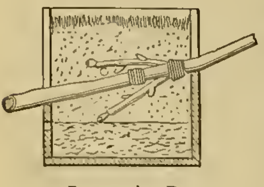
Prop.

Prop. (*Vehicle.*) A stem fastened to the carriage bow for the attachment of the stretcher-piece, known as the *prop-joint*, and upon which the bows rest when down.

In the example, the inner plate has a square, tubular, projecting socket, which receives the screw-shank of the prop. An outer collar fits on the square socket, and on a square portion of the prop, so that the latter cannot rotate.

Prop'a-gat'ing-box. A box in which a cutting is placed to germinate. In the example, it is one of a series of boxes having slots down their sides in order that a grape-vine, for instance, may be laid along the row of boxes and layers, obtaining plants by the striking of roots at the joints of the vine.

Fig. 3972.



Propagating-Box.

Prop'a-gat'ing-glass. A hand-glass to cover small plants.

Pro-pel'ler. A means for the propulsion of vessels. The varieties may be classed as follows: —

1. Paddle-wheels.
   - *A.* On horizontal shaft or shafts.
     - *a.* Fixed paddles.
     - *b.* Feathering paddles.
     - *a'.* Turning on horizontal axes.
     - *b'.* Turning on radial axes.
     - *c.* Sliding paddles; moving toward and from the paddle-wheel shaft.
     - *d.* Paddles attached to traversing chains.
     - *e.* Paddles attached to cranks.
     - *f.* Collapsing paddles.
     - *g.* Paddles in reciprocating frames.
     - *h.* Sculling paddles.
     - *i.* Cycloidal paddles.
   - *B.* On vertical shaft.
2. Hydraulic propeller.
3. Screw-propeller.
4. Rope-traction.
5. Spike-wheel.
6. Pole-propeller.
7. Rack and pinion propeller.
8. Wave-power propulsion.
9. Oars.
10. Sails.

The boats by which the Roman army under Claudius Codex were transported into Sicily were propelled by wheels moved by oxen. The substitution of paddles for oars is mentioned in many old military treatises. Thomas Savery, in England, obtained a patent, in 1696, for a paddle-wheel on each side of a ship, to be turned by means of a capstan.

In the "Vitruvia de Architectura," folio, Como, 1521, there is an engraving of a large vessel propelled by paddles worked by animal power. A pen-and-ink sketch on an Italian manuscript of the fifteenth century, preserved in the British Museum, shows a vessel propelled by a pair of paddle-wheels on a shaft rotated by gearing and hand-power. From 1619 to 1662, six patents were granted in England for devices purposely described with great looseness, for concealment, but which appear to have been paddle-wheels of some kind.

In 1690, Papin describes "oars fixed to an axis," a pinion on the latter being engaged by a rack on the piston-rod.

In 1729, Dr. John Allen patented the hydraulic propeller, forcing water through the stern of the ship at a convenient distance under water.

In 1737, Jonathan Hulls patented a steamboat propelled by a paddle-wheel astern.

In 1738, David Ramsey obtained a patent in England for a mode of propulsion of vessels by the force of water ejected by a steam-pump.

In 1780, Watt suggested the *spiral oar* to move canal-boats.

In 1780, the present arrangement of connecting-rod crank and fly-wheel was patented. In the same year the Marquis de Jouffroy worked a steamboat 140 feet long on the Saône.

In 1782, Rumsey propelled a freight-boat on the Potomac by means of the hydraulic propeller. A steam-engine worked a vertical pump amidships; the water was drawn in at the bow and expelled through a trunk astern.

In 1785, Joseph Bramah patented a rotatory engine on a propeller-shaft.

In 1786, Fitch had a steamboat on the Delaware, propelled by paddles like those of an Indian canoe.

In 1786, Benjamin Franklin and Oliver Evans advocated the hydraulic propeller, receiving the water forward and forcing it out astern.

In 1787, Patrick Miller patented, in England, paddle-wheels for propulsion.

In 1788, Fitch ran his boat by means of reciprocating paddles.

In 1788, Symington had a steamboat on the lake of Dalswinton, propelled by an engine and side paddle-wheels.

In 1789, Symington had a boat on the Forth and Clyde Canal, propelled by an engine, and a pair of paddle-wheels placed amidships, respectively fore and aft the engine, and working in a trough extending from stem to stern of the boat, over the keel.

In 1789, Oliver Evans, of Philadelphia, had a stern-wheel steamboat which navigated the Schuylkill.

In 1795, Lord Stanhope invented the "duck-feet paddles," and ran a boat three miles an hour.

In 1796, Fitch had a steamboat on Collect Pond, New York, propelled by a screw astern.

In 1802, Symington's double boat, "Charlotte Dundas," was propelled by one middle paddle-wheel abaft the engine and working in the space between the twin boats.

Fulton's and Bell's steamboats had side paddle-wheels, as also the "Savannah," 1819, "Enterprise," 1825, "Great Western" and "Sirius," 1838. The "Great Britain," 1843, had a screw, and after this the screw became common. See PADDLE-WHEEL.

The term *propeller* is usually applied to the longitudinal revolving shaft with vanes or wings, and more specifically known as the *screw-propeller*.

The first use of the propeller was by Steveus, of Hoboken, who used twin-bladed screws in 1804. See SCREW-PROPELLER.

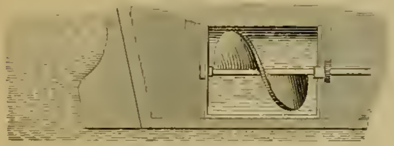
The bladed screw-propeller was brought forward by Ericssou in 1836, and the spiral screw in the *dead-wood* was patented by F P. Smith.

Captain Robert F. Stockton, United States Navy, and Francis B. Ogden, of New Jersey, became interested in Ericsson's invention, and the propeller "Francis B. Ogden" was launched on the Thames, and made trips as early as May 28, 1837. An iron vessel, the "Robert F. Stockton," fitted with a screw-propeller, was launched into the Mersey, July 7, 1838. She was the second screw-propeller in England, as the "Francis B. Ogden" was the first. She crossed to the United States the next year, received an American register, was re-named the "New Jersey," and was the first screw-propeller (excepting the small, twin-screw propeller of Stevens) in American waters Ericsson's patent was July 13, 1836, and his propeller had spiral blades, the preferable form.

The first propeller war-steamer was the "Princeton," launched into the Delaware.

Francis P. Smith's name is intimately associated with the introduction of the propeller. His patent is dated May 31, 1836. He was the first to make it a continuous screw and to place it in the dead-wood. His screw was attached to the "Archimedes" in 1839.

Fig. 3973.



Smith's Propeller.

Of the four cigar steamers of Messrs. Winans, the propeller of the first was placed around amidships; the second, beneath; the third is fitted for trying in various positions; the fourth has a propeller at each end.

In 1863, the "Far-East," a propeller with two screws, was launched at Millwall, England.

The screw-propeller generally consists of a *boss* fitted upon the end of a propeller-shaft, and with two or more *blades* arranged symmetrically around it, so as to balance each other.

The propeller is said to *overhang* when it has no after bearing in the *after* stern-post or rudder-post.

The propeller may be made to rise out of the water when the ship is under canvas alone. In this case it is detached from the shaft and drawn up into a *screw-well* in the stern of the vessel.

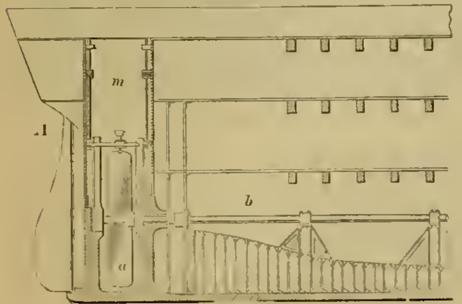
The *pitch* of a propeller-screw is the length, measured along the axis, of a complete turn.

The *speed* of the propeller means the pitch multiplied by the number of turns in a unit of time; or the speed may be stated in the number of revolutions of the propeller-shaft per minute, where *pitch* does not enter into the computation.

The effective *area*, or *disk*, of a screw-propeller is measured in a thwartship plane, and has for its outer boundary the circle swept by the tips of the blades, and for its inner boundary the outline of the boss.

The *slip* of a propeller is the difference between its rate of progression, the length of its pitch to each revolution, and the actual progress of the vessel through the water.

Fig. 3974.



Unshipping-Propeller.

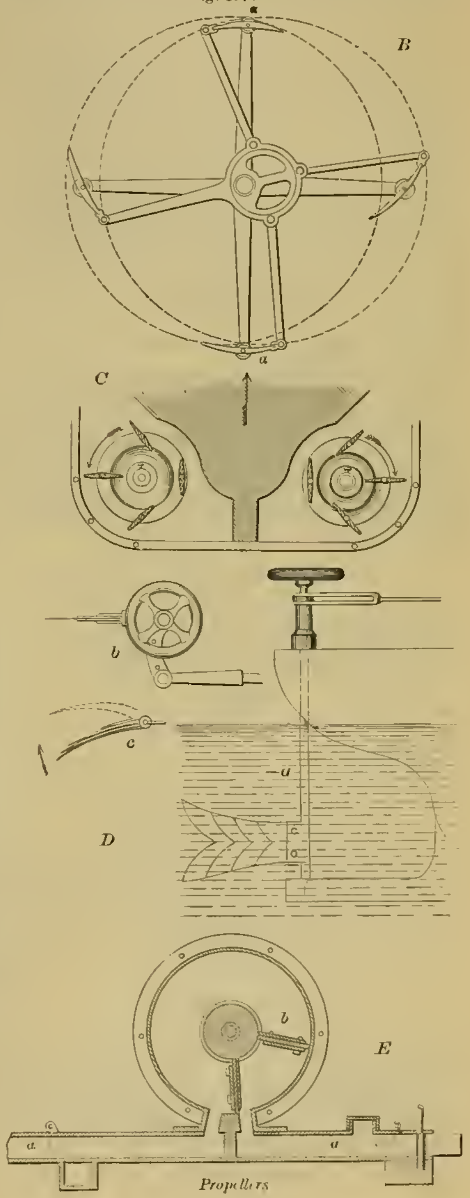
Screw-propellers are known as *adjustable, unshipping, auxiliary, twin* or *double, gaining.*

Woodcroft introduced the increase-pitch or *gaining-screw* propeller; the pitch gradually gaining from the *leading* to the *following* edge.

When twin-screws are used, one screw is *right-handed* and the other *left-handed*, so that, being turned in contrary directions in driving ahead, they may counteract each other's tendencies to produce lateral vibration.

Griffith's had a hollow spherical ball, forming an enlargement of the hub being substituted for the central portion of the blades. The blades taper toward the extremities. The pitch

Fig. 3975.



Propellers.

is alterable, by the rotation of each screw on its stem, which is radial to the main shaft.

Ericsson's blades were on the exterior of a cylinder.

James Montgomery's propeller has a cylindrical rim around the outer edges of the wings, to prevent radial projection of the water and strengthen the wings. Patented April 12, 1859.

A (Fig. 3974) shows a section of a three-decked vessel with a screw-propeller. To disconnect the propeller when the ship is under canvas, it is lifted into a hollow trunk *m* constructed over it in the stern of the vessel, entirely out of the water, the outer screw-shaft fitting into a vertical frame of gun-metal which rises along with it. The screw *a* is disconnected either by withdrawing the driving-shaft *b* out of a socket in the screw-shaft, or, which is the better plan, by forming a coupling on the end of the driving-shaft, into which the screw-shaft fits and adjusts itself when slipped down between the guides and trunk. The screw is then retained in its position by a catch pressed down from above upon the gun-metal frame supporting the bearings, as well as by its own weight. The screw is raised into or through the trunk by pulleys and ropes worked by a capstan, the weight of the screw and its shaft being supported by a pawl and rack on each side of the trunk. In some cases, the screw is only capable of being disconnected from the engines, and left free to revolve by the action of the water upon it, from the motion of the vessel.

Maudslay's substitute is a feathering contrivance, applicable only to two-bladed screws, consisting in placing the blades in a fore-and-aft direction, so that they may lie within the deadwood of the vessel and present little or no projecting surface to impede her progress or affect her steering. See SCREW-PROPELLER.

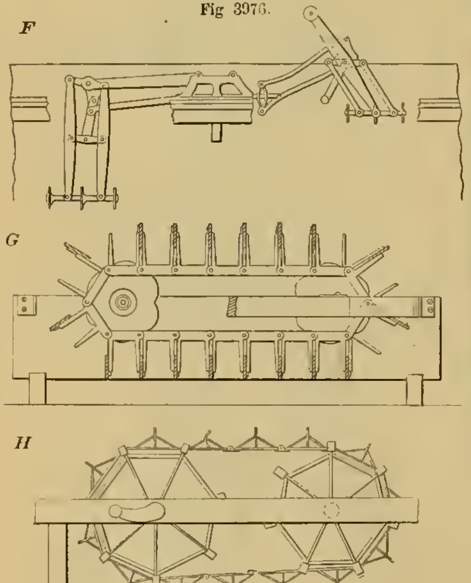
Fowler's steering-propeller (*B*, Fig. 3975) is a submerged wheel turning on a vertical shaft, with paddles which are feathered by an eccentric cam, in such manner that the paddles shall have a pushing and drawing action on the water while passing through the sectors shown by dotted lines, and present only their edges to the water while passing the points *a a*, which may be called dead-points so far as their influence in the propulsion of the ship is concerned. By turning the cam-wheel, which is done by "the man at the wheel" by a simple connection, the feathering is done at different points, and the ship may be backed or turned round and round on her center without reversing the engine.

A propeller of this kind is in use in one of the new torpedo-boats of the United States Navy.

Hunter's steering-propeller *C*, patented 1874, is similar to the Fowler propeller in some respects. It has two wheels on opposite sides of the stern-post, revolving in opposite directions. The blades are feathered so as to have but one dead-point.

Hunter's fish-tail propeller *D* consists of a flexible attachment to a post *a* at the stern of a ship The propeller vibrates from side to side with the revolution of the engine. The leaves of the propeller may be of rubber or thin metallic plates. The shape the propeller assumes while in motion is shown at *c*, and the pressure of first one side and then the other obliquely against the water causes the vessel to advance

Fig 3976.



Paddle-Propellers.

The hydraulic propeller so often projected — by Allen, in 1729; Hulls, 1737; Ramsay, 1738; Rumsey, 1782; Franklin and Evans, 1786 — has been lately revived, the English government vessel the "Water-Witch" being propelled by a rotary pump taking in water at one end and expelling it at the other. The vessel is double-ended. *E* is a modified form of this propeller. *a a* is the passage by which the water enters and leaves the pump-chamber.

Fig. 3976 shows propellers with paddles. *F* is a form of propeller whose floats are carried on the ends of levers, which lift them out of the water on the completion of their stroke, at the same time dropping into the water the corresponding set at the other end of the compound lever.

G H are forms of propellers in which the floats are carried on endless chains, which pass over wheels propelled by the engine.

See Browne's "Treatise on the Screw-Propeller," London, 1867; Burgh's "Modern Screw Propulsion," London, 1869.

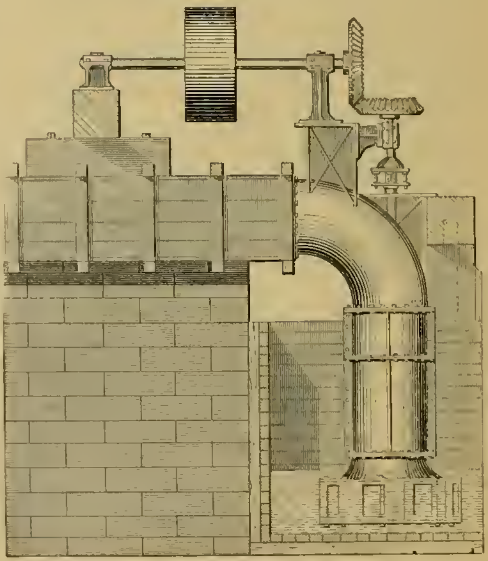
See under the following heads: —

Archimedean-screw propeller.
Auxiliary screw.
Duck's-foot propeller.
Elastic propeller.
Endless-chain propeller.
Fish-tail propeller.
Hydraulic propeller.
Nautilus-propeller.
Oar.
Oar-propeller.
Paddle-wheel.
Pole-propeller.
Propeller-engine.
Propeller-wheel.
Rack and pinion propeller.
Rail and traversing-wheel propeller.
Reciprocating propeller.
Rope-traction propeller.
Screw-propeller.
Spike-wheel propeller.
Traveling-belt propeller.
Wave-power propeller.
Windmill-propeller.

Pro-pel'ler-en'gine. The introduction of the screw-propeller has brought into use a new class of engines of short stroke, a number being ranged in a line coincident with the line of the propeller-shaft. For this service the oscillating-cylinder engine is peculiarly adapted. See OSCILLATING-CYLINDER ENGINE; SCREW-PROPELLER ENGINE.

Pro-pel'ler-pump. A form of rotary pump in which the wheel resembles the propeller-wheel of the marine service. It is driven by band-shafting and gearing in a direction to *gather* the water and force it upward in the vertical tube; interior radial wings direct the column of water upward and prevent its acquiring a vortical motion.

Fig. 3977.

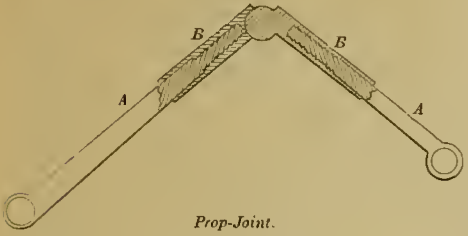


Shaw's Propeller-Pump.

Pro-pel'ler-wheel. The blades are sections of spiral flanges winding around the shaft like screw-threads. The rotation of the shaft causes the blades to bear obliquely against the water, and produces a motion of the vessel in the direction of the axis of the screw. Generally called a screw-propeller. See PROPELLER; SCREW-PROPELLER.

Prop-joint. (*Carriage.*) The jointed bar which spreads the bows of a calash-top. Its ends are socketed upon the *props*, known technically as *top-props*. The portions *A* are attached by welding or otherwise to the portion *B*, which is known as the *stub-joint.*

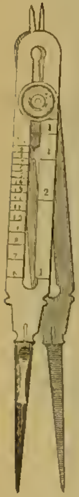
Fig. 3978.



Prop-Joint.

Pro-por′tion-al Com′pass-es. This instrument is used for copying drawings on a larger or a reduced scale. The pivot is secured in a slide which is adjustable in the slots of the legs, so as to vary in any required proportion the relative distances of the points at the respective ends. The legs are provided with marks by which the ratio of proportion of the respective ends may be arranged or determined. One side may be graduated in powers of 2; another in an ascending series, $\frac{1}{10}$, $\frac{1}{9}$, $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, etc.

Fig. 3979.



Proportional Compasses.

A pair of compasses, the arms of which are as 1 to $3\frac{1}{7}$, will denote approximately the proportion between the diameter and circumference of a tube, so that, the diameter being measured by the shorter arm, the longer will denote the width of the strip of metal required to produce it.

Pro-por′tion-al or Prim′i-tive Ra′di-i. (*Gearing.*) If the line of centers connecting the centers of two wheels in gear be divided into two parts, proportioned to the number of teeth in the respective wheels, the said two portions will be the proportional or primitive radii.

The *true* radius of a wheel is the distance from the center to the circumference.

Prop-stay. A transverse water-tube crossing a boiler-flue, forming a passage for the water and increasing the flue-surface by the exposure of its exterior surface to the heated current.

The most notable instance of the use of *prop-stays* is in the Galloway boiler, which has *tubes* crossing the *flues*. See TUBULAR BOILER.

Prop′y-læ′um. (*Architecture.*) A portico in front of a gate or temple doorway.

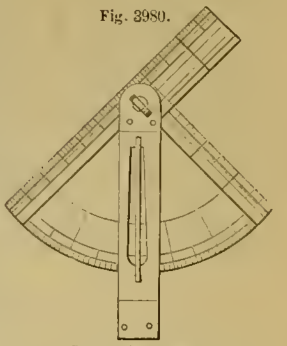
Pros′o-pom′e-ter. (πρόσωπον, the countenance; μέτρον, a measure.) An instrument for measuring the superficies of the head and face, thence to deduce the cubic contents of the cranium.

Pro′te-an-stone. A preparation of gypsum, resembling alabaster. By a peculiar process the gypsum is made to assume a semi-translucent appearance, and is then wrought into form or powdered and pressed into a mold. It is then oiled or varnished.

Pro-tec′tive Pa′per. Paper made to prevent tampering with the printing or writing subsequently put upon it. A means of preventing or detecting fraud. Water-marks are made in paper for this purpose. Paper is also made with distinguishing marks, by which it may be identified. See SAFETY-PAPER.

Pro-tract′ing-bev′el. A plotting-instrument having a protracting sector and a prolongation of one radius, which forms a rule. In Fig. 3980, the bevel-stock is pivoted to the protractor, at the center of the circle of which its curved edge is an arc, and has an oblong slot, divided longitudinally by a small metallic strip, which serves as an index to the graduated arc beneath.

Fig. 3980.



Protracting-Bevel.

Pro-tract′or. 1. An instrument for laying down angles on paper, etc. They are either of rectangular, semicircular, or circular shape, and are made of paper, ivory, horn, or metal.

a is the ivory or boxwood protractor usually embraced in a case of mathematical instruments. It is about six inches in length; the ends and one side are beveled, and are graduated from 0° to 180°. Its face has one or more diagonal scales for setting off distances.

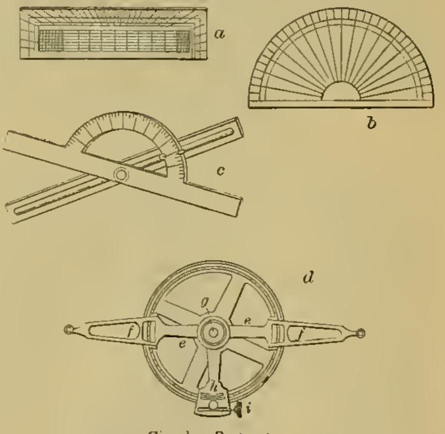
b is a semicircular protractor of transparent horn. This is a very useful instrument in some cases, enabling the draftsman to see the surface of the paper beneath.

c. A metallic *bevel* protractor.

d is a circular metallic protractor.

Each end of the arm *e e* is provided with a vernier, reading usually to minutes, and carries a light frame *f f*, having a button on its upper and a finely pointed pin on its lower side; these frames have sufficient spring to keep the pins clear of the paper as the arm is turned on its axis. The center of the instrument and the two pins lie in the same straight line, the former being usually indicated by the intersection of two fine cross-lines engraved on a plate of transparent material in the opening *g*; *h* is an arm provided with a vernier and carrying a set-screw by which the arm may be clamped to the circle while a slight movement is imparted to it by means of the tangent-screw *i*. The graduations may extend from 0° to 180° each way, may be continued round the circle from 0° to 360°, or both graduations, one exterior to the other, may be employed

Fig. 3981.



Circular Protractor.

In use, the center of the protractor is placed immediately over the point from which the angular distance is to be measured; the arm *e e* is turned to coincide with the line forming one side of the angle and adjusted by the tangent-screw until the pins are brought exactly over this line, when they are depressed, forming two minute dots in the paper; the arm is then unclamped, set approximately to the required angle, again clamped, the verniers, by means of the tangent-screw, caused to indicate the exact angle to be laid off, and the pins pressed down into the paper as before; the protractor being removed, a straight line may be drawn between the two points first laid down, and another between the two last pricked into the paper; if the instrument is in correct adjustment these should intersect exactly at the central point.

A rude sort of protractor may be made by doubling a square piece of paper diagonally from corner to corner; this gives an angle of 45°, which may be again subdivided by doubling into angles of 22° 30′, 11° 15′, etc.; these correspond to the rhumbs of the mariner's compass

"This parallelogram [pantograph] is not the same as a *protractor*, but is a most useful instrument." — PEPYS'S *Diary*, February 4, 1669.

2. (*Tailoring.*) An adjustable tailor's pattern, expansible to agree in its proportions with the particular measurements and capable of being secured in the obtained adjustment.

Prov′ing. An experiment to test the strength of anything.

Of gunpowder, see EPROUVETTE; BALLISTIC PENDULUM.

Of barrels, see GUN-BARREL.

Of ordnance, see CANNON; PROOF.

The *proof* of spirit is ascertained by a HYDROMETER (which see).

The *proof* of a form or engraving is a trial-impression.

The *proof* of horizontality, see LEVEL.

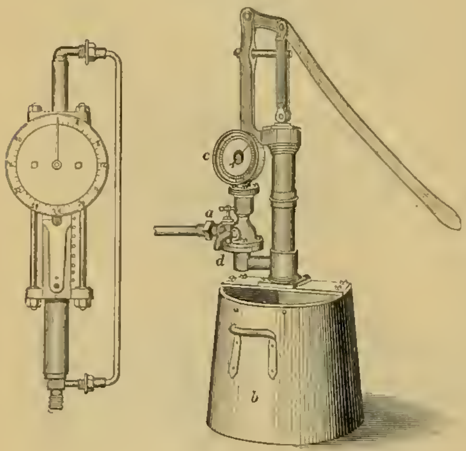
Of flatness, see PROOF-STAFF.

Prov′ing-hutt. See PROOF-HOUSE.

Prov′ing-ma-chine′. One for testing the resistance of springs or the strength of materials. See TESTING-MACHINE.

Spencer's machine for proving india-rubber springs by compression consists essentially of a strong iron frame, the top of which is provided with two longitudinal guide-bars; between these are arranged two sliding-plates, one of which is operated by a horizontal screw and lever, and the other rests against a piston in the frame whose end presses against the shorter arm of one of a system of three levers: the long arm of the lowest lever is connected with the hook of a spring-balance The spring to be tested is inserted between the two plates and pressure applied by the screw, causing the spring to react against the piston, which communicates the pressure to the compound levers, its amount being indicated by the spring-balance. Springs having a power of twenty tons may be tested by this machine.

Fig. 3982.



Proving-Pump.

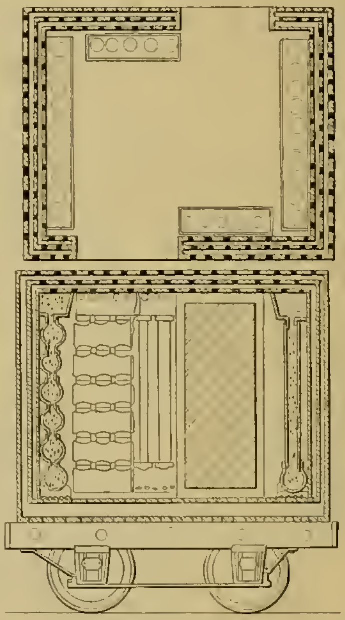
Prov′ing-press. One arranged to test the strength of iron girders, etc.

Prov′ing-pump. A forcing-pump for testing boilers, tubes, etc. The object to be proved is connected to a coupling *a*, and water from the bucket *b* is forced into it by operating the lever; the amount of pressure is indicated by the gage *c*. A cock *d* is provided for drawing off the water after testing.

On the left is a differential pressure-gage, in which the force of the water from the pipe is brought upon an upper and a lower piston in two cylinders, the difference between the motions of the two being communicated to the rack which operates the pinion on the arbor of the dial-hand.

Pro-vis′ion-car. One specially constructed for preserving and transporting provisions, meats, etc. In Fig. 3983 the preserving-chambers are surrounded by non-conducting walls, floor, and ceiling. These chambers are cooled by pipes communicating with an ice-chamber and drain-traps. The pipes may have perforations allowing the cool air to flow out into the preserving-chamber, and the air from this chamber, passing into the ice-chamber and through the pipes, establishes an endless circulation.

Fig. 3983.



Provision-Car.

Prow. (*Shipwrighting.*) The stem or forward post of a vessel. It is *scarfed* to the *keel*, supports the bowsprit, and is the forward point of attachment for the *strakes*.

Pru-nel′la. (*Fabric.*) A smooth, woolen, dark-colored stuff, used as lasting, for making the uppers of shoes and gaiters. *Prunello.*

Prun′ing-chis′el. A chisel for pruning trees.

Fig 3984

Pruning-Chisel.

The example has a concave edge to prevent its slipping off the bough.

Prun'ing-hook. A cutting tool with a hooking blade, used in trimming trees, shrubs, and vines. The references to pruning, in Scripture, are numerous, but the pruning-hook is, on each of the occasions on which it is mentioned, spoken of in reference to its conversion into a spear (Joel), or from a spear (Isaiah and Micah). It was probably a heavier tool than our pruning-knife, and cut by a blow, like a bill or machete. See Fig. 679, page 282.

Prun'ing-knife. A knife with a concave edge used for pruning. See *b*, Fig. 3986.

Prun'ing-saw. The pruning-saw is set in a stock of buckhorn, and has double teeth sharpened to points on alternate sides. The edge is thicker than the back, which answers for a *set*. See *c*, PRUNING-TOOLS.

Prun'ing-shears. (*Husbandry.*) A jaw-tool for trimming trees, shrubs, and hedges, pruning fruit-trees, vines, etc.

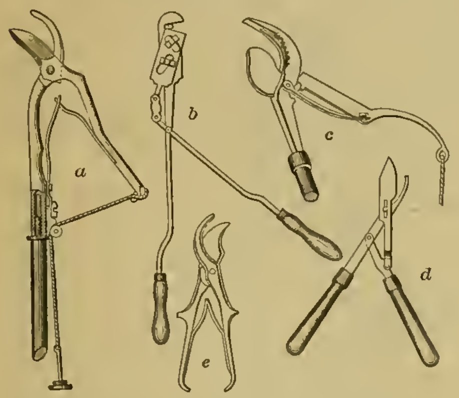
Fig. 3985 shows several forms: —

a is socketed on the end of a pole, and the movable jaw is worked by a cord and retracted by a spring.

b has a chisel which is thrust endwise against the apposed jaw, being moved by a lever and toggle.

The blade of *c* shuts into a slot in the opposite serrated jaw.

Fig. 3985.



Pruning-Shears.

In *d* the parts are so swiveled together on two centers and a sliding joint as to make a *draw-cut*.

e is a single-handed implement.

Prun'ing-tools. The tools used in pruning are the knife, saw, chisel, mallet, bill-hook, and shears. To these may be added a sword-like instrument, such as a corn-knife or machete.

a is a combined implement, having a cutting-hook, a chisel, and a saw.

The knife *b* has a curved blade, and its tang is set fast in a handle. In another form, the blade shuts into a handle. The sizes and shapes vary. The shape represented is adapted for cutting osier willows and trimming vines.

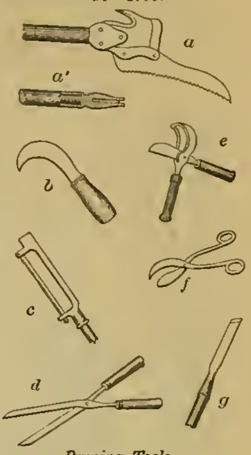
Pruning-saws are fine or coarse, according to the work. A saw is sometimes placed on the end of a pole, so as to sever a limb from a standpoint on the ground.

In *c* the pruning-chisel is placed at the end of a long handle, in which position it may be combined with a saw.

For the lopping tools which act by a blow, see BILL-HOOK.

The pruning-shears are made in several forms.

Fig. 3986.



Pruning-Tools.

d. The shears resembling large scissors with tangs inserted in wooden handles.

e. With a blade opposed to a serrated hook, which holds the branch while the blade severs it. By making the blade cut between two hooks, the tendency of the branch to bend in cutting and pry the jaws apart is avoided.

f. The pruning-scissors has two blades, one being hooked to keep the branch from slipping away. By slotting one of the parts for the passage of the other and making a link connection between the two, the blade is made to give a *draw-cut* in closing, which is favorable to its efficiency.

g is a pruning-chisel, usually placed on the end of a long handle.

> "The name of Martius, a friend of Augustus, has been handed down to us as that of the individual whose predilection for unnatural constraint first introduced the custom of cutting and training trees into artificial imitations of architectural and plastic models." — HUMBOLDT.

Pry'an. (*Mining.*) Ore which breaks up into small pebbles with a mixture of clay.

Psal'ter-y. (*Music.*) An ancient stringed instrument of the harp order; probably of a triangular shape and struck with a plectrum. See PIANO-FORTE.

The psaltery is shown in two forms in Plates LXV., LXVI., Bonanni's "Istromenti Armonici," Roma, 1776. In each it has a series of strings over a sounding-board. In one case it is played by the fingers, in the other by mallets. In Plate LXXII. it resembles a guitar.

Pseu'di-sod'o-mon. A style of masonry in which the face is formed of squared stones, the courses varying in hight, and the middle of the wall being filled in with smaller flat stones in courses. See MASONRY.

Pseu'do-dip'ter-al. (*Architecture.*) Having a single row of columns placed at a distance from the cell equal to twice their distance from each other.

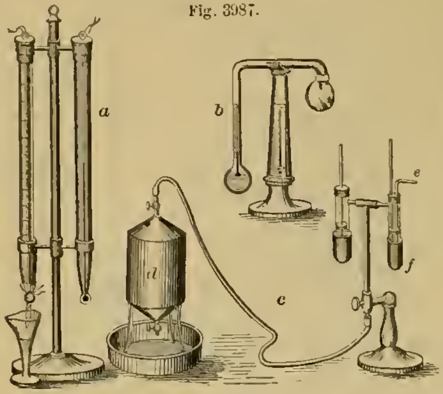
Pseu'do-pe-rip'ter-al. (*Architecture.*) Having the side-columns attached to the walls instead of separated by an interval, as in peripteral.

Pseu'do-scope. An optical instrument invented by Wheatstone for producing an apparent reversion of the relief of an object to which it is directed, by the transposition of the distances of the points which compose it. A false impression is thus conveyed to the eye, a globe becoming apparently concave and a hollow body assuming a convex form.

Psy-chrom'e-ter. A form of hygrometer invented by August. It is on the principle suggested by Hutton, and employed by Leslie in his differential thermometer. It has two very sensitive thermometers freely suspended to the same frame. Of the two bulbs, one is wrapped with linen rags and the other is free. The wrapped bulb is moistened and the evaporation is rapid in proportion to the hygrometric condition of the air. The evaporation reduces the temperature of the inclosed bulb and the mercury sinks. From the different indications of the two thermometers the amount of moisture in the air is derived.

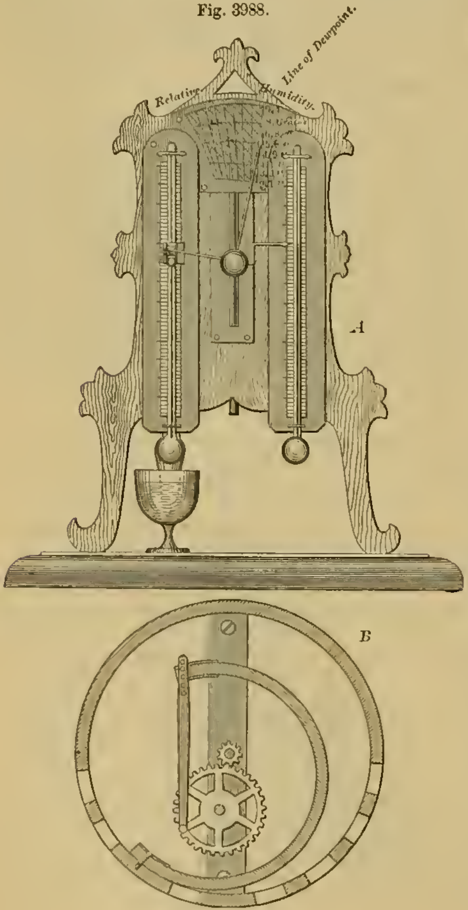
a is the kind known on the Continent of Europe as *August's psychrometer*, and in England as *Mason's hygrometer*. It has a cotton-wick leading to water in a glass below the wet bulb. The air circulates freely around the wet bulb This is now the accepted form of hygrometer, being more convenient than the Daniell's dew-point instrument. (See HYGROMETER.) This is shown at *b*. It consists of a bent tube with a globe at each end, and is partly filled with ether, the remainder of the space with vapor of ether, the air having been expelled One of the tubes contains a thermometer whose bulb is in the liquid. The stem has another thermometer as a means of comparison. The upper globe being moistened externally with ether, evaporation takes place, producing condensation of ether in the upper bulb, which causes evaporation from the ether in the lower bulb, and consequent fall of temperature in the liquid. By watching the lower globe, the exact point at which dew commences to fall may be noticed, and the temperature of the inclosed thermometer is compared with that on the stem.

Fig. 3987.



Psychrometers.

Fig. 3988.



Psychrometers.

The precise temperature at which this moisture begins to form at the level of the surface of the ether is the *dew-point*, and the difference between the *dew-point* temperature and the natural temperature is the degree of dryness — *thermometric*

By the use of tables prepared for the purpose, the degree *hygrometric* also may be ascertained, together with other conditions of the aqueous vapor; such as its elasticity, density, weight in a cubic foot of air, rate of evaporation.

c is Regnault's hygrometer; has a pair of glass-tubes closed at the ends by thin silver cups, containing ether; in these are thermometers whose stems rise through the corks which close the upper ends of the tubes. Air is drawn, by means of an aspirator *d*, through the tube *e*, and bubbles up through the ether in cup *f*, causing it to evaporate and lose sensible heat, the vapor passes with the air through the stem of the standard, and by the elastic tube to the aspirator. The moment of the deposition of dew is observed by means of a telescope so as to prevent vitiation of the result by the warmth of the body.

A (Fig. 3988) shows a form of instrument in which two indexes, that of the wet bulb and that of the dry one, are so combined that when one is placed at the hight of the mercury in a dry-bulb thermometer, and another at the hight of the mercury in a wet-bulb thermometer, a third point will indicate on a scale the proportion of moisture in the atmosphere.

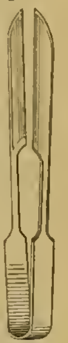
The finger, whose position is a result of the two conditions stated, points on the diagram of lines, which is so constructed as to indicate the relative humidity by the upper arc of degrees, the dew-point by a diagonal range of figures, and the absolute moisture by a vertical column of figures.

B is a hygrometer in which a semicircular strip of wood. having the grain running transversely, has its convex side coated with water-tight cement The free end of the strip is connected to a registering apparatus which indicates the humidity by the expansion of the exposed side of the strip.

Pter-yg'i-um. (*Surgical.*) A delicate pointed instrument for removing a membraneous excrescence from the internal canthus of the eye. The membrane expands on the albuginea and cornea, toward the pupil.

Pu-cel'las. (*Glass-making.*) A pair of tongs whose flat jaws rub upon the exterior surface of an object to reduce its diameter while it is being rotated as the *ponty* rests on the arms of the glass-maker's chair. *Procellas.*

Fig. 3989.



Pucellas.

Pu-cheux'. A sugar-boiler's copper ladle.

Pud'den-ing. (*Nautical.*) *a.* A thick wreath or grommet of matting or oakum tapering toward the ends, and used as a fender; on ropes or spars, to prevent chafing; or to act as preventers to the yards in case the slings are shot away; in the latter case called a *dolphin*.

b. A braid of yarns around the ring of an anchor when a hempen hawser is to be bent thereto.

Pud'die. (*Fabric.*) A kind of cloth.

Pud'ding-stone. A composite marble formed of pebbles united by calcareous cement. *Breccia* is a pudding-stone whose portions are all calcareous. Some pudding-stones have siliceous and aluminous portions. The cement of pudding-stone is softer and not susceptible of polish.

Pud'dle. 1. (*Hydraulic Engineering.*) Well-tempered clay and sand used to render banks or dikes impervious.

2. PISÉ-WORK (which see).

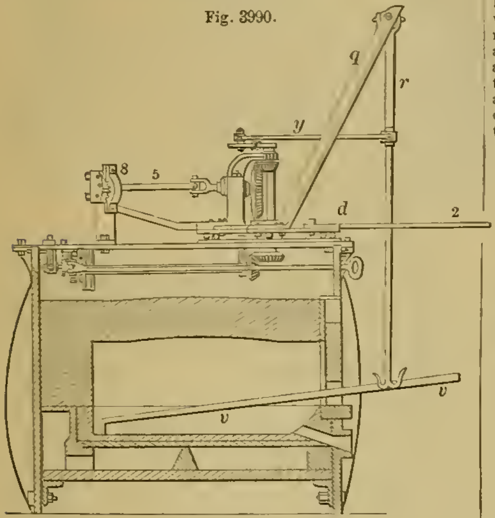
Pud'dled Steel. (*Metallurgy.*) Pig-iron is puddled in a reverberatory furnace, and the process is stopped on the instant that the carbon has been sufficiently eliminated. Reported to have been first made by Anton Lohage, of Westphalia. In 1848, he began his trials at the Haspe Iron Works, near Hagen, in Westphalia, and after some time he succeeded in producing steel of good and uniform quality by the ordinary puddling process. His invention was patented 1850, in England, by Ewald Riepe, and introduced at Low Moor; but, owing to the quality of the pig-iron, its use was very limited in England until, in 1858, Mr. William Clay introduced the process on a large scale at the Mersey Steel and Iron Works, Liverpool. In Germany, about 100,000 tons of puddled steel are made every year, and it forms the principal material for Krupp's celebrated cast-steel.

Pud'dler. Mechanical puddlers have assumed two forms.

1. The *Mechanical Rabble.* The rabble is worked back and forth through the stopper-hole in the door, as in the hand operation, except that motion is given by machinery outside. The rabble is worked in and out, and at the same time has a horizontal sweep so as to reach the various parts of the floor of the furnace.

The rabble *v* is suspended from the rod *r*, which is reciprocated by the pitman *y* and crank *x*. The point of suspension of the rod *r* is at the head of a gib *q* which rises from a bed-plate *d* which is movable automatically in a horizontal plane, in an arc of a circle, so that a reciprocating motion is given to the point of suspension of the hanger *r*, which is communicated to the end of the rabble, causing the latter, instead of working backward and forward in the same line, to assume a new direction at each stroke, working successively over every portion of the floor of the furnace, within certain limits, in lines radiating from the working hole in the door of the furnace, corresponding exactly to the action in hand puddling. The movement of the hanger and rabble is controlled by means of a bow 2, proportioned in shape and dimensions to the character and extent of the furnace bottom. The in-and-out motion of the rabble is by means of bevel-gearing, while the reciprocating motion of the bed *d* which runs on balls is by means of a pinion on the end of the shaft 5 working in an endless rack 8.

Fig. 3990.

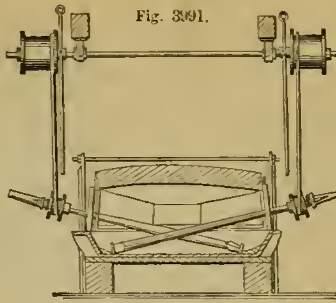


Mechanical Rabble.

When the iron begins to thicken, or, as it is termed, is *coming to nature*, the machinery is disconnected by knocking out the cotter that fixes the upper end of the vertical working arm; the arm then drops out, leaving the furnace door clear for the puddler to ball up the iron, which is done exactly in the same manner as in ordinary puddling-furnaces.

Fig. 3991 is a mechanical puddler having a rotative motion by machinery, while the *rabble* is directed by the attendant to any part of the furnace. The tool-handle is hollow, and is used for injecting air, steam, or other gases into the molten iron during the puddling.

Fig. 3991.



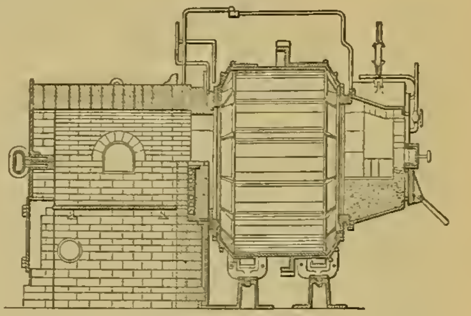
Mechanical Puddler.

2. The *rotary puddling-furnace.*

Many forms of rotary furnaces have been essayed, in which the charge is rolled around in a rotating barrel-shaped chamber.

The Danks puddling-furnace has an ordinary furnace grate, but, instead of the large chamber of the reverberatory metal-chamber, a barrel-shaped vessel receives the charge of pig-metal, and through this the flame passes to the chimney. The metal once melted, the barrel is caused to revolve by steam power, and as the fluid metal flows around the interior, the carbon which it contains and the accompanying silicon are oxidized by contact with the passing oxygen in the furnace gases, and with that of the iron ore with which the barrel is lined. Gradually it loses its fluidity, becomes viscous and finally spongy, and is then malleable iron. One end of the barrel is movable, and that being removed, the *ball* of spongy iron, weighing 600 to 700 pounds, is taken out, carried by tongs suspended from an overhead railroad to the squeezers, where it is rolled and compressed into a billet of quite compact iron, and thence to the *muck train* of rolls, in which it is given the shape of a long rough-looking bar, which only requires additional rolling to convert it into *merchant bar.*

Fig. 3992.



Danks Rotary Puddler.

The foundation for the lining of the cylinder consists of a mixture of pulverized iron ore and pure lime, worked with water into the consistency of a thick paste. Upon the completion of the initial lining, a quantity of pulverized iron ore, about one fifth of the total amount required to fettle the apparatus, is thrown in, the furnace is heated and made to revolve slowly until the iron is found to be completely melted, and the apparatus is then stopped. That part of the molten iron which has not been consumed by glazing the initial lining surface runs to the lowest level of the furnace, and there forms a pool, into which there are put a number of small and large lumps of iron ore. This part of the fettling is allowed to set, when a fresh quantity of pulverized ore is thrown in. The furnace is again made to rotate slightly until the newly added ore is liquefied, when the apparatus is again stopped, and the pool is filled with lumps as before. The operation is continued in this way until the whole of the vessel is properly fettled. From 2 to 2½ tons of iron ore are required to fettle a 700-lb. furnace.

The iron is charged into the furnace either in a solid or molten condition. When charged in the shape of pig-iron, the melting down occupies from thirty to thirty-five minutes, during which a partial rotation is given to the furnace from time to time in order to expose equally all sides of the charge to the flame. When the whole of this is thoroughly melted, the furnace is made to rotate once or twice per minute only during the first five or ten minutes, in order to obtain the most perfect action of the cinder upon the molten iron. A stream of water is injected through a stopper-hole along and just above the line of contact between the floating cinder and the inner surface of the vessel on the descending side. A certain portion of uncontaminated cinder is thereby solidified on the metal surface, and is carried down into or below the bath of molten iron in a continuous stream, which, in rising up through the iron, combines with the impurities of the latter. On the expiration of the five or ten minutes, the iron begins to thicken, and the motion is stopped. The heat is then raised so that the cinder shall be perfectly liquefied, and the vessel is brought into such a position that the tap-hole shall be just over the level of the iron, which by this time has become partly pasty. The cinder is then run off The heat is again raised, and the furnace is put in motion at a velocity of from six to eight revolutions per minute, by which means the charge is dashed about violently in the furnace. A high temperature being kept up and the charge being continually turned over, the particles begin to adhere, when the velocity of the apparatus is lowered to from two to three revolutions per minute, upon which the ball then very speedily forms. The puddler then solidifies the front end of the ball by a few blows from a tool applied through the stopper-holes, and it is withdrawn through the end — opened by the removal of the head and the moving out of the way of the flue — of the chamber.

A large fork, suspended from a crane, is put into the vessel along one side, and the ball, which by a turn of the vessel is rolled on to the fork, is then taken out by means of the crane The ball is then worked in a squeezer. The flue is replaced after the requisite quantities of cinder and metal have been again charged, and the process is continued. From eight to ten charges are made before any refettling is required, and these heats are worked in a day of ten hours See PUDDLING-FURNACE.

Mechanical Puddlers.

Griffith 1865	Gove 1858
McCarty 1852	Dormoy 1869
Berard 1867	Riley 1873
Harrison 1864	Danes 1873
Bloomhall 1872	Sellers 1873
Bennett 1864	Wood 1870
Heatley 1873	Heatley 1869

Revolving Puddlers.

Beadlestone . . . . . Dec. 9, 1857	Danks . . . . Nov. 24, 1868
Heaton . . . . Aug. 13, 1867	Danks . . . . Oct. 20, 1869
Allen . . . . Apr. 14, 1868	Yates . . . . Feb. 23, 1869
Yates . . . . Feb. 23, 1869	

See also patents to Boynton, Allen, Jenkins, Smith, 1871; Jackson, Goodrich, Richardson, *et al.*, Davies, Post, 1872; Jones, Danks, 1873.

Pud′dle-rolls. The first, or *roughing*, *rolls* of a rolling-mill. Invented by Henry Cort, England, and patented in 1783.

The loop, or ball of puddled iron, after a preliminary forging, is drawn out by passing through the puddle-rolls, instead of being extended under the hammer. It is then a rough bar.

The rolls which bring the iron to definite merchantable shape are known as the *merchant train.*

The process of drawing the loops in grooved rolls was suggested in Payne's patent (England, 1728), but does not seem to have been practiced.

Pud′dling. 1. (*Metallurgy.*) *a.* The lining of the hearth or boshes of a furnace in which metal is melted.

The material of the *puddle* was formerly, for some uses, of clay and charcoal worked into a plastic condition.

The term *puddling* has arisen from the fact that the hearth was originally made by a *puddling* of clay upon the bricks or masonry of the furnace. The clay is now superseded by a *fixing* of ore, cinder, and scrap, which is banked up around the boshes to protect them from the heat. It is known as *fettling* in some parts of England. See FIXING.

b. The process of converting cast into wrought iron by boiling and stirring in connection with the decarbonizing action of the atmosphere which passes through the furnace. Contact between the metal and solid fuel is thereby avoided.

The process was invented and brought into extensive use by Henry Cort, and patented in 1784. Cort also invented the *puddle-rolls*, by which the bloom resulting from a preliminary forging of the loop is drawn out into bars, instead of being extended under the hammer; this Cort patented in 1783.

In each case Cort does not seem to have been the first inventor, though he was the most successful and meritorious. He was ruined by the chicanery of partners and government officials, and died poor. Several acts of Parliament, and government grants of small amount, were made to his descendants, even as late as 1856.

The puddle-rolls patented by Cort in 1783 are described in Payne's patent, 1728.

The process of puddling iron in a reverberating furnace, stirring, gathering the loop, hammering, and rolling, is described in the specification of the Brothers Cranage, 1766, and the furnace in Onion's patent, 1783.

The pig-iron, broken into pieces and mixed with a certain proportion of *hammer-slag*, is put into the furnace, and in the course of 35 or 40 minutes is melted. During this time it has to be constantly stirred with the *rabble;* the pieces, as they soften, being broken finer, until at last the mass melts and passes to the boiling stage. At this point the severer part of the puddler's work commences. The rabble must be quickly and violently moved throughout the whole charge to promote ebullition. After a while the metal gets thick or pasty, and offers greater resistance to the tool, which is worked from side to side of the furnace, to separate the tough mass into portions This stage is called *coming to nature*, and is that in which the pig, deprived for the most part of its silicon and carbon, passes to a purer form, as wrought-iron, requiring only compression to expel the slag and consolidate its particles, and rolling or hammering into merchantable shape, to fit it for use or market. Preparatory to these last-indicated operations, the *balls*, into which the puddler has separated the pasty mass, are taken out and subjected to the hammer or squeezer, which condenses them into blooms that pass to the rolling-mill. The whole time occupied in the puddling is about an hour and a half. See PUDDLING-FURNACE.

2. (*Hydraulic Engineering.*) Working plastic clay behind sheet-piling, in a coffer-dam, a wall in a dike, the lining for a canal, or in other situation, to resist the penetration of water; generally as supplementary to a main structure and forming a retentive stratum or clothing therefor.

Pud′dling-fur′nace. (*Metallurgy.*) One in which pig-iron, broken into pieces and mixed with *hammer-slag*, cinder, ore, according to circumstances, is melted and continuously stirred for a considerable time while boiling, in order to expose it thoroughly to the action of the current of air passing through the furnace, so as to effect the chemical changes required for the separation and removal of the impurities originally combined with the iron. The metal has then to be balled up into separate masses of about one hundred and twenty pounds each for the shingling hammer; and the whole process extends over about an hour, from the time of melting the pig-iron for each heat, of which six are worked in the day.

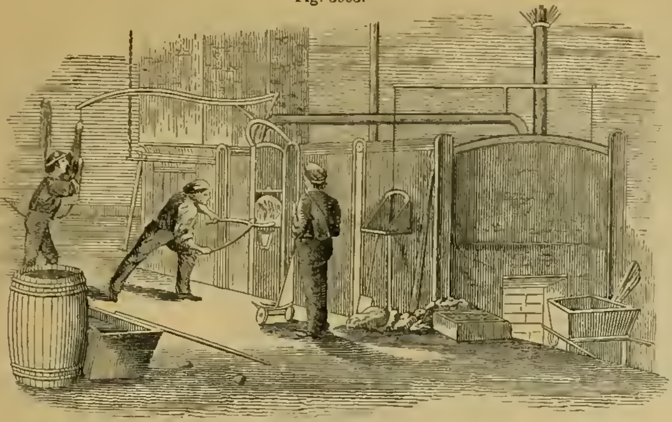
The process involves very laborious and long-continued hand-labor, and the current of air passing through the furnace has to be regulated and changed as the process advances.

Fig. 3993 gives an idea of the general appearance of the exterior of the furnace. The furnace-door is by the man in the foreground, who is holding the handle of the *ball-trolley* to catch the *ball* or *loup*, which the furnace-man is just taking out of the iron chamber. A third man lifts the door by means of the lever.

Fig. 3994 shows a puddling-furnace of usual construction. The furnace-door is at *L*; *D*, the door of the iron-chamber; *K*, the neck; *M*, the stack. The iron boshes stand on pillars, and their exteriors are cooled by water introduced by tubes The *stack M* also stands on pillars, so that it is not affected by the tearing down of the *neck*.

Fig. 3995 shows two forms of puddling-furnaces; a single-chambered and a double-chambered furnace.

Fig. 3993.



Puddling-Furnace.

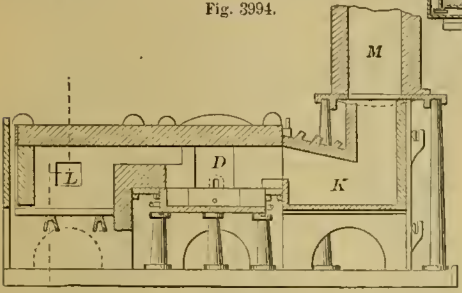
In Fig. 3995, *A*,—

a, fire-chamber.	*h*, stack.
b, iron-chamber.	*i*, velvet-tree.
c, hearth.	*k*, grate.
d, stock-hole.	*l*, roof.
e, throat.	*m*, tap-hole.
f, neck.	*n*, stopper-hole.
g, bridge.	

In Fig. 3995, *B*,—

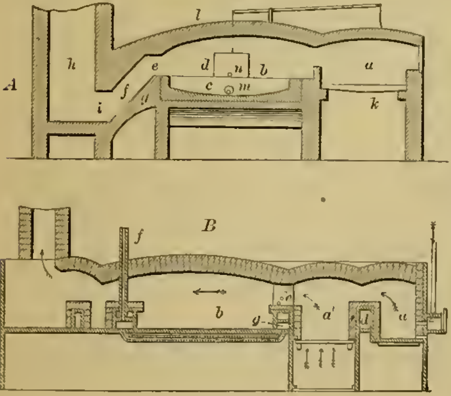
a, first fire-chamber.	*d*, water-back.
a', second fire-chamber.	*f*, pipe to supply water-boshes *g*.
b, metal-chamber.	
c, bridge.	

Fig. 3994.



Puddling-Furnace.

Fig. 3995.

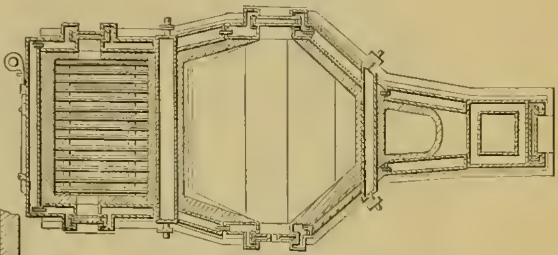


Puddling-Furnaces.

Fig. 3996 shows the plan-view of the fire-chamber, iron-chamber, neck and stack. The water-jacket is open above, giving free exit to steam, and the separate sections are connected by tubular bolts, allowing passage of water. The bridges contain water, and have ascending and descending steam and water pipes.

The puddling-furnace was invented by an iron-master of the name of Henry Cort, about the year 1780, the bed of whose furnace was made of sand, consequently the carburet was refined, many of its impurities, especially the carbon, which is the metalloid causing fluidity, was driven from it; hence, when the pig-iron was melted, it assumed the form of grain. Mr. Samuel Baldwin Rogers introduced the present system of iron bottoms to furnaces, which obviated the deteriorating influence of the silicon due to the sandy bed of the Cort furnace, and eventually did away with the finery process.

Fig. 3996.



Plan of Puddling-Furnace.

The chamber the pig-metal is charged with consists of iron plates forming the bottom and sides, which are lined with refractory slags rich in oxides of iron. In changing the heat, slags and scales from the hammers and rollers are thrown on the hearth or bottom, and on this the charge of pig-metal, consisting of 510 pounds to 540 pounds. Fuel is then thrown into the grate, and in about twenty-five or forty minutes this carburet of iron becomes liquid, and assumes the form of a molten plate of iron some one and a half to two inches thick. Being heavier than the slags, the latter pass through it, and rise to the top. In passing, the oxygen contained in the silicates combines with the carbon of the iron, and decarbonizes it; but unless the iron is agitated it will not become malleable. Hence the puddler, with a bar called the *rabble*, agitates the metal, and brings in contact the oxygen of the silicate with the carbon and other impurities of the iron. As the carbon is leaving the metal, its atoms expand and become of less specific gravity, and it throws off carbonic oxide gas, the blue flame of which is plainly seen by any one who watches the process. The puddler, at this stage, must be incessant in his operation, for the transformation scene is coming, and the crude iron is becoming malleable. The boiling of the mass is kept up by the fresh energy of the puddler until, as the carbon diminishes, the atoms of the iron begin to knit or agglutinate together in a soft spongy consistency, the *cinder* taking the place of the once molten iron. The iron is now as sensitive to oxygen as a tropical plant would be if placed in a temperature at zero, and as the human lungs would be if inhaling pure oxygen; it lives, as it were, too fast. It is at this point that smoke-preventers are puzzled; but a deoxidizing flame is kept on the iron while it is being kneaded and divided into balls, preparatory to being brought out of the furnace; and, when done, the lump is taken to the hammer and beaten into the required shape for rolling it into the puddled bar of commerce. This operation is called *shingling*.

Pud'dling-ma-chine'. A mechanical puddler. It operates by means of mechanical rabbles, or by rotation of the furnace. See PUDDLER.

Puff'er. A vat in which goods are boiled in an alkaline solution. See BUCKING-KIER.

Puff'er-pipe. The vertical axial pipe in a kier in which cotton goods are washed during the bleaching process. See KIER.

Pug. (*Pottery.*) The mill in which *slip* is kneaded and from which it comes in the form of bricks. These are stored in cellars to *ripen*. See PUG-MILL.

Pug'ging. 1. (*Building.*) *a.* Lining the spaces between floor-joists with coarse mortar to prevent the passage of sound.

b. Stuff laid on partition-walls to deaden sound; felt, saw-dust, tan-bark. *Deadening.*

2. *Claying;* tamping with clay; stopping with *puddle.*

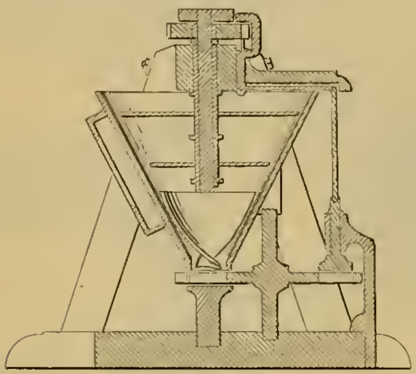
3. Grinding of clay, with a sufficiency of water to render it plastic. *Tempering.*

Pug-mill. A mill by which clay is worked, to blend its materials and render it plastic, for bricks or pottery.

It has an upright cylinder armed with intruding blades, and an upright revolving axis armed with radial blades which work in the intervals of the former. Having a spiral arrangement or oblique position, the tendency of the blades is to force the clay constantly downward to the exit.

Fig. 3997 shows a mill in which the clay is cut into pieces by the knives, and then ground and tempered, being eventually pressed out at the lower end by the spiral blade which discharges it into the brick molds beneath.

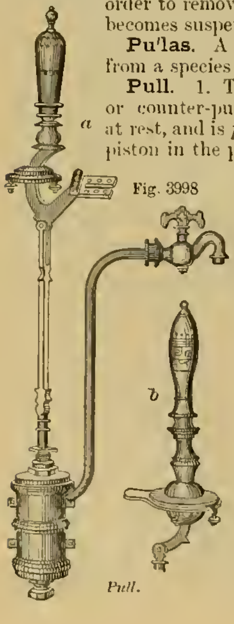
Fig. 3997.



Pug-Mill.

Pug-tub. (*Metallurgy.*) A cistern in which argentiferous slimes are stirred up with water in order to remove some of the mud which becomes suspended in the water.

Fig. 3998



Pull.

Pu'las. A twine made by the Malays from a species of nettle.

Pull. 1. The lever of a beer-engine or counter-pump. It is vertical when at rest, and is *pulled* down to actuate the piston in the pump-cylinder.

a shows a *quadrant-pull;* being pulled to the right, the arc-shaped piece travels in its guide, lifting the pump-rod and ejecting the beer at the faucet.

b is a *sphere-pull,* the ball rolling in its socket as the lever is drawn over to the right.

2. The knob and stem of a door-bell or door-gong.

3. A catch or lip upon a drawer or door by which it is pulled open.

4. (*Printing.*) *a.* The space on the form which was impressed by the platen, in the old style of printing-press, where two impressions were sometimes required for a large form.

b. A single impression.

Pull-cock. A faucet whose spigot or movable member is vertical while the passage is closed, and is pulled over to a horizontal position to discharge. It rotates 90° in a vertical plane, while the ordinary spigot moves in a horizontal plane.

Pull-down. (*Music.*) A brass wire which is attached to the under side of the valve of an organ and by which the valve is operated as the key of the manual is depressed; the *pull-down* passes through a perforation in a brass plate on the bottom of the wind-chest, and connects by a lever and a small rod called a *sticker* with the rear end of the key.

Pul'ley. A wheel with a grooved, flat, or slightly convex rim, adapted to receive a cord or band, which runs over it. Its function is to transmit power or change the direction of motion.

It is said to have been invented by Archytas of Tarentum, a disciple of Pythagoras, about 516 B. C. It does not appear to have been used by the ancient Egyptians.

The combination of pulleys is ascribed to Archimedes, who died 212 B. C.

Vitruvius described the pulley. He refers to the sheaves (*orbiculi*) in the blocks (*trochlea*), and defines the system by the aggregate number of sheaves in the two blocks, — *trispastos, pentaspastos,* etc.

We read of pulleys on the great ship built by Archimedes for Dionysius of Syracuse, about 250 B. C. They were used for hoisting stones into the towers for the supply of the catapults and other engines.

The cord and pulley principle is employed in the tendons of animals, some of which have their directions changed by passing over fixed pulleys of cartilage.

One of the muscles by which the eyeball is moved is called the *trochlearis,* from the *trochlea* or pulley through which the tendon passes.

The pulley is classed as one of the mechanical powers.

Pulleys without blocks or carriers are properly *sheaves* or *pulley-wheels,* which are mounted in various ways, according to the purpose for which they are designed.

The simplest form is that of a wheel with a nearly flat face (*a*), over which a band passes. This is the common machine-pulley used on shafting, which is ordinarily supported by hangers from the ceiling of the shop. Couplings and hangers are described under those separate heads. Pulleys to be mounted on machine-shop shafting are: —

Fast; being firmly attached to their shaft, from which they receive, or to which they communicate, motion.

Loose; running free on the shaft, to receive the belt and allow it still to traverse without being affected by, or affecting the motion of, the shafting.

Speed; having a number of faces or grooves of different diameter (*b*), so as to communicate varying speeds with a given rate of motion of the belt or cord. This is common in lathes and analogous machines, and is sometimes called a *cone*-pulley.

Conical; used in cotton machinery, etc., where a gradually increasing or decreasing speed is required. See CONE-PULLEY.

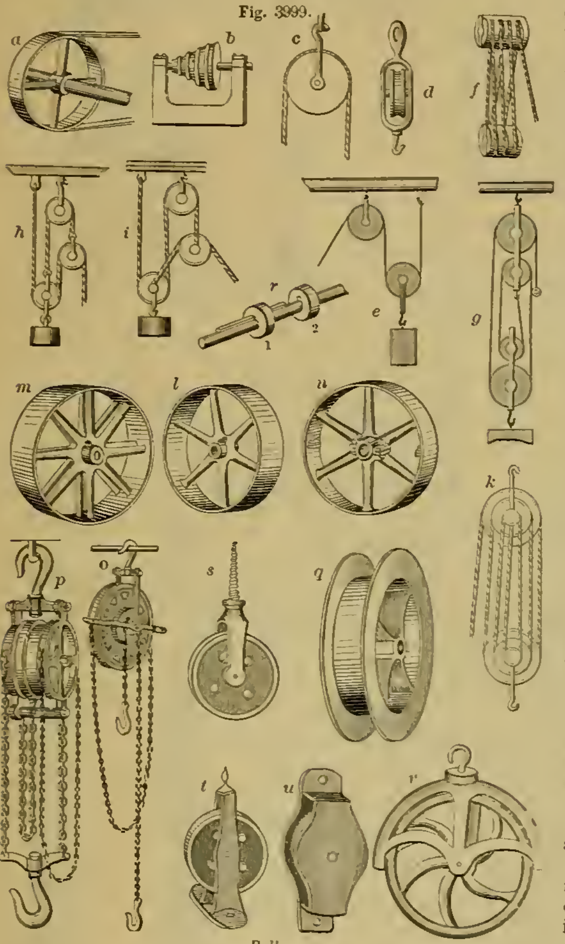
The ordinary single-sheave pulley transmits and changes the direction of motion without increasing the power. The most familiar form of mounting is that used on shipboard (*d*), in which the sheave runs on a pintle in a block which is embraced by a *strap* of metal or rope having an eye at one end and a hook at the other. See Block.

Another form of mounting a single sheave is a simple hanger (*c*); this is not so common in regular hoisting-tackle, but is familiar in models and experimental machines. Having no *cheeks*, the line may get out of its groove and cease to *run*.

In compound systems of pulleys, the sheaves of each block are usually arranged upon the same through pin, which passes through each cheek and the walls of separation between the sheaves.

In another method, the sheaves turn in slots arranged in vertical series in a *long-tackle block*, instead of horizontally. The sizes of the sheaves vary, so that the respective ropes do not run in contact, and thus rub against each other.

Fig. 3999.



Pulleys

Compound pulleys and combinations of pulleys are used for gaining power with a corresponding loss of speed. The arrangements are various.

e. The rope runs over sheaves in a *standing* pulley and a *running* pulley. The gain in power is twofold. (Friction will not be considered in this and the following estimates, though this causes a considerable loss of power under even the most favorable circumstances, increasing with the number of sheaves.)

The *block* and *tackle* or *fall* and *tackle*, as it is variously called, has a pair of pulleys in which several sheaves are arranged to run on the same pintle in the block (*f*), or one above the other (*g*). The effect is the same, as each sheave runs independently on its own pintle at such a rate as it is impelled by the rope. The power is thus calculated: Divide the weight by double the number of sheaves in the lower block; the quotient is the power required to balance the weight.

In systems of pulleys with one rope and one movable block, the load is as many times the power as there are different parts of the rope engaged in supporting the movable block.

The tension on each part of the rope is equal to the power; or, in other words, has the same tension throughout its length. Each portion of the rope connecting the two pulleys is adequate to the support of the power, which is 1, and, the strands connecting the pulleys being 6, the statement of the power to the load is 1 to 6, in the example shown; the rope traveling 6 feet for every foot gained in the raising of the lower block and its load.

The Spanish Barton (*h i*) has two cords and two running blocks and one standing block. See Barton.

Pulleys are susceptible of many other combinations, by increasing the number and varying the points of attachment to the load or to the support. See Brown's "507 Mechanical Movements." See Tackle.

In White's pulleys (*k*) the diameter of each sheave is proportioned to its rate of revolution, so that all may revolve in the same time. All the sheaves turn on the same pin, and each may constitute an independently revolving pulley, or they all may be cut on the face of a solid conical block after the manner of speed-pulleys. In an arrangement of this kind, in which the theoretical power is to the weight as 1 to 6, the diameters of the set on one block would be 1, 3, 5. and of those on the other 2, 4, 6. The rule above stated for estimating the relations of the power and load may be stated in another form.

Pulleys for driving machinery by means of flat belting are usually made somewhat swelling on their peripheries. It is found by experience that the band when in motion has a tendency to work up toward the highest part of the face of the pulley, so that it is kept more centrally to its work when this form is adopted. Grooved pulleys are used for ropes or circular bands, and for some purposes flat-faced pulleys having a circumferential ledge at each side are employed (*q*).

l is a *plain* or ordinary machine-pulley; *m*, a *double-arm* pulley, by which means additional stiffness is imparted to the rim; *n* is a *split* or divided rim pulley; the halves are bolted together by flanges on the hub and interior of the rim. *o p* are differential pulleys for hoisting. The *flat-rope* pulley (*q*) is used, as its name indicates, for transmitting power in some cases by means of a band or flat rope. *r* is a lock-pulley. In this arrangement, the spline which secures the fast pulley 1 to the shaft is fitted somewhat loosely, so that it may be pushed forward to engage with a hole in a loose pulley 2, and withdrawn therefrom, compelling it to revolve with the pulley or allowing it to stand loose on the shaft.

Pulleys for household hardware have specific names derived from their modes of attachment.

s, screw-pulley.
t, frame-pulley.
u, side pulley.
v, well-pulley for dumb-waiters, etc.

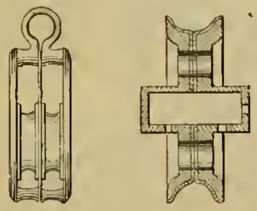
Specific names are given to pulleys, according to place, purpose, material, construction. See —

Anti-friction pulley.
Barton.
Belting
Block (varieties, see Block)
Block and tackle.
Bull's eye.
Chain-pulley.
Click-pulley.
Clutch-pulley.
Cone-pulley.
Conical pulley.
Differential pulley.
Double-speed pulley.
Expanding pulley.
Expansion-drum.
Fall and tackle.
Fast and loose pulley.
Fast pulley.
Flat-rope pulley.
Friction-clutch pulley.
Friction-pulley.
Guide-pulley.
Idler.
Lock-pulley.
Loose pulley.
Pulley-block.
Pulley clutch or tongs.
Pulley-sheave
Pulley-stand.
Pulley suspension-hook.
Pulley-wheel
Rigger.
Runner
Sash-pulley.
Scored pulley-sheave.
Sliding-pulley.
Snatch-block.
Speed-pulley.
Tackle.
Taglia.
Tension-pulley.
Tightening-pulley.
Traversing-pulley.
Two-speed pulley
Variable-speed pulley.
Whip.
Whip and runner.
Whip-on-whip.

Pul'ley-block. A shell with a sheave or sheaves. See Pulley.

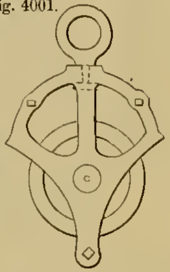
Fig. 4001 is a skeleton frame with an iron sheave, cast in two pieces and with hollow axis. The sheave is shown on an enlarged scale on the left.

Fig. 4000.



Pulley-Block.

Fig. 4001.



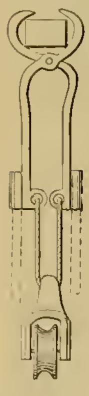
Iron Pulley-Block.

Pul'ley-box. (*Loom.*) A frame containing the pulleys for guiding the tail-cords in a draw-loom.

Pul'ley-check. An automatic device by which the rope is kept from running back over a pulley. In Fig. 4003, the upper branch of hook *A*, pivoted to an arm hanging loosely from the axis of the pulley, allows the rope to move freely in one direction, but prevents movement in the opposite direction when a weight is suspended from the lower part.

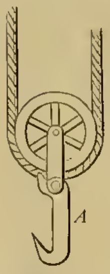
Pul'ley-clutch. A device for fastening a hoisting pulley to a beam or rafter. The grapple is adapted to hold automatically to a beam above, and has at the lower end of its arms eyes to receive the supporting rope of a pulley and sockets to receive handles to unclasp and adjust it.

Fig. 4002.



Pulley-Clutch.

Fig. 4003.



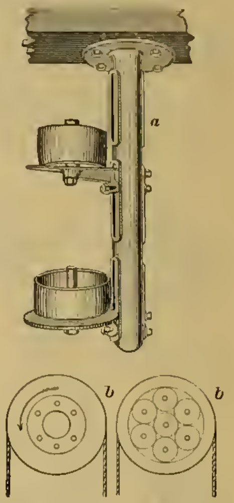
Pulley-Check.

Pul'ley-drum. The block inclosing the sheave.

Pul'ley-mor'tised. (*Carpentry.*) A mode of securing a ceiling-joist to a binding-joist so that their lower surfaces shall be flush. The end of the ceiling-joist has a tenon which lets into a mortise in the binding-joist.

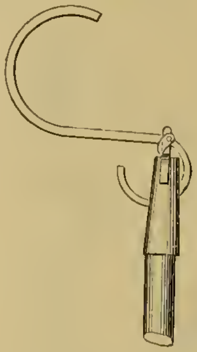
Pul'ley-sheave. The roller with a grooved surface over which a rope runs in a block. To avoid the friction of the pulley-sheave *b* on its pin, an annular system of anti-friction rollers has been interposed between the inner bearing surface of the sheave and the pin on which it rotates. Each of the intervening rollers has an axial pin at each end, journaling into a ring which is at liberty to travel around the common axis. The rings keep the rollers at their proper relative distances, and prevent their becoming jammed against each other.

Fig. 4004.



Mule Pulley-Stand and Anti-Friction Sheaves.

Fig. 4005.



Pulley Suspension Hook.

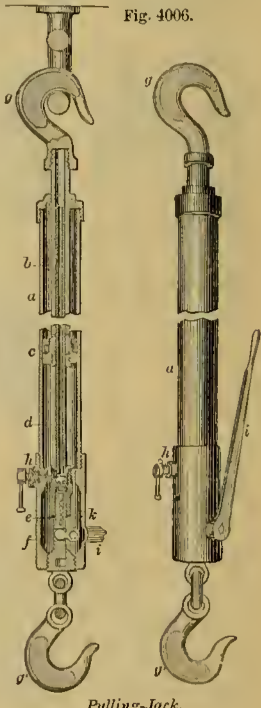
Pul'ley-stand. A hanger *a* on which the pulleys are adjustable in hight and angle of axis, so as to make them suit the belting, which may reach them at angles varying with the stem of the hanger.

Pul'ley Sus-pen'sion-hook. One to catch above a rafter or beam of a barn to afford a hold for the block of a hay-elevating fork. The socket is mounted on the end of a pole, the stop holding the hook in inclined position ready to slip over the rafter; the pole is then withdrawn from the socket.

Pul'ley-wheel. This is more properly termed a *sheave.* It is a wheel running on a pintle in a block and grooved on its periphery for the reception of a rope. See Pulley.

Pull'ing-jack. A hydraulic device for lift-

Fig. 4006.



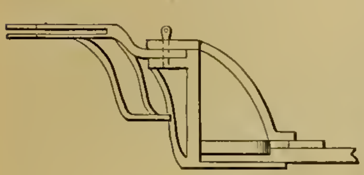
Pulling-Jack.

ing or pulling heavy weights. It consists of a cylinder *a* containing a tube *b* pivoted with a piston *c*, and having a second, interior tube *d* passing into the foot of the pump *e*, which projects into the reservoir *f*. In operation, one of the hooks *g g′* is attached to some fixed object, and the other to the weight to be moved; the water is introduced into the cistern, and the communicating valve between it and the interior tube *d* is closed by turning the screw *h*; working the lever *i* operates the plunger *k*, causing water to pass through the tube *d* from the cistern to the upper part of the cylinder *a*, into which it is discharged through apertures in the tubes *b d*, forcing the piston downward and lifting or drawing the object to which the hook *g′* is attached a distance equal to the movement of the piston. By unscrewing the valve *h* the water is again returned to the cistern *f* as the weight is lowered.

The view shows section and elevation.

Pull-i′ron. The piece at the hind end of the tongue of a street-car by which it is attached to the car.

Fig. 4007.



Pull-Iron.

Pull′man-car. (*Railway Engineering.*) A first-class car, usually fitted with capacious seats by day and with couches and berths by night. Named from the promoter of the enterprise and one of the inventors of the contrivances now used by the company.

The Pullman cars are owned by a company which puts them on the various railways of the country, carrying passengers who have first-class tickets and who pay extra for the use of the superior accommodation of the Pullman car. It is fast becoming the equivalent of the European "first-class," being superior in its fittings to the other cars of the train, and is more select and safe. See SLEEPING-CAR.

Pul′lock. See PUT-LOG.

Pull-piece. (*Horology.*) The wire or string attached to the striking mechanism by pulling which the clock is made to strike, for the purpose of bringing the striking and going mechanism into accordance or repeating the hour previously struck.

Pull-to. (*Weaving.*) The upper bar of the *lay*, *lathe*, or *batten*, which is used to beat up the weft. Also called the *lay-cap*.

Pul-mom′e-ter. An instrument for measuring the capacity of the lungs. A *pneumatometer*. See SPIROMETER.

Pull-o′ver. (*Hat-making.*) A conical cap of felted fur, forming a napping to be pulled over a hat-body. The napping is made upon a triangular piece of paper or metal, sometimes called a *bason*, the fur extending over both sides of the paper, which prevents the sides from uniting.

The term *pull-over* refers to the mode of fitting it to the body, in contradistinction to the mode of applying the napping by lapping it around the body, one side at a time.

Pulp. (*Paper-making.*) Paper-making material cut fine and suspended in water ready for manufacturing into paper.

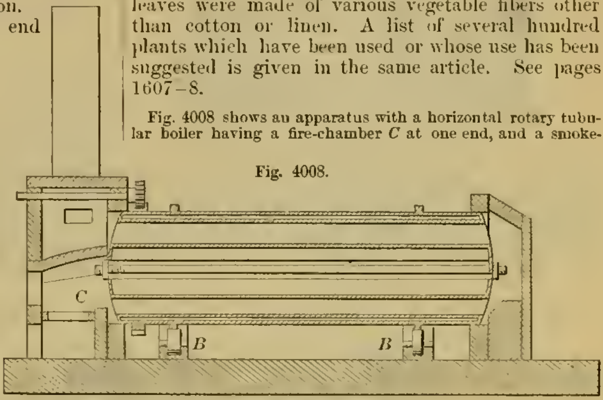
There are but few vegetable fibers collectible in any quantity which have not been tried for paper-making. A list of the more prominent is given under the head of PAPER (which see). For the machinery by which the fiber is reduced, see RAG-ENGINE.

Pulp-boil′er. An apparatus for treating paper stock, especially ground wood or cut straw, to remove gum, silex, starch, etc., from the fiber. See next article.

Pulp-di-gest′er. (*Paper-making.*) A machine for boiling stock for paper, such as wood, straw, and other material, to remove the amylaceous, glutinous, and siliceous matters, and obtain the fiber comparatively pure. The usual course is to boil the stock in an alkaline solution. The manufacture of paper from wood, straw, and various plants has been practiced for over a century, and reference is made under PAPER to three works of the last century whose leaves were made of various vegetable fibers other than cotton or linen. A list of several hundred plants which have been used or whose use has been suggested is given in the same article. See pages 1607–8.

Fig. 4008 shows an apparatus with a horizontal rotary tubular boiler having a fire-chamber *C* at one end, and a smoke-chamber at the other end. The fire-chamber has a roof, over which is a chamber communicating with a chimney. The heat passes through the tubes in the boiler below the level of the roof, and into the above-mentioned chamber, and then passes through those above said roof, into the chamber, and then into the chimney. The boiler rotates on bearing rollers *B*, and is moved by a pinion and annular gear.

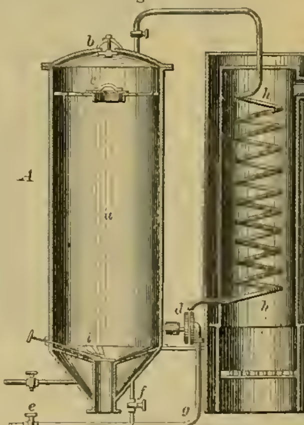
Fig. 4008.



Nixon's Straw-Boiler.

A (Fig. 4009) represents Dixon's straw-boiler. Rye-straw is chopped into lengths of about $\frac{3}{4}$ of an inch, cleansed, dusted, and passed through a heavy pair of iron rollers to open out the tubes and knots, after which it is transferred to the boiler *a*; this is partially filled with a solution of caustic soda in the proportion of 60 gallons to each 100 pounds of straw. The manhole cover *b* and diaphragm cover *c* are removed, and the straw and caustic solution alternately introduced; the latter is drawn from a tank by a rotary pump *d*, and when the boiler is filled the supply is cut off. The caustic alkali percolates through the straw, collects at the bottom of the boiler, and is drawn therefrom by the rotary pump, through the pipes *f g*, returning through the heated coil *h* to the upper part of the boiler, to be again passed through the straw. The boiling being finished, the straw is removed by withdrawing the slide valve *i*, provided with an exterior handle.

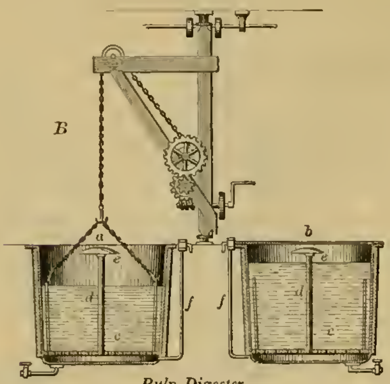
Fig. 4009.



Dixon's Straw-Boiler.

B is an apparatus for boiling paper stock It has a crank for removing it from the tubs after boiling. *a* and *b* represent the boiling-tubs; these have perforated false bottoms *c c*, carrying upright pipes *d d* surmounted by the bonnets *e e*; steam is admitted through the pipes *f f* and distributed throughout the mass in the boiler by means of apertures in the perforated false bottom. The tubs are ⅔ or ¾ filled with a solution of soda; steam is then turned on until the liquid boils, rising through the pipes *f f*, and is deflected by the under surface of the bonnet; the paper scraps are then gradually thrown in and distributed as uniformly as possible. After boiling, the mass is hoisted out of the tub by chains which are hooked to a frame connected with the false bottom and attached to the lifting chain of the crane. The tubs have covers of wood or metal to prevent escape of heat and steam. The liquid is drawn off by the pipes below.

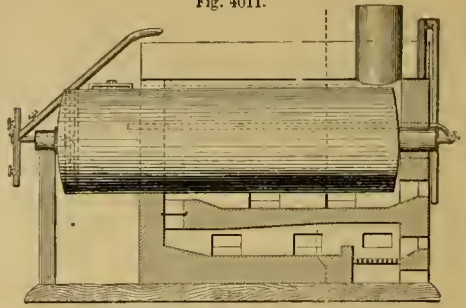
Fig. 4010.



Pulp-Digester.

Fig. 4011 is a view of the Palser and Howland rotary pulp-digester. It has a rotary boiler with a hollow trunnion through which passes a pipe having an internal partition, so that the steam from the upper portion of the boiler may find exit through one compartment of the pipe, and the liquid contents of the boiler may find an exit through the other compartment.

Fig. 4011.

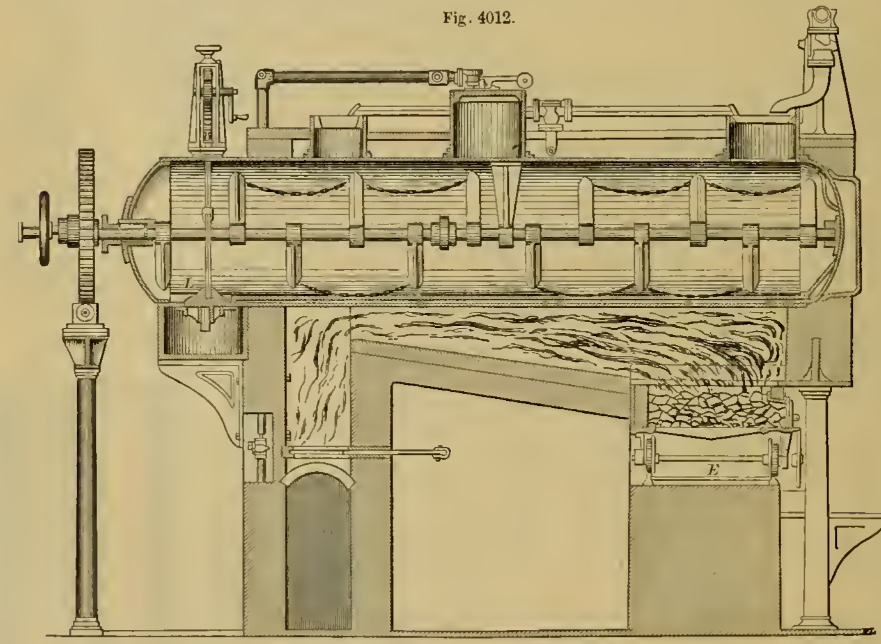


Palser and Howland Pulp-Digester.

A perforated diaphragm near the end of the boiler protects the steam and alkaline liquid pipes, and serves also to strain the liquid from the stock under treatment. The boilers are arranged in pairs, so that the steam arising from the boiling of the alkaline and other contents of one boiler is injected into the other. The rotary-boilers are heated by a furnace below, and the chimneys pass through the cylindrical-bottomed vats above.

Fig. 4012 is an apparatus for reducing straw to "half-stuff" for the manufacture of paper. The straw, after being cut up into short lengths, is immersed in an alkaline solution, and subjected to steam pressure in a boiler, after which it is washed and discharged from the boilers by the aid of a copious stream of water. The boilers are charged from above with stock and with water. The paper stock is stirred by chains on a rotating shaft, and is removed by lifting valve *L*. The fire is on a movable car *E*.

Fig. 4012.



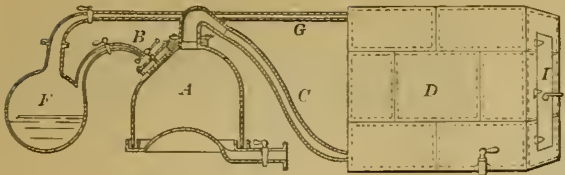
Easton and Thiry's Straw-Boiler.

Robbins and Southmayd's apparatus for treating bamboo and similar fibers consists of a retort *A*, boiler *F*, and digester *D*. Heat is applied to the retort and boiler, and vapor from oleaginous substances in the first, and steam from the second, are conveyed through the pipes *C G* to the digester *D*, in which the fiber is placed.

The boiler and retort have direct communication through the pipe *B*, and each pipe is provided with a cock by which the proportions of steam and oily vapor admitted to the digester may be regulated, or either may be cut off. *I* is a door for entering or removing the fiber.

The spread of intelligence and the consequent demand for more books and newspapers has rendered the supply of rags entirely inadequate to fill the demand for paper stock. In working raw material some eliminative process became necessary.

Fig. 4013.



Boiler for Bamboo Fiber.

See the following United States patents, Nos.

1,753*
4,093
6,980
7,497
9,910
11,987
17,381
20,294
24,484*
24,819
25,418
26,199
26,202*
38,901
40,659
41,812
43,015
43,073
45,791*
45,845
47,539
50,266
51,430
51,571
52,543
52,544
52,694
54,308
54,510
55,418
55,835
57,947
71,728
73,138
106,135
109,595
110,873
113,502
114,301
115,327
116,980
117,427
119,465
131,749

The principal methods now in use in England of preparing paper pulp by chemical means are those of Sinclair, Houghton, Lee, Deininger, Ungerer, Thode, and Lahousse, and the special processes of Belgian and Alsatian manufacturers, such as Orioli, Jarosson, and Bushaert, Moerman, Laubuhr, Bastit, Rieder, and others. The general principle upon which all these chemical methods is based is the treatment of vegetable material containing the fibrous matter with alkaline lyes under high pressures of steam and corresponding temperatures for a greater or less time, in order to separate the fibrous matter from the gluten, gum, starch, etc.

The chemical methods in the production of paper pulp, although somewhat cheaper than the mechanical methods, are not sufficiently so to effect an important alteration in the cost of paper The inventors of chemical processes have had to look for a saving somewhere, in order to effect such a desirable result. Many attempts have been made to recover the alkali, and, although as high as eighty-five per cent of the alkali was recovered by Sinclair, others failed altogether or produced very unsatisfactory results, and now the processes of boiling with alkaline solutions have become so much improved, that the recovery of the alkali has become of secondary importance. These chemical processes being all founded upon one general principle, the differences in the apparatus employed are simply in details of construction. They consist mostly of cylindrical vessels, heated either directly or by steam from a steam-boiler In the latter case, the boiler apparatus is provided at a short distance from the bottom with a perforated plate, which separates the material to be treated from a certain serpentine steam-pipe. The boiler apparatus has also to be provided at the lower end with a man-hole for the drawing out of the finished materials. The differences in the details of the various apparatus have certain advantages and disadvantages which do not alter the main conditions. Fry's process (Swedish) consists in boiling the wood in water or alkalies, under pressure of steam of from five to six atmospheres It can only be applied to sawdust, and requires much more time than the others. Adamson's process consists in the employment of hydrocarbons for digesting woody fiber. The ligneous matter is placed between two perforated plates in a boiler heated by a steam-coil and filled with benzine, petroleum, gasoline, or equivalent liquid, which is vaporized, and after condensation in a coil passing through a water chamber above returns again to the boiler, whence it is drawn off by appropriate cocks The disintegrating effect, though not so thorough as that produced by alkalies, is yet sufficient for the purpose.

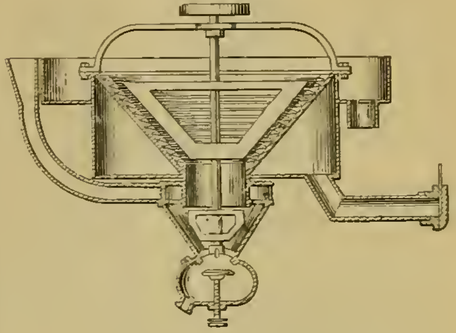
Sinclair's method is employed in reducing wood, bamboo, straw, thistles, etc. The material partially comminuted is treated with a solution of caustic soda at a temperature of 360° to 375° Fah. (11 or 12 atmospheres pressure). The boiler is vertical, and consists of an inner perforated and exterior close cylinder, between which and the wall of the brick-work furnace is an open space, permitting the products of combustion to surround the boiler, whose interior perforated shell is charged with the fiber and filled up with water, which, passing through the apertures, constitutes a water-jacket between the two shells, so as to prevent overheating.

A cylindrical receiver, connected by a pipe with the boiler beneath, is filled with concentrated lye, and the application of heat causes a circulation and interchange of the steam and fluids to ensue, removing the silicates, resinous matter, etc. The fiber is withdrawn from the apparatus, washed, bleached with chloride of lime, and afterward treated in the centrifugal machine or hydraulic press. The lye is passed through an evaporator having inclined flues, by which about 85 per cent of the soda is recovered.

When superheated steam is employed for heating the disintegrator, a special form of boiler, having inclined water-tubes between which the products of combustion pass, is employed; these, after circulating below, through, and round the boiler, descend a downcast flue to reach the chimney. It may be noted that steam-heated digesters require a less quantity of alkali, and complete the process in shorter time, than those heated by direct firing. In treating esparto, straw, etc., a temperature of 312° to 320° Fah. is sufficient, instead of 360° to 375°, as required for wood.

Pulp-dress′er. A machine for removing specks and knots from paper-pulp. The diluted pulp is passed into a screen in which the specks, by superior specific gravity, are collected into a receiver, from whence they may be discharged. The knots too large for the meshes are delivered over the edge of the screen into an annular trough.

Fig. 4014.



Sellers's Paper-Pulp Dresser

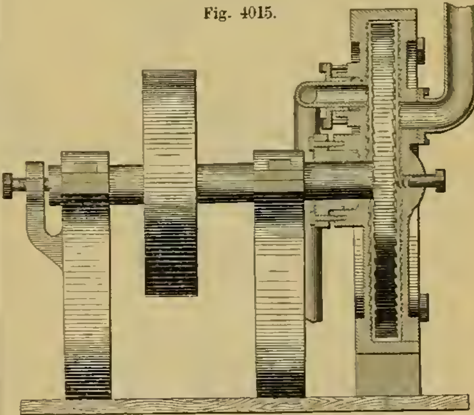
Pulp′er. 1. An apparatus for freeing the coffee-berry from the fleshy pulp by which it is surrounded. See COFFEE-MACHINERY.

2. A machine for reducing paper stock to pulp. See PULP-DIGESTER; PULP-GRINDER; PULP-MACHINE.

Pulp-grind′er. A machine for grinding paper stock for pulp.

Kingsland's pulp-grinder (1848 and 1856) has a closed reservoir with serrated circular sides which form the opposing surfaces to the toothed grinding-disk. The paper stock to be ground is fed in with a current of water at one pipe and dis-

Fig. 4015.



Kingsland's Pulp-Grinder.

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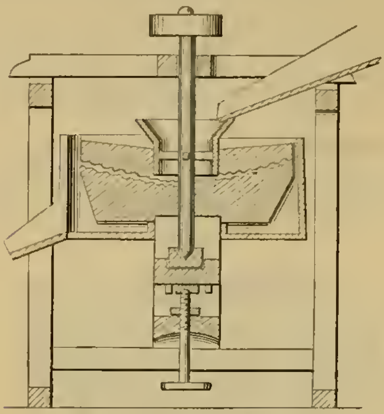
* Reissued.

charged at another, the pressure being obtained by a hydrostatic column, and the rate of passage determined by means of the regulatable discharge-aperture.

Fig. 4016 has grinding surfaces on a vertical shaft in the manner of millstones. The half-ground stuff is fed in at the spout to the eye of the stone, is discharged at the skirt, and leaves the tub by the lower spout.

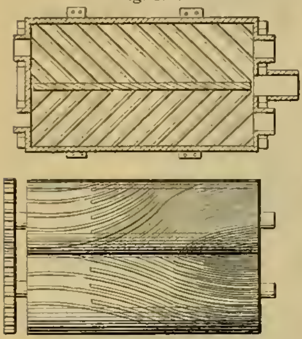
Fig. 4016.



Jones's Pulp-Grinder.

In Fig. 4017 the spirally ribbed cylinders are geared together, the edges of the ribs acting as shears to cut the material. The case has ribs in opposite directions to those on the rollers, and acting with them to disintegrate the pulp. A longitudinal bar is placed below and nearly touching the engaging portions of the rollers. The hopper is near one end and the exit pipe centrally situated at the other. The cutting-ribs on the rollers are multiplied toward the exit.

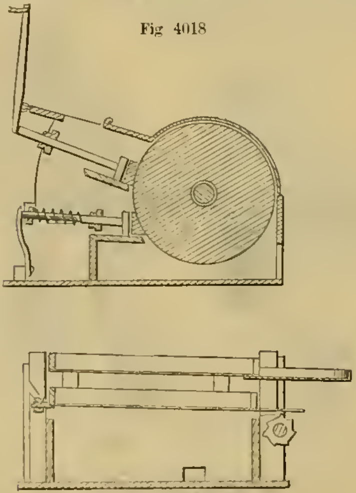
Fig. 4017.



Pulp-Grinder.

Fig 4018 is a form of machine for grinding wooden blocks into pulp. The blocks are pressed against the grindstone by a spring or weighted lever. The sieves are made of metallic plates, which are perforated by elongated meshes, separating the pulp according to the diameter of the fibers, and delivering the different qualities into different receptacles.

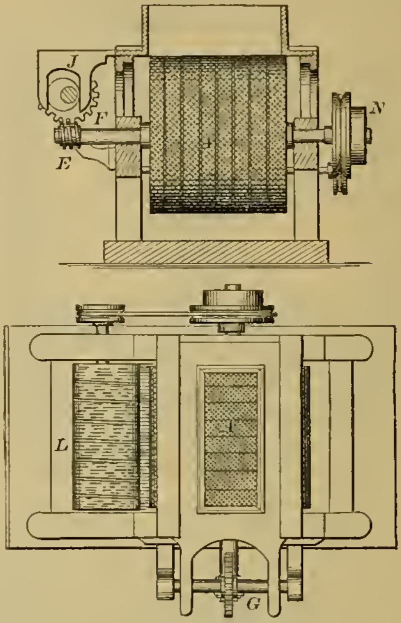
Fig 4018



Wood-Pulp Machine.

Fig. 4019 is an apparatus for grating wood to form paper pulp. The cylinder *A* has a surface adapted for grating, rasping, or filing, and is rotated by a pulley *N* at the same time that a traversing motion is imparted by a worm-wheel on the shaft *G*, and the worm *E* on the shaft *F*, to a hopper above, which contains the wood. The wheel is journaled in an eccentric in the slot *J* to cause this motion. *L* is a cleaning cylinder covered with card leather, and running in contact, or nearly so, with the cylinder *A* for removing the pulverized wood therefrom. See also WOOD-PAPER.

Fig. 4019.

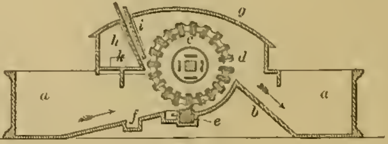


Wood-Grinder.

Pulp'ing-ma-chine'. A masticator for reducing roots to a pulp for food. Revolving knives and spikes are the essential feature of the machine. A sausage-grinder will do it.

Pulp-ma-chine'. (*Paper-making.*) A machine for reducing *half-stuff* to a fine pulp. It is similar to the *half-stuff engine*, consisting of an oblong iron vat *a* rounded at the ends and divided by a partition *b*, over which is journaled a cylinder *c* having grooves into which chisel-edged blades *d* are inserted in sets of 3, generally to the number of 60; beneath these and set at an angle therewith, other cutters *e* are fixed in the bottom of the vats; the distance between the two may be adjusted by raising or lowering the roller *c*.

Fig. 4020.



Pulp-Machine.

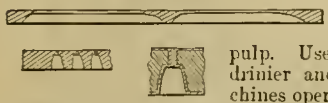
The part *e* of the bottom is sloping, and has a depression *f* for the reception of grit.

The machine is charged with dry half-stuff, to which water is added, and the cylinder *c* caused by appropriate gearing to make from 150 to 200 revolutions per minute, causing the stuff to pass between the cutters in the direction indicated by the arrows; a hood *g* is provided to prevent the pulp from being thrown out of the machine, and one side of this is a sieve *h* with a removable cover *i*, through which the foul water expelled from the pulp passes and is discharged through the opening *k*. See also Half-stuff Machine.

Pulp-me′ter. (*Paper-making.*) An apparatus invented by Cowan of Valley Field, near Edinburgh, for measuring out a uniform and exact supply of pulp to the paper-machine, according to the width and thickness of the sheet of paper to be made. It consists of a cup having an adjustable slide, which may be set so as to deliver from a box connected with the pulp-chest and kept constantly filled with the exact quantity of pulp required for a sheet of given dimensions, thus securing uniformity of thickness.

Pulp-mill. A machine for grinding paper pulp. See Pulp-grinder; Pulping-machine.

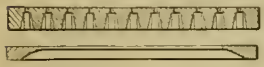
Fig. 4021



Winchester's Pulp-Screen.

Pulp-strain′er. A sieve for stopping knots and hard or bulky portions of material ground to form paper pulp. Used in the Fourdrinier and cylinder machines operating on cotton and linen stock; it is known as a *knotter*. In preparing paper pulp from wood, straw, and other unspun fiber it is a strainer with fine meshes, and is made of fabric or wire-cloth (Voelters, 1869); of finely slitted thin plates (Sweet, 1833); rollers closely assembled in parallel order (Bishop, 1845); slats laid in louver order (Hebard, 1839); of slats with facings of electro-plated metal (Winchester, 1869); of hard rubber parallel slats (Curtis, 1867). Others might be noticed.

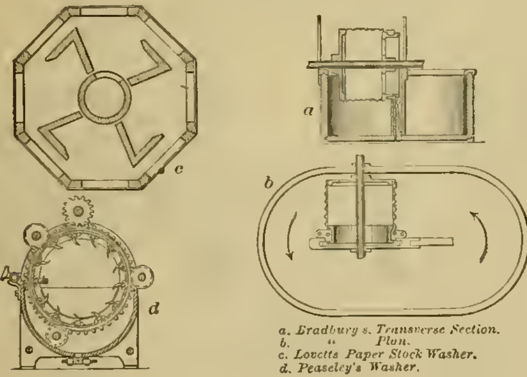
Fig. 4022.



Curtis's Screen-Plate.

Pulp-wash′er. A machine for removing dirt or foreign matters from paper pulp. The machines are of various kinds, as will be seen by examining those shown in Fig. 4023, which will be understood without lengthy explanation. Means are provided for supplying fresh water and discharging foul water without carrying off the stock. A screen is employed to separate grain, gravel, etc. See also Pulp-dresser.

Fig. 4023.

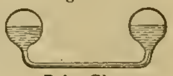


a. Bradbury's Transverse Section.
b. " Plan.
c. Lovett's Paper Stock Washer.
d. Peaseley's Washer.

Pulp-Washers.

Pulse-glass. An instrument invented by Dr. Franklin and constructed like a *cryophorus*, but intended to exhibit the ebullition of liquids at low temperatures. The bulbs are connected by a slender stem and partially charged with water, the supernatant air having been expelled by boiling, and the opening hermetically sealed by a blow-pipe. By grasping one of the bulbs the heat of the hand will cause the formation of vapor and drive the liquid into the other bulb, producing a violent ebullition in the latter.

Fig 4024.



Pulse-Glass.

Pul-som′e-ter; Pul-sim′e-ter. 1. An instrument for measuring the force or frequency of the arterial pulsation. A *sphygmometer*.

Santorio of Padua describes in his "Commentarius in Primum Fen Primi Libri Canonis Avicennæ," Venet. folio, 1626, an instrument of his invention for measuring the force of the pulse. He was also the first to apply the thermometer to measure the heat of the skin in disease and at different periods of the same disease. See Sphygmometer.

2. A name applied to a form of vacuum pump. See Steam-vacuum Pump.

Pul′ver-iz′er. See a number of typical forms on Plate XXXIV. illustrative of Ore-mills; also "Blake's" Crusher, Fig. 3417. Also Amalgamator; Arrastra; Bone-mill; Cement-mill; Chilian-mill; Disintegrator; Edge-mill; Pan; Quartz-mill; Stamp. See list under Mill.

Pul′ver-iz′ing. (*Gunpowder-manufacture.*) A mill in which the ingredients are separately reduced to an impalpable powder before being transferred to the incorporating-mill.

In the United States this is generally effected by the rolling-barrel.

Pum′ice-stone. A light cellular and fibrous rock of grayish-white color produced by volcanic action. Extensively used in the arts for smoothing and polishing purposes. It is regarded as a form of trachytic lava, in which a porous structure has been induced by the expansion of gas while in a plastic state. Campo Bianco, one of the Lipari Islands, which is entirely composed of this substance, is the principal source of supply. It is frequently employed in its natural condition, but more generally in the state of powder.

Pump. 1. (*Hydraulics.*) A device for lifting water by the motion of a piston in a cylinder.

Whether they were invented by Danaus, who dug the wells in Argos, 1485 B. C., or by Ctesibus of Alexandria, about 224 B. C., it is not possible to determine. In either case, the origin is Egyptian, and that is the most likely part of the statement. Danaus is said to have been the brother of the Pharaoh Rameses, and to have carried many useful devices from the Nile to the Peloponnesus.

The piston working in a cylinder is the *piston-blower*, a very ancient form of blast for the native smelting-furnaces of Asia, Africa, and Europe. See page 1717.

The water-pump of Ctesibus of Alexandria was described by Hero, 150 B. C., and the invention may be much older than the time of this distinguished mechanician and physicist, who was also a barber, as it certainly was in quite a complicated form. It consisted of two single-acting pistons in as many cylinders, which raised water on the up-stroke and expelled it on the down-stroke into a chamber which received the water from both pumps. See FIRE-ENGINE.

Vitruvius ascribes the invention of the pump to Ctesibus. He did not understand the *lift*, but the *force* pump. The pressure of the atmosphere was not estimated then. It was described by the Spanish Saracens, and correctly determined by the Italian Torricelli.

The true laws of the equilibrium of fluids were discovered by Archimedes and rediscovered by Stevinus and Galileo. Of the latter Milton writes, in reference to his tour in Italy: —

> "There it was that I found and visited the famous Galileo, grown old, a prisoner in the Inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought."

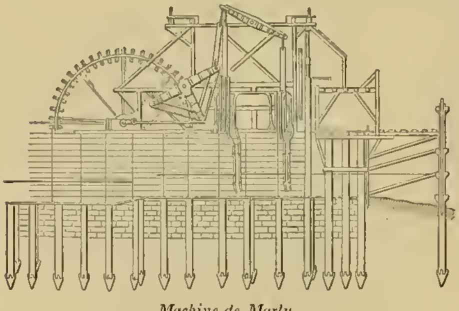
The next we hear of the piston is in the air-pump of Otto Guericke of Magdeburg, and in the steam-engine of Dr. Papin of Blois. If we knew better what the philosophers of Alexandria and Cordova had been doing in the mean time, we should probably find that the piston-pump was not entirely laid away for fifteen or sixteen centuries.

Dr. Papin was the first, so far as we know, to suggest raising water by means of a steam-*engine*, 1698. The devices of the Marquis of Worcester and Savery were not *engines*. They were water-raising devices, in which steam pressed upon the surface of water in a tank and raised it to a hight proportioned to the pressure. They did not differ essentially (except in the size of the parts) from the inventions of Baptista Porta and Leonardo da Vinci. Savery and Worcester proposed to make their apparatus available for driving machinery by "raising water to turn a water-wheel," which is all nonsense. Papin's was an *engine*. See STEAM-ENGINE.

A number of large water-raising machines were constructed at various points on the Continent of Europe during the seventeenth and eighteenth centuries, which are curious, but operate by modes which are now antiquated.

Among these may be noticed the "Machine de Marly," constructed by Rannequin, 1682, to raise water for the fountains of Marly and Versailles.

Fig. 4025.



Machine de Marly.

It was situated on the Seine between Marly and Lachausseè, and consisted of 14 water-wheels, which first raised the water to a cistern 150 feet high and 600 feet distant, then worked the balance-beams of the pumps which raised the water to a second cistern, 175 feet above the first and 1,944 feet from the river. From thence it was lifted by other pumps to a strong tower or reservoir, 502 feet above the river and 3,684 feet from it. From thence the water was conveyed by an aqueduct to its destination. This was a piece of the kingly magnificence of "le Grand Monarque," and was far ahead of what was enjoyed by Paris. The pumping-machine is said to have cost $1,600,000.

The cut is a longitudinal section showing one of the fourteen water-wheels. On the bed of the river a floor was laid on piles filled in with masonry; 14 feet above this was the platform which supported the pumps. To the axle of the great wheel a crank was attached which communicated motion to the balance-beam, and this worked the piston-rods of four pumps on each side, which sucked and forced water alternately.

The pumps at the first and second cisterns were of a similar character, and were worked by rod-and-chain connection from the water-wheels in the river.

The machines used by Belidor, Dueille, Desargues, Wahl, Morel, etc., are described by Cresy. Several of them are only peculiar in the modes of obtaining the reciprocating motion of the pistons from the rotation of the water-wheel.

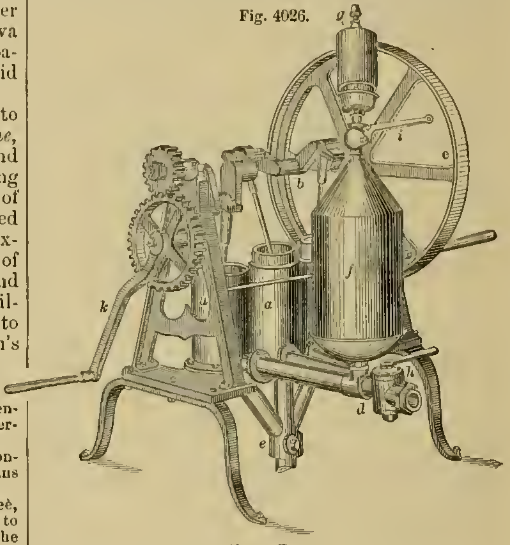
The chapelets used by the architect Perronet in pumping out the coffer-dams of his numerous bridges are described under CHAIN-PUMP.

The bucket-wheel used by Perronet is described under NORIA (which see).

See also BASCULE; SCOOP-WHEEL; TYMPANUM.

The work of a man on a pump is estimated as equivalent to an effort of 17½ pounds exerted through 2½ feet in 1 second; or, 150 feet per minute = 9,000 feet per hour = 157,500 foot pounds or 70 foot tons per hour = 560 foot tons per day of 12 hours.

Fig. 4026.

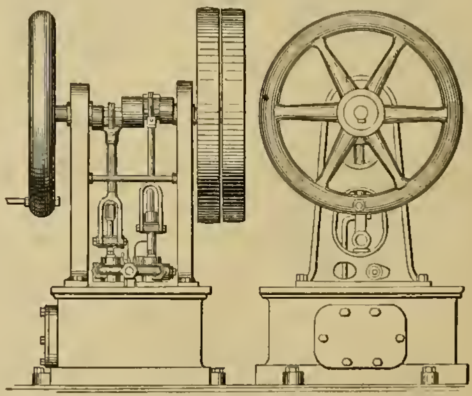


Alarm-Pump.

The most favorable length of stroke on fire-engines is from 30 to 35 inches.

The power necessary is about 1 man for every 22 cubic inches of pump-barrel; double this power if double-acting.

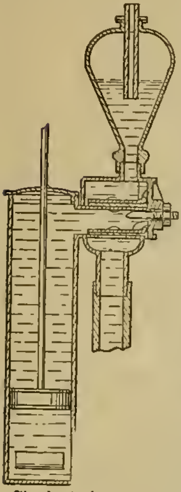
Fig. 4027.



Hydraulic-Pressure Pump.

Haskell's alarm-pump for nautical use has three cylinders *a a a*, the pistons of which are connected to crank-arms arranged at equal angles around the shaft *b*, and operated, when worked as a pump, by an arm on the fly-wheel *c*. The three delivery-pipes from the cylinders coalesce at *d*, so as to form but one; their respective suction-pipes are also united above *e*, and the pipe formed by their junction is provided with two valves, one of which opens connection with the pipe leading to the hold and the other with a hose leading overboard, when it is desired to wash decks. An air-chamber *f* is located above the pipe *d*, and over this is a whistle *g*, used for sounding signals or alarms. For this purpose the pipe *d* is closed by turning the cock *h*, when, by turning the fly-wheel, air, admitted through a valve in the suction-pipe, is forced into the cylinder and allowed to escape by depressing the lever *i*, which works a valve. When desired to increase the supply of air to effect a more rapid succession of sounds, the crank *k* is employed.

Fig. 4028.



Single-Acting Pump.

The hydraulic-pressure pump (Fig. 4027) is intended for forcing water in working presses, etc. It is provided with a cistern, and has suitable suction and delivery pipes with appropriate valves, and may be driven either by hand-power or by belt-and-pulley connections. See Plate XXV. and page 1157.

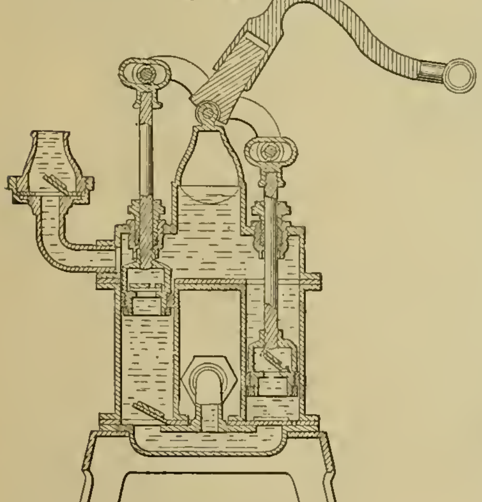
The principal distinctions of pumps are into *single* or *double* acting, *lift* or *force*, *reciprocating* or *rotary*, etc. These names indicate construction. Other names have reference to purpose, etc.

See under the following list: —

Air-pump.
Archimedean screw.
Aspiring-pump.
Bare-pump.
Bar-pump.
Barrow-pump.
Beer-machine.
Bellows-pump.
Bilge-pump.
Bottle-pump.
Brake-pump.
Breast-pump.
Brine-pump.
Burr-pump.
Cattle-pump.
Centrifugal pump.
Centripetal pump.
Chain-pump.
Change-pump.
Chapelet.
Circular-brake pump.
Circulating-pump.
Cistern-pump.
Cold-water pump.
Cupping-pump
Deep-well pump.
Dental pump.
Diaphragm-plunger pump.
Diving-bell pump.
Donkey-pump.
Double-action pump.
Double-cylinder pump.
Double-piston pump.
Draining-pump.
Driven-well pump.
Eccentric pump.
Ejector.
Elastic-piston pump.
Feed-pump.
Fire-engine pump.
Force-pump.
Forcer.
Fountain-pump.
Garden-engine.
Garden-pump.
Garden-syringe.
Giffard injector.
Hand-pump.
Hogger-pump.
Horse-power pump.
Hot-water pump.
Hydrapult.
Hydraulic-pressure pump.
Hydrostatic-press pump.
Injector.
Jet-pump.
Leech. Artificial
Lift-pump.
Locomotive-pump.
Measuring-pump.
Mining-pump.
Monte-jus.
Noria
Oil-pump.
Oscillating-pump.
Paternoster-pump.
Pendulum-pump.
Plumber's force-pump.
Plunger-pump.
Pneumatic pump.
Portable pump.
Pressure-pump.
Pump-bit.
Pump-dale.
Pump-head.
Pumping-engine.
Pump-lamp.
Pump-packing.
Pump-piston.
Pump-spear.
Pump-valve.
Rope-pump.
Rotary pump.
Saliva-pump.
Sand-pump.
Screw. Archimedean
Ship's pump.
Spiral pump.
Steam-jet pump.
Steam-pump.
Steam-vacuum pump.
Stomach-pump.
Submerged pump.
Suction-pump.
Syringe
Test-pump.
Tympanum.
Vacuum-pump.
Water-ram.
Water-screw.
Water-snail.
Wind-pump.
Wrecking-pump.

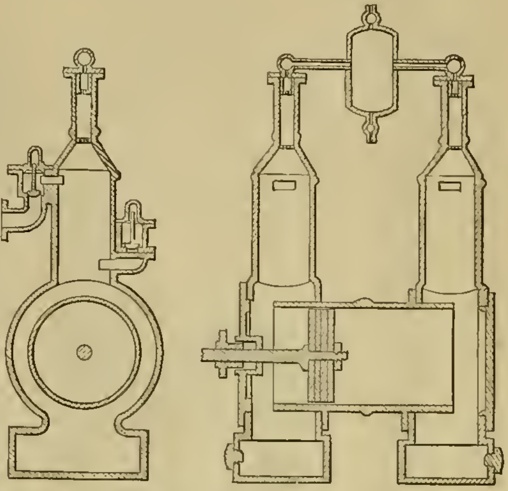
See WATER-ELEVATOR for other forms of water-raising contrivances.

Fig. 4029.



Double-Acting Pump.

Fig. 4030.



Double-Acting Single-Cylinder Pump.

Pump-back. A wooden casing over a chain-pump to receive the water when raised.

Pump-bit. A wood-boring tool of relatively large diameter and a long shank. It is adapted to be rotated by a cross-handle, and is used in boring out timbers for pump-stocks and wooden pipes. It has a routing cutter and grooved barrel. See BIT.

Pump-bob. A species of bell-crank lever employed for converting the rotary motion of a steam-engine into reciprocating motion for operating a pump-piston. In the illustration, the pitman is connected to a crank-pin on the pumping-wheel; the braces, standard, and bed-piece of the bob are mounted on a rock-shaft journaled, and supported

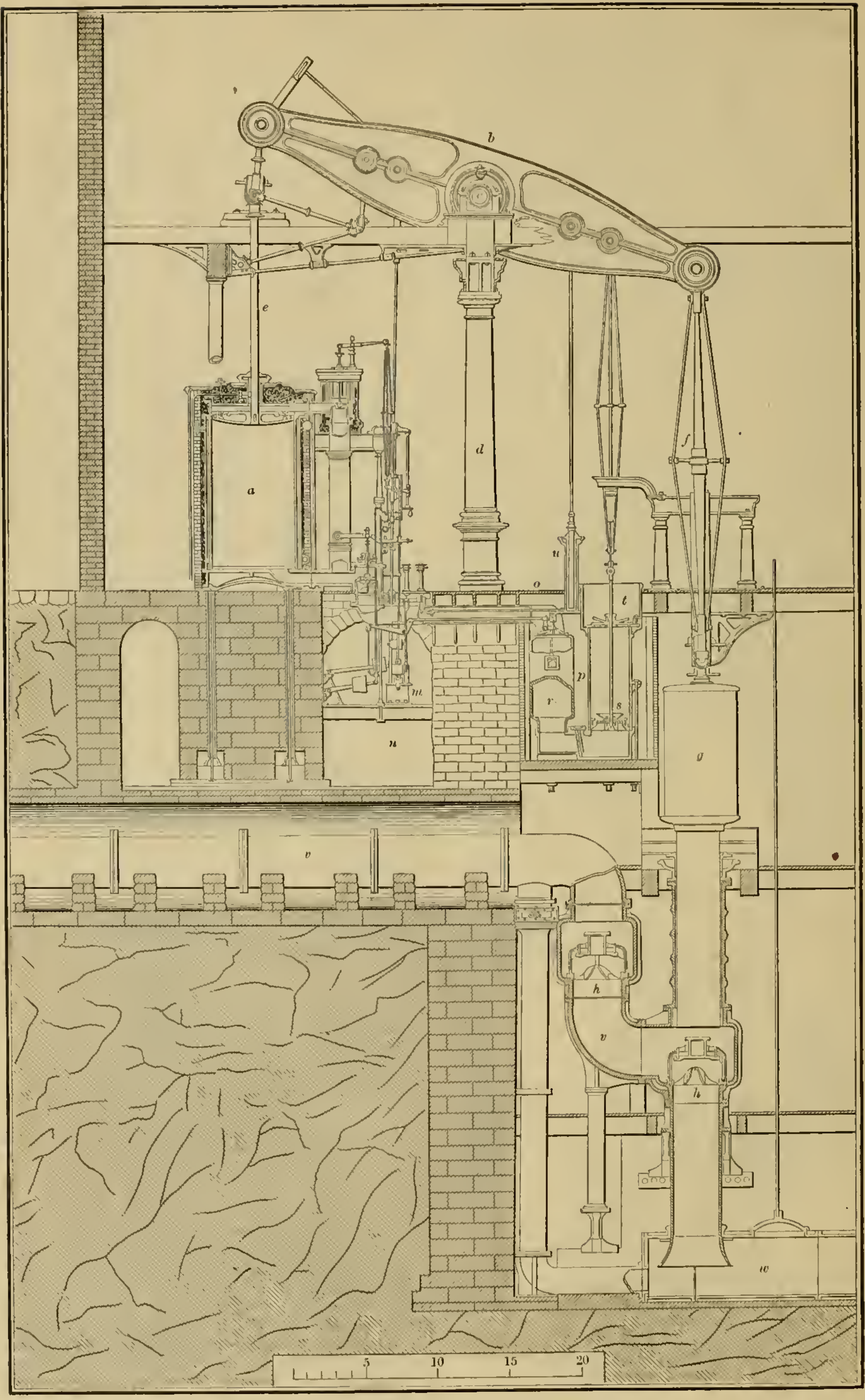
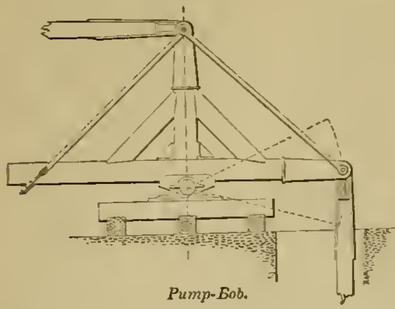


PLATE XLIV. PUMPING-ENGINE, LOUISVILLE WATER-WORKS. *See page* 1829.

(Theodore R. Scowden, Engineer.)

Fig. 4031.



Pump-Bob.

on the frame; the bed-piece and pump-piston are connected, as shown on the right.

Pump-box. *a.* A cap or case covering the top of a pump.

b. The casings of the upper and lower valves are the *upper* and *lower* pump-boxes.

Pump-break. The handle or lever by which a pump is worked.

Pump-chain. A long chain with buttons forming valves at proper distances, working on two wheels, one above and one below, and passing down through one wooden tube and returning upward by another.

Pump-cheeks. A forked piece serving as a fulcrum for the handle.

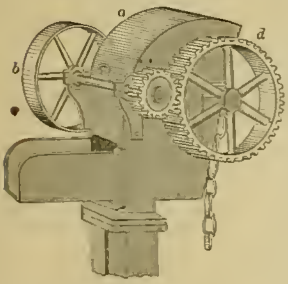
Pump-dale. (*Nautical.*) A pipe to convey water from the pump-cistern through the ship's sides.

Pump-drill. An upright drill acting by percussion.

Pump-gear. (*Nautical.*) The apparatus used in pumping on shipboard.

Pump-head. An arrangement for causing all the water raised by a chain-pump to be directed into the discharge-spout instead of permitting a part to be thrown off by centrifugal force. In the figure, *a* represents the pump-head; *b*, driving-pulley; *c*, pinion driving the spur-wheel *d*, around the axis of which the chain passes.

Fig. 4032



Pump-Head.

Pump-hook. A hook used for setting the lower pump-box in the barrel.

Pump'ing-en'gine. A steam-engine for raising water.

The engines of the Louisville Water-Works, shown in Plate XLIV., are on the Cornish plan. The engines are exactly alike, working each a single-acting lift and force plunger-pump. The dimensions of the principal parts of the engines and pumps are as follows, viz.: Steam-cylinder *a* 70 inches diameter, stroke of steam-piston 10 feet. The beam *b* for each engine is double; the two members, 3 feet 5 inches apart from center to center, are each 31 feet 10 inches long between end centers, 6 feet 9 inches deep in the middle, with 3-inch thickness of web and 9 inches width of center rib and outside flanges; the cylinder and pump ends of the beam are equal in length, each pair of beams weighs 42 tons. The beam vibrates on a main center or shaft *c* 20 inches diameter, 9 feet 8 inches long, with journals 15 inches diameter, and 19½ inches bearing. The plummer-blocks, for the beam centers of both engines, rest in pedestals bolted to a massive cast-iron entablature, which (extending transversely across the house and into the brick walls) is supported by four Tuscan columns *d* of cast-iron, standing on and anchored to the beam wall, by means of arched cast-iron bed-plates, built in the masonry. The piston-rods are guided by parallel motions, and the pump connecting-rods by cross-heads and slides; piston-rods *e* 6¼ inches diameter and 16 feet long each; pump connecting-rods *f* 8 inches diameter and 28 feet long each.

The pump-barrels are 36 inches in diameter each, plungers 36 inches diameter, with stroke same as steam-piston, 10 feet. The extreme lift of the pumps, when the river is at its lowest stage, is 21 feet 10 inches. The pumps are connected with the stand-pipe by two lines of 40-inch flanged pipes, provided each with a stop-gate near the stand-pipe. The pump-valves *h h* are of the kind known as Harvey and West's double-beat valve. The pumps and pump-mains to the stand-pipe have a circular waterway of 40 inches diameter throughout, thus admitting the introduction of pump-barrels 40 inches in diameter, and increasing the present pump capacity 23 per cent whenever the consumption of water will demand a greater supply than at present provided for.

The metal (cast-iron) of the pumps and pump-mains is from 2 to 3 inches in thickness, varying as the forms vary from the cylindrical to the oval or rectangular. All the joints are made with lead by means of flanges and bolts; the flanges are from 2½ to 3 inches thick, and from 4 to 6 inches wide, with 1¼-inch bolts.

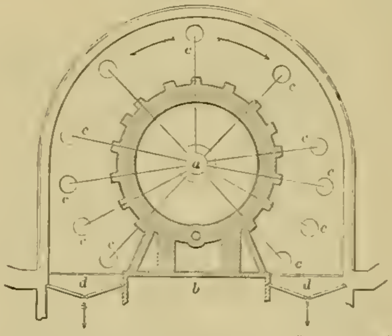
Each engine is provided with a battery of three single-flue Cornish boilers. The performance of the engines has been very satisfactory. The highest daily duty (calculated by the Cornish method) was 48,363,344 pounds of water raised 1 foot high per 100 pounds of coal: the highest monthly average was 35,957,629 pounds, and the yearly average duty 30,217,865 pounds. Cost of the engines and connections complete, $117,753.64.

The other parts of the engine are similar to those described under Air-pump, Cataract, Cornish-engine, etc., which see.

The *cataract m* is in the vault *n*; the *condenser* and *air-pump* are in the well below the main floor *o* of the engine-house. *p* is the cistern, *r* condenser, *s* bucket of air-pump, *t* hot-well. *w* is the induction water-pipe at the foot of the pump-stock, *v* the eduction main, *u* the feed-pump

The drainage of the Haarlem Lake in Holland, by which 45,230 acres of land were reclaimed, was effected between the years 1848 and 1853 by steam-pumping engines. These were three in number, named the *Leeghwater*, *Cruquius*, and *Von Lynden*, from three eminent men who had at different times, the first as far back as 1623, proposed plans for the drainage of this lake. The Leeghwater was the first erected, working 11 pumps of 63 inches diameter and 10 feet stroke. As a preliminary step, an earthen dam was constructed at the edge of the lake and inclosing about 1½ acres of its surface; the water was withdrawn from this by pumping with a small steam-engine, and foundation piles, 1,400 in number, were driven to the depth of 40 feet until a stratum of hard sand was reached. Upon these piles, at a depth of 21 feet below the surface of the lake, a strong platform was laid, on which a wall pierced with arches was built at a distance of 22 feet from the site of the engine-house; over this wall, and connecting it with the engine-house, was laid a thick flooring of oak. The pumps were supported by the lower platform, their heads passing through the flooring and extending about 3 feet above it. The water drawn up by the pumps was received in the space between the wall and the engine-house, and discharged through gates into canals leading to the sea sluices.

Fig. 4033.



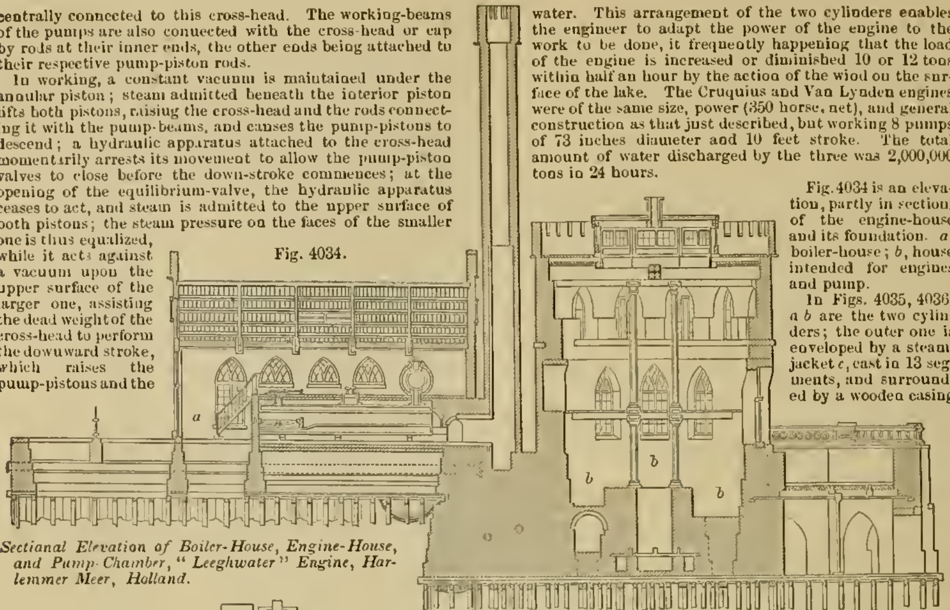
Ground Plan of Engine-House and Pumps, Harlemmer Meer.

Fig. 4033 represents this arrangement in plan; *a* is the engine, *b* the boiler-house, *c c* the pumps, *d d* the discharge sluices.

The engine has two steam cylinders, one within the other, the outer being 144¾ inches in diameter and 1½ inches thick, and the inner 84¼ inches in diameter and 1¼ inches thick; between the inner cylinder and the cylinder head, which is common to both, is a space of 1½ inches. The piston of the outer cylinder is annular, and is connected with a circular cross-head by four rods; the main piston, that of the interior cylinder, is centrally connected to this cross-head. The working-beams of the pumps are also connected with the cross-head or cap by rods at their inner ends, the other ends being attached to their respective pump-piston rods.

In working, a constant vacuum is maintained under the annular piston; steam admitted beneath the interior piston lifts both pistons, raising the cross-head and the rods connecting it with the pump-beams, and causes the pump-pistons to descend; a hydraulic apparatus attached to the cross-head momentarily arrests its movement to allow the pump-piston valves to close before the down-stroke commences; at the opening of the equilibrium-valve, the hydraulic apparatus ceases to act, and steam is admitted to the upper surface of both pistons; the steam pressure on the faces of the smaller one is thus equalized, while it acts against a vacuum upon the upper surface of the larger one, assisting the dead weight of the cross-head to perform the downward stroke, which raises the pump-pistons and the water. This arrangement of the two cylinders enables the engineer to adapt the power of the engine to the work to be done, it frequently happening that the load of the engine is increased or diminished 10 or 12 tons within half an hour by the action of the wind on the surface of the lake. The Cruquius and Van Lynden engines were of the same size, power (350 horse, net), and general construction as that just described, but working 8 pumps of 73 inches diameter and 10 feet stroke. The total amount of water discharged by the three was 2,000,000 tons in 24 hours.

Fig. 4034.

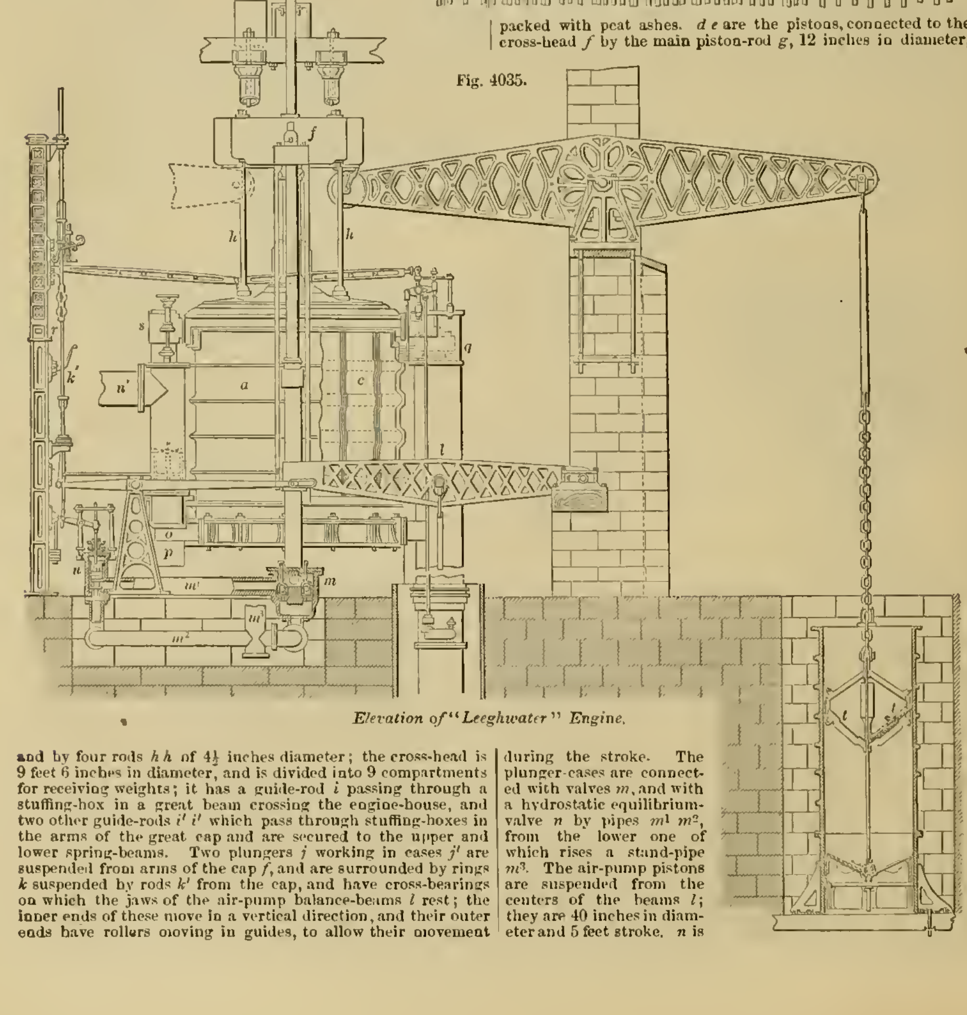


Sectional Elevation of Boiler-House, Engine-House, and Pump-Chamber, "Leeghwater" Engine, Harlemmer Meer, Holland.

Fig. 4034 is an elevation, partly in section, of the engine-house and its foundation. *a*, boiler-house; *b*, house intended for engines and pump.

In Figs. 4035, 4036, *a b* are the two cylinders; the outer one is enveloped by a steam-jacket *c*, cast in 13 segments, and surrounded by a wooden casing packed with peat ashes. *d e* are the pistons, connected to the cross-head *f* by the main piston-rod *g*, 12 inches in diameter, and by four rods *h h* of 4½ inches diameter; the cross-head is 9 feet 6 inches in diameter, and is divided into 9 compartments for receiving weights; it has a guide-rod *i* passing through a stuffing-box in a great beam crossing the engine-house, and two other guide-rods i' i' which pass through stuffing-boxes in the arms of the great cap and are secured to the upper and lower spring-beams. Two plungers *j* working in cases j' are suspended from arms of the cap *f*, and are surrounded by rings *k* suspended by rods k' from the cap, and have cross-bearings on which the jaws of the air-pump balance-beams *l* rest; the inner ends of these move in a vertical direction, and their outer ends have rollers moving in guides, to allow their movement during the stroke. The plunger-cases are connected with valves *m*, and with a hydrostatic equilibrium-valve *n* by pipes m^1 m^2, from the lower one of which rises a stand-pipe m^3. The air-pump pistons are suspended from the centers of the beams *l*; they are 40 inches in diameter and 5 feet stroke. *n* is

Fig. 4035.



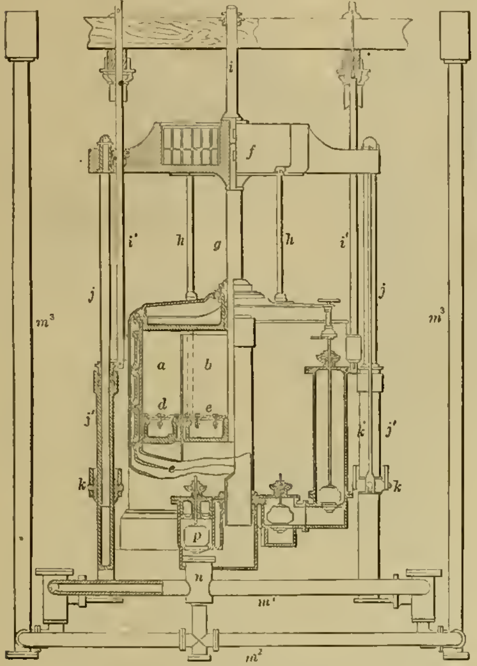
Elevation of "Leeghwater" Engine.

the steam-pipe, o induction-valve, *p* equilibrium-valve, *q* eduction-valve. The hand gear is connected to the weigh-post *r*, and the rods *k'* are worked by a lever and shaft operated by a pin on the sliding-ring *k*

The induction and equilibrium nozzles are each connected to a separate port cast in the cylinder's bottom. The eduction-nozzle is connected by a pipe to the bottom of the cylinder, which communicates with the space under the annular piston, by which a vacuum is maintained under this piston.

The hydraulic apparatus which maintains the great cross-head *f* in upward position while the valves of the pump-pistons open, so as to prevent shock on the down-stroke, operates as follows: When the engine makes its up-stroke the plungers *j* are lifted, and the water from the stand-pipes and reservoirs flows through the valves, following the plungers during their upward movement. At the end of the stroke the spherical valves instantly close and the dead-weight is suspended at that point; the pump-piston valves *t* then fall out solely by their own weight. At the down-stroke the equilibrium steam-valve *q* and the hydraulic valve *n* are opened simultaneously, the water escapes from beneath the plungers to the stand-pipes m^3 and reservoirs by the pipes m^2, and the steam from the small cylinder passes by the pipe *s* round to the upper side of the two steam-pistons, forming a steam equilibrium on each side of the smaller one and pressing against the annular piston, beneath which a constant vacuum is maintained.

Fig. 4036.



Steam Cylinder and Pistons of "Leeghwater."

The Leeghwater engine is furnished with five cylindrical boilers, each 30 feet long and 6 feet in diameter, with a central fire-tube 4 feet in diameter; a return flue passes under the boilers to the front and then splits along the sides. Over the boilers is a steam chamber 4 feet 6 inches in diameter and 42 feet long, from whence the steam is conducted by the pipe to the engine. The total steam space in the chamber, boilers, and pipes is nearly 1,520 cubic feet; this large volume effectually prevents primage, and secures a constant and uniform supply of steam to the engine

The power is 400 horse, net: the Cruquius and Van Lynden engines can be worked up to 500 horse-power if required.

The pair of pumps of the Chicago Water-Works have steam-cylinders of 44 inches diameter, 8 feet stroke. Water-pump 28 inches in diameter, double acting

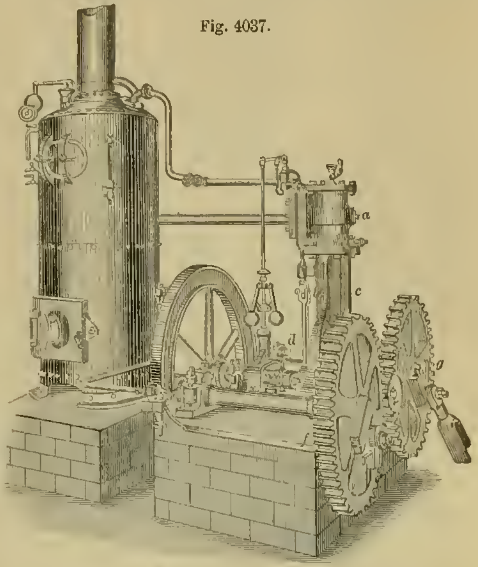
The Brooklyn pumping-engine cylinder is 85 inches diameter, 10 feet stroke: the bucket is 51½ inches in diameter

The Pittsburg engine is 64 inches diameter, 11 feet stroke. The plungers are 4 in number, of 100 tons each, driving water into the Highland reservoir, 356 feet above.

The Lehigh Zinc-Works engine is 110¼ inches, 10 feet stroke: estimated to raise 15,000 gallons per minute from a depth of 300 feet.

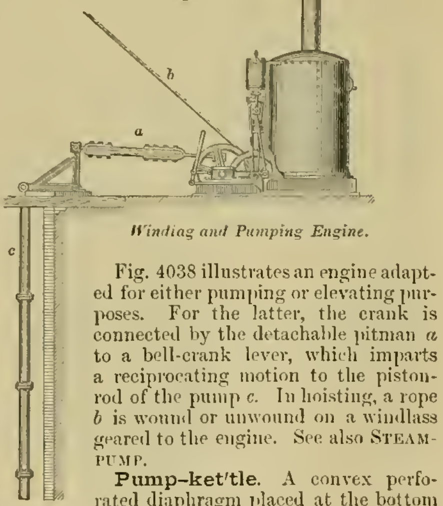
Fig. 4037 is a form of pumping-engine constructed at Leeds for the use of the state railways in India. *a* is the cylinder. The cross-head of the piston-rod reciprocates between the upright guides *b c*. The crank-shaft *d* carries on its outer end a pinion *e* gearing with the two wheels *f g*, to which the upper ends of the pump-pistons are connected by sliding forks in such a way that their stroke may be lengthened or shortened at pleasure.

Fig. 4037.



Steam Pumping-Engine, India State Railways.

Fig. 4038.



Winding and Pumping Engine.

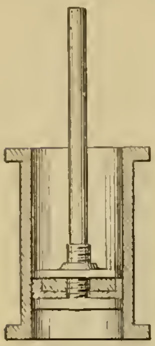
Fig. 4038 illustrates an engine adapted for either pumping or elevating purposes. For the latter, the crank is connected by the detachable pitman *a* to a bell-crank lever, which imparts a reciprocating motion to the piston-rod of the pump *c*. In hoisting, a rope *b* is wound or unwound on a windlass geared to the engine. See also STEAM-PUMP.

Pump-ket'tle. A convex perforated diaphragm placed at the bottom of a pump-tube to prevent the entrance of foreign matters. A *strainer.*

Pump-lamp. One having a pump employed for forcing up oil to the wick. Used in that class of lamps in which the reservoir is too distant to permit the oil to be drawn up by capillary attraction. It may be operated by hand or by clock-work mechanism, as in the Carcel lamp. See MECHANICAL LAMP.

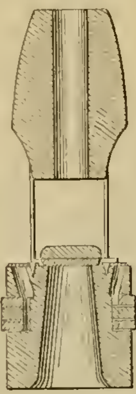
Pump-pis'ton. The reciprocating disk within a cylinder by which the fluid is expelled. The example is a *plunger*-piston having no opening through it. The leather which works against the cylinder is expanded by the sub-caliber rubber disk when compressed by screwing down the upper disk.

Fig. 4039.



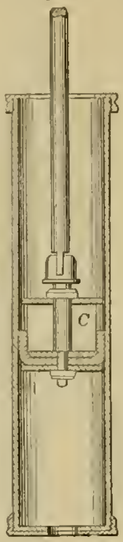
Pump-Piston.

Fig. 4040.



Pump-Bucket.

Fig. 4041.



Pump-Piston.

In Fig. 4041, the leathern cup receives its shape and expansion from an elastic cylinder *C*.

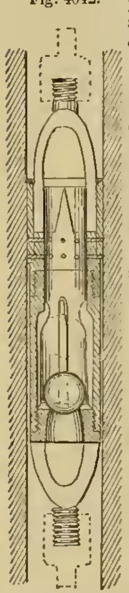
Fig. 4040 is a bucket. The expansible packing is composed of a ring of a soft substance, as leather or rubber, interposed between and protected by sectional rings of a hard substance, as metal or wood. The rings occupy a peripheral chamber of the piston and expand together.

Fig. 4042 is for deep wells. The packing is kept tight by the pressure of the water inside the same. The ribs constitute the cage of the valve, and permit the water to pass upward as the piston descends. See also Piston.

Pump-scrap′er. A round plate used for cleaning out the pump-barrel.

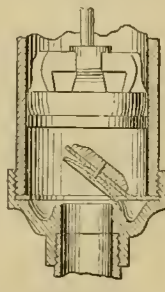
Pump-spear. The rod which is suspended from the end of the brake or handle and attached at its lower end to the bucket or "upper box."

Fig. 4042.



Pump-Bucket for Deep Wells.

Fig. 4043.



Pump-Valve.

Pump-staff. The pump-spear in a hand-pump.

Pump-valve. A hinged, oscillating, sliding, rotating, or lifting plate, lid, or ball in the barrel, the bucket, or both, to alternately open and close the apertures as the piston reciprocates.

The piston of a pump is a *bucket* when hollow, or a *plunger* when solid. In the former case it has a valve which opens as the bucket descends, and closes as it rises.

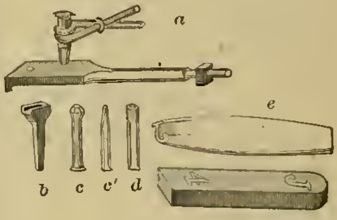
The lower valve of a pump is fixed in the pipe below the barrel, and rises as the bucket or plunger rises. See Pump-piston.

Pump-well. (*Shipwrighting.*) A compartment extending from the ship's bottom to the lower or the upper deck, as the case may be, to contain the pump-stocks, etc. The *bilge-water* collects in the *limbers*, and is discharged through a spout called the *pump-dale*.

Punch. 1. A tool operated by pressure or percussion, employed for making apertures, or in cutting out shapes from sheets or plates of various materials.

In Fig. 4044, *a* is the common blacksmiths' round punch; they are also made square or quadrangular. The stem is preferably of octagonal form, enabling it to be readily turned by the tongs or by a withe twisted around it, and it is struck on the head by a hammer. The point is formed by drawing down from a steel rod and tempering. In using punches of this kind the work is interposed between the punch and a hole in the anvil.

Fig. 4044.



Punches.

b is a *seam-set* for closing up the seams made in joining the edges of sheet-metals on the *hatchet-stake*.

c is a hollow, and *c′* a solid punch; the cutting edges of the former meet at an angle of about 50°; *d* is a *riveting-set* or punch for the heads of rivets. These are struck upon a thin plate of lead or solder placed on the *stake*, or upon the stake itself, without the leaden plate. See Bench-stake.

A punch for driving out a bolt is a *starting* or *teeming* punch.

Punches for cutting out the disks, called *planchets* or *blanks*, in coining, and those for making washers, are solid cylinders, accurately fitting a cylindrical hole in the bed on which the sheet of metal is laid for punching.

Punches for making wafers, lozenges, and other articles of similar shape cut from plastic material, are merely cylindrical tubes with a sharp cutting-edge.

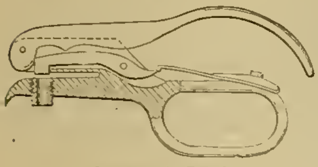
Punches for cutting out gun-wads are hollow for some distance upward from their face, and have a transverse opening above to allow the wads to be forced out by the pressure of those below as the work progresses.

Those for cutting out irregular forms are made in a similar way. They are employed for cutting paper, cloth, etc., and are generally used with a screw press.

A punch for cutting mortises in sheet-metal is made of uniform width, but the ends are cut into a series of steps, by which the length of the mortise is extended as the steps successively take out a small piece at both ends at every cut, thus entailing but little risk of breaking the punch or bulging the metal. This is used in combination with a bolster having an aperture corresponding to it in length and width, and may be employed for forming mortises of any length up to the extreme length of the upper step.

Punch-pliers, having a conical punch with a hollow cylindrical aperture, are used by saddlers for cutting holes in leather; such punches are sometimes made oval for making elongated holes; they usually cut against a piece of copper in the other jaw of the pliers.

Fig. 4045.



Conductor's Punch.

The conductor's or ticket-taker's punch is used for canceling checks, tickets, etc., on railroads, street-cars, at theaters, and other places. The punch proper may be of the shape of a cross, heart, star, diamond, crescent, circle, pentagon, etc., etc. One manufacturer has 74 varieties.

In Fig. 4045 the cutter is pivoted to one handle and operated by a lever of the second class upon the other handle. A plate pushes the card off the cutter when the pressure is withdrawn.

A punch is used for indenting rasps. It has a peculiarly shaped point, and for a fine cabinet rasp is about 3½ inches long and ⅝ inch square at its widest part. The point has 4 facets: viewed in front, it shows an angle of 60°; in profile, 50°. Different sized punches are used for rasps of varying sizes. The teeth are so arranged in the rows, that each is intermediate between two preceding ones.

2. (*Type-making.*) A steel die (*c*, Fig. 4044) having one of the letters of the alphabet cut on its face, employed for making the intaglio impression in the copper matrix from which a type is cast. It is formed by hammering down the hollows and filing up the edges of the letter while the metal is in a softened state. Great care must be taken to form the set of punches required for producing a font so that faces of the letters may be of equal hight and uniform thickness. The steel is hardened after the letter is formed. See TYPE-FOUNDING.

3. (*Die-sinking.*) A hardened piece of steel having the design of the coin projecting from its face (*cameo*), and used to make indented impressions in the faces of *dies* for coining. See PLUG; DIE; MATRIX.

4. (*Hydraulic Engineering.*) An extension piece on the end of a pile, when the latter is beyond the stroke of the *monkey*. A *dolly*.

5. (*Carpentry.*) *a.* Studding used to support a roof. *b.* A tool for driving nail-heads below the surface.

6. (*Mining.*) A timber balk to support the roof of a gallery.

7. A stone-mason's chipping-tool.

8. (*Dentistry.*) An instrument to extract stumps of teeth.

See under the following heads: —

Belt-punch.
Button-hole punch.
Conductor's punch.
Duplex-punch.
Eyelet-punch.
Gang-punch.
Hand punch.
Leather-punch.
Paper-punch.
Pinking-punch.
Pipe-slotting punch.
Punch and shears.
Punching-bear.
Punching-machine.
Rail-punch.
Rasp-punch.
Screw-punch.
Sheet-metal punch.
Spring-punch.
Staple-punch.
Wad-punch.

Punch′eon. 1. (*Carpentry.*) *a.* A short post; a *stud* or *quarter* to support a beam at an intermediate point between *principals*.

b. The small quarters of a partition over the head of a door.

c. A slab of split timber, with the face adzed or smoothed with an axe. Used for flooring or bridge boards where sawed boards are inaccessible.

2. (*Coopering.*) A cask containing 84 or 120 gallons; the quantity varying in different countries and trades.

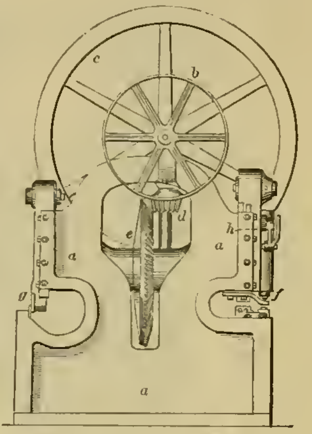
3. (*Stone-working.*) The punch of the marble-worker. An iron instrument with a sharp steel point. The *dog's-tooth* and *gradine* are marble-worker's punches.

4. A steel die, either in cameo or intaglio, with which impressions of objects or figures are stamped on metals and other substances, used in coining and other arts.

Punch′ing and Shear′ing Ma-chine′. (*Metal-working.*) A machine by which the operations of punching and shearing may be simultaneously effected. In that illustrated, the main frame *a a a* is made hollow; the pulley *b* is driven by belting, and is on the same shaft with the fly-wheel *c*.

Gears, one of which is shown at *d*, actuate the wheel *e* keyed on a shaft which operates two eccentrics, one actuating the punching slide *f*, and the other the shearing slide *g*, through the medium of connecting-rods. At *h* is a bar for lifting the punch without stopping the machine.

Fig. 4046.



Punching and Shearing Machine.

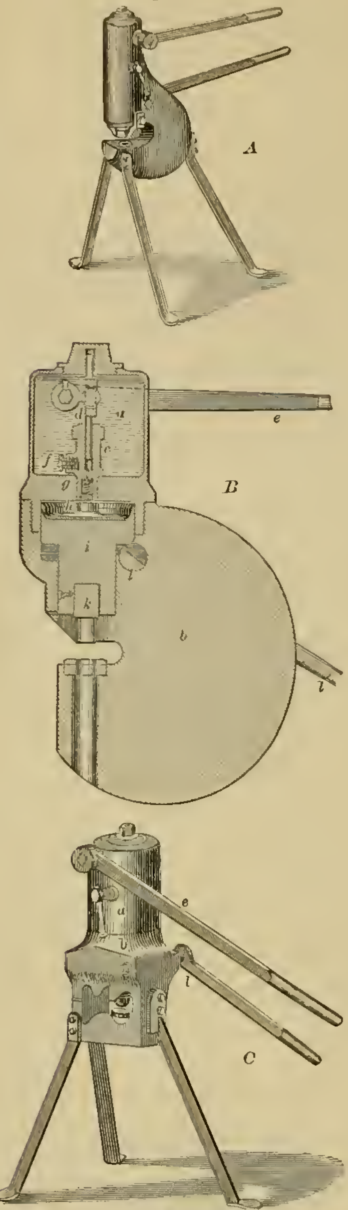
In the smallest machines of this kind the punching and shearing devices are on the same side. In the largest the driving-gear is somewhat differently arranged, but the operative mechanism is similar to the above.

Punch′ing-bear. A machine for making holes in sheet-metal, operated by simple lever power or by hydraulic pressure, after the manner of Bramah's press.

In Fig. 4047, *A* shows one of the latter kind, with an open mouth. *B* is a section on an enlarged scale. *a* is the cistern, screwed into the top of the solid iron block *b* and inclosing the pump *c*, which contains the plunger *d*, operated by the lever *e*; the upward movement of this lever causes water from the reservoir to enter the pump, passing through the wire-gauze covered inlet valve *f*, and its downward movement forces the water down past the spring-valve *g* into the chamber *h* over the head of the ram *i*, depressing the ram and punch *k* inserted therein. *l l* is a lever for raising the punch. *C* is a closed-mouth bear of similar internal construction, and is used for punching bolt-holes in railway rails for the reception of the bolts of fish-plates.

Punch′ing Buhl-work. Buhl-work is punched out by means of cutters inserted in the cavities of the upper one of two hinged plates, which are placed between the upper and lower beds of a press. The cutters may be made in any convenient number of pieces to form the pattern, so that if one be broken or injured it may be replaced by another. The inlay

Fig. 4047.



Hydraulic Punching-Bears.

and the piece into which it is inserted are successively cut out, each being perforated so as to perfectly correspond with the other. This process is well adapted for large works and where a large number of articles of the same pattern are to be made, but is not economical in other cases on account of the outlay required to produce the cutters.

Punch′ing-ma-chine′. The punching-machine is used for making the holes for rivets in boilers, tanks, flues, tubes, and other structures made of thick wrought-iron plates.

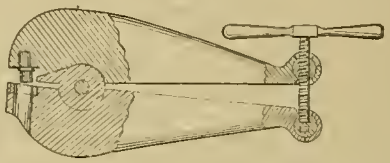
Its construction is necessarily of a strong and massive description, and as great force is to be exerted at short intervals, an equalizer must be provided, to avoid a shock or sudden diminution of velocity at each blow of the punch. This object is effected by means of a heavy fly-wheel, the momentum of which, while in motion, overcomes with comparative ease the resistance offered by the metal operated on, maintaining a nearly uniform speed and power.

In some machines of rather primitive construction, the punch is inserted in the shorter arm of a heavy lever, whose longer arm is raised by an eccentric on the fly-wheel shaft.

In more modern forms punching and shearing are generally effected by the same machine, the two operations being identical in principle; this result can be effected with but trifling modifications and additions to the appliances of the machine. See Punching and Shearing Machine; Punching-bear.

Fig. 4048 is a form in which the jaws are approached by a screw operating at the tail ends of the lever jaws.

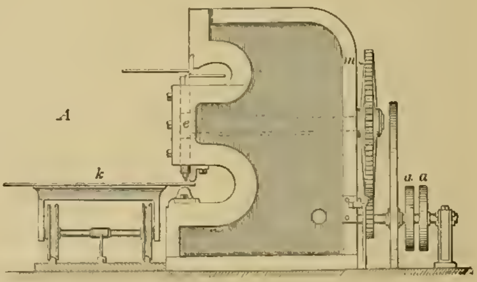
Fig. 4048.



Punching-Apparatus.

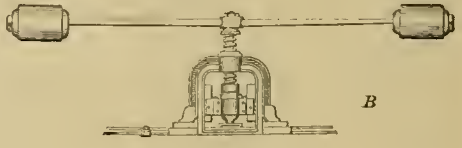
In the machine (*A*, Fig. 4049) for punching holes in boiler-plates, the plate is secured to the top of the movable table *k* by means of clamps, and the machine adjusted to the required distance between the rivet-holes. By the motion of the carriage, the plate is brought between the die and the punch; the latter is moved by an eccentric *e* on the axis of the main spur-wheel, which is moved by the pinion on the driving-shaft on which are the fast and loose pulleys *a a*. The carriage receives an intermittent impulse by means of a rock-bar which is set in mo-

Fig. 4049.



Punching Boiler-Plates.

Fig. 4050.



Screw-Punch.

tion by a stud *m* projecting from the rim of the large spur-wheel.

B is a screw-punch with an oscillating weighted lever from 9 to 11 feet long to rotate the screw, which acts upon the end of the punch. A circular flange on the end of the screw is engaged by a collar-box on the upper end of the punch, so as to retract the same in the backward movement. The punch has a square shank which moves in the guide-socket.

Plates or bars should be punched *from* the *faying-surface*, that is, from the surface which is to touch that of the piece to which it is to be riveted. This is because the hole has a different diameter at the other side of the plate; the enlargement is favorable to the hold of the rivet when the above rule is observed.

The following table gives some data derived from experiment as to the pressures required for punching plates of copper, brass, and iron: —

Diameter of Punch.	PRESSURES.			Thickness of Sheet.	PRESSURES. Circ. hole 1 in. diam.		IRON.	
	Brass, .05 inch thick.	Copper, .15 inch thick.	Iron, .105 inch thick.		Copper.	Brass.	Thickness.	Pressure. Circ'r hole 1 in. diam.
In.	Lbs	Lbs.	Lbs.	In.	Lbs.	Lbs.	In.	Lbs.
1.5	8,475	15,996	23,273	3	21,248	.....	.615	82,871
1.375	7,723	14,570	21,445	.205	15,542	.....	.565	76,962
1.25	6,980	13.275	19,682	.150	11,088	.....	.510	69,984
1.0	5,450	11,073	16,535	100	7,461	.....	.445	62,591
.9	5.092	9,788	14,778	....	......	.....	.404	57,623
.8	4,332	8,580	12,602	.050	3,646	.....	.358	51,382
.7	3.772	7,827	11,468	.045	3,362	5,448	.283	40,486
.6	3.267	6,706	9,772	.041	......	4,997	.245	35,712
.5	2,635	5,507	7,916	.034	2,538	3,730	.183	27,978
.4	2,183	4,585	6,660	032	2,212	3,540	.145	22,213
.3	1,673	3,435	4,970	.028	......	2,964	.104	16,533
.2	1,110	2,240	3,333	.022	1,544	2,448	.057	9,452

These amounts may vary somewhat according to the quality of the metals. A general rule for wrought-iron is that about 50.000 lbs. pressure is required for punching a circular hole 1 inch in diameter through a plate ¼ of an inch thick, and that this force varies in direct proportion to the area of the hole and the thickness of the metal. Thus, to punch a hole of ½ inch diameter through iron $\frac{1}{8}$ inch thick would require but ⅛ the above pressure.

Keir's punches for red-hot iron are made of chilled iron, whose temper does not draw, like steel. The punches are fixed in cast-iron sockets, from which they only project sufficiently to perforate the wheel-tires, in the formation of which they are used.

The diameter of the punch for thick plates should be about $\frac{3}{16}$ inch less than the die; for thinner plates ⅛, or even $\frac{1}{16}$, of an inch less. Upon the amount of this difference depends the degree of taper in the hole, for the side on which the punch enters will correspond with the size of the punch, while the lower portion of the piece forced out of the plate will correspond with the hole in the die, thus making a tapered hole. This peculiarity, if carefully attended to, may be made available to a useful end, by giving the rivet, when compressed into the hole, the form of a double cone; and great care should be taken to punch the hole from the inside, or the side next the plate to which it is to be riveted, that the taper in the hole may be in the direction favorable for the rivet.

Punch-pli′ers. One jaw of this tool has a hollow punch, and the other forms a flat die against which the punch operates. They are used by shoemakers, conductors on railroad and street cars, and generally for mutilating tickets to prevent their being used a second time.

Pun′gy. A small sloop or shallop or a large boat with sails.

Pun′jum. (*Fabric.*) A fine, heavy, unbleached cotton long-cloth made in India.

Pun′kah. A large broad fan suspended from the ceiling, or a number of such fans acting simultaneously and worked by an attendant.

It is common in India, being suspended over a table or bed or in any other apartment. It has a line attached to one end, which passes through the wall or door to an attendant on the porch outside. In some of the houses of the European residents and princes of India, the *punkah* is worked day and night, the servant shifting his attendance as the *sahib* moves from room to room, — from his study, dining-room, or bedroom.

The Nabob of Oude, some years since, when there was such a thing, imported a steam-engine from England to work the *punkahs* of his palace.

Punt. A small flat-bottomed boat, usually with square ends. It is not adapted for speed, but is used in ducking, or in calking or painting vessels afloat.

Pun′ty. (*Glass.*) A *ponty.* A glass-maker's iron rod, by which he manipulates the glass. *Pontil.*

Puoy. A spiked pole used in propelling a barge or boat.

One with a cap to prevent its sticking in the mud is called a *quant.*

Pu′pil, Ar′ti-fi′cial. (*Surgical.*) *a.* An opening made for the passage of rays of light by the removal of a portion of the iris. The operation is to obviate the effect of opacity of the lens, or adhesion or permanent contraction of the iris. The operation is *iridectomy.*

b. Artificial pupil is formed also by simply dislocating the natural pupil. The iris is drawn out through a small incision, and a piece of it tied off by fine *ligature;* the ligatured piece of iris *sloughs* off in a few days, and the pupil remains in its new position. *Irido-desis.*

c. The operation is also formed by dividing with scissors the iris by two incisions, diverging from each other, the loosened triangular-shaped flaps of iris being left to shrivel up.

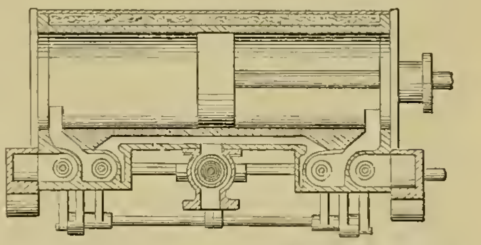
Pup′pet. 1. (*Turning.*) A standard rising vertically from the bed or shears of a lathe and holding the *centers* on which the work is placed to revolve. In the ordinary lathe the head-stock has also a mandrel and grooved wheel to which motion is imparted by a band. The *puppets* are also known as *head* and *tail stocks.*

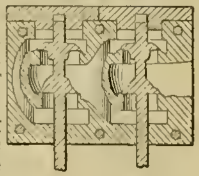
2. A disk-valve having a stem and vertical motion to and from its seat.

Pup′pet-head. Of a lathe or boring-machine. A sliding device on the upper part of the bed; it holds the back center, and may be fixed at any required distance from the front center.

Pup′pet-valve. A valve which moves vertically and is guided to and from its seat by a central vertical stem, coincident with the axis of the seat. In the example, the puppet-valves governing the supply and exhaust of steam to the cylinder are actuated by cams on a revolving shaft. The valve-stems are guided above in sockets in the top plates of the valve-chests, and by removing these plates the valves may be reached or removed.

Fig. 4051.





Puppet-Valves.

Pur′chase. A mechanical power to increase the power applied. The names are various: some indicate a difference in character, others merely in application. Among them are: *whip, whip-upon-whip, luff-tackle, luff-upon-luff, runner, double-runner, burton, jeer, viol, gun-tackle;* as well as *winch, gin,* *jack, derrick, crab, capstan, windlass,* etc. See HOISTING; BLOCK; TACKLE; PULLEY.

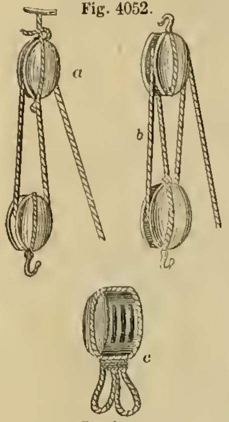
A *single purchase* is one in which a rope reeves through a single fixed block. It merely changes the direction of the rope. See WHIP.

A *double purchase* (*a*) or *double whip* is made by reeving a rope through a single block, then through another single block, and making the end fast to the one it was first rove through.

When used as a *gun-tackle purchase*, the *standing-block a* is made fast to a ring-bolt on the cheek of the gun-port, and the hook of the *running-block* is connected to an eye on one of the cheeks of the gun-carriage. By the *purchase* the gun is run out, and by similar means is run in when required.

The *threefold* or *luff-tackle purchase* (*b*) is composed of double and single blocks, and is used for many purposes on board ship.

Fig. 4052.



Purchases.

A luff-tackle applied to the fall of another luff-tackle is called *luff-upon-luff*.

Pur'chase-block. (*Nautical.*) A double-strapped block (*c*) having two scores in the shell for that purpose; the strap is wormed, parceled, served, and spliced together. It is then doubled so as to bring the splice at the bottom of the block.

Pur'dah. (*Fabric.*) An Indian blue and white striped cotton cloth.

Pure. (*Leather Manufacture.*) The *bating*-bath, consisting of a solution of dogs' and birds' dung, used to counteract the action of the lime used in unhairing.

Pur'ger-y. (*Sugar.*) The portion of a sugar-house where the sugar from the coolers is placed in hogsheads or in cones, and allowed to drain off its molasses or imperfectly crystallized cane-juice. It is generally one of the wings of the plantation sugar-house, in the bottom of which, in place of a floor, is a hydraulic cement cistern about four feet deep. Over this cistern are laid strong timbers, on which the hogsheads or cones rest while they are being filled from the coolers. At the bottom of the hogsheads are holes through which the molasses drains into the cistern.

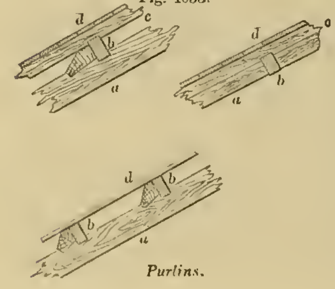
Purg'ing-cock. (*Steam.*) The mud-cock or discharge-valve of a steam-boiler.

Purl. A gold or silver wire, formed into a spiral, used in lace work.

Pur'lin. (*Carpentry.*) A horizontal timber resting on a *principal rafter*, or a *purlin-post*, which is stepped into the *tie-beam*, and helps support the *rafters* of the roof. (See KING-POST TRUSS.) In the cut: —

a, principal rafter.
b, purlin.
c, common rafter.
d, sheathing or slate-boarding.

Fig. 4053.



Purlins.

Purlins are also known as *side-timbers* or *side-wavers*.

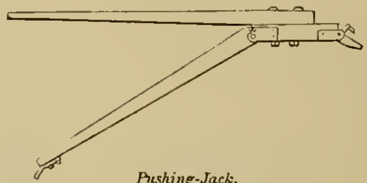
Pur'lin-post. A strut supporting a *purlin*, which is a longitudinal plate beneath the rafters, to prevent their sagging.

Push'er. A form of *bobbin-net machine*, so called from having independent *pushers* to propel the bobbins and carriages from front to back, instead of pulling or hooking them, as in other arrangements.

Push-hole. (*Glass-making.*) A hole in the flattening-furnace for annealing and flattening plate-glass.

Push'ing-jack. One for moving a railway-car or other object through a small distance. The example is a toggle bar; one end is placed against a tie, and the upper end against the car, and the latter moved by depression of the lever.

Fig. 4054.

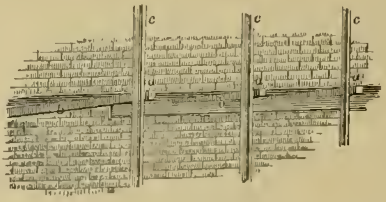


Pushing-Jack.

Put'logs. The transverse pieces *a a* in a scaffolding which rest in holes in the wall at one end, and on the *ledgers b* at the other end. The ledgers are fastened or lashed to the scaffold poles.

The holes for the *putlogs* are yet visible in the Pont du Garde erected by the Romans in Gaul. They are called *columbaria* by Vitruvius, from their resemblance to nests in dovecots.

Fig. 4055.



Putlogs.

Put'tock-shrouds. (*Nautical.*) The short shrouds which lead from the lower shrouds to the top. See FUTTOCK-SHROUDS.

Put'ty. 1. (*Glazing.*) A composition of pounded whiting and linseed-oil, beaten up into a tough, tenacious cement.

It is used for securing window-panes in sash, in stopping (*badigeon*) crevices in wood-work which is to be painted, and for various other work for which its present plasticity and future hardness adapt it. Some trades employ glue-putty, in which hot melted glue is substituted for the oil.

2. (*Plastering.*) A fine mortar, nearly all lime, used in stopping crevices of shrinkage.

Put'ty-knife. A knife with a short lanceolate blade, used for spreading putty.

It is sometimes called a *stopping*-knife.

The knife used by glaziers for removing old putty has a single edge, a stout back, and a nearly square end. It is driven by a hammer, and is called a *hacking-out* knife.

Put'ty-pow'der. An oxide of tin, or of tin and lead mixed in various proportions, used as polishing powder by opticians and lapidaries.

It is prepared by oxidizing the metal in a closed iron box having a perforation in front, which is surrounded by the fire and maintained at a red heat, the metal being constantly stirred to expose all portions of it to the air; when entirely oxidized it is removed from the box, the lumps of oxide are selected from the mass and ground, the powder being afterward sifted. The whitest powder, if heavy, is the purest. Inferior kinds are brown or yellow; others, having a small quantity of ivory-black intermixed, are known as *gray putty*. Pure white putty, used by marble-workers, opticians, etc., is the smoothest and most cutting: it should consist of oxide of lead alone; but to lessen the difficulty of manufacture, a little lead (the linings of tea-chests) or of an alloy called *schruff* (prepared by the pewterers) is added to assist oxidation.

Putty-powder of fair commercial quality is prepared from equal parts of tin and lead. A common dark-colored powder is prepared from lead alone, but is much inferior in quality.

Putty-powder for fine optical uses may be prepared by dissolving tin in nitro-muriatic acid, filtering the solution, and precipitating the peroxide thus formed with liquid ammonia; the precipitate is washed with water, collected on a cloth filter, dried and pressed so as to form a lump, which is broken into pieces and, after farther drying, levigated on a glass plate with an iron spatula, and subjected in a crucible to a low white heat. The powder is then washed or elutriated to remove the coarser particles. This process is due to Mr. Ross.

Puz′zle. A contrivance for affording amusement and exercising the ingenuity by taking apart a set of connected devices, combining a number of separate pieces so as to produce one or more figures, finding the mode of entry in or egress from a space inclosed by a complicated series of lines, etc., etc. Sometimes the puzzle consists of a miniature ship or other device inclosed within an object which has no opening of sufficient size to admit the passage of the inclosure. Of this class are the Chinese puzzles, consisting of a series of balls one within the other, and all apparently carved out of a single piece.

The familiar toy, "puzzle-rings," sold in the stores and on railroad-cars, — in which the ingenuity consists in getting the rings on and off a link, — engaged the pen and attention of Cardan in the sixteenth century; and the celebrated mathematician and philosopher, Dr. Wallis, has given a clear and elaborate description of the same instrument in the second volume of his works, under the title of "Complicati Annuli," or puzzling-rings.

Puz′zle-lock. A lock of the letter or dial kind, which can only be opened when a hand is caused to point to a certain figure or figures on one or more dials, or particular letters, out of a number engraved on a series of rings, are brought into a certain position with respect to one another. The puzzle consists in finding the proper combination, which can only be done, if at all, by one unacquainted with the secret, after repeated trials. A *letter-lock*.

Puz′zo-la′no; Puoz′zo-la′no. See Pozzuolana.

Pyc′no-style. (*Architecture.*) Having the distance between the columns $1\frac{1}{2}$ times their diameter.

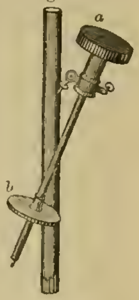
Pyr-he′li-om′e-ter. An instrument invented by Pouillet for measuring the amount of heat radiated from the sun.

It consists of a shallow cylinder *a* of very thin copper or silver on a stem, provided with means of attachment to a stationary object, and carrying a disk *b* on which the shadow of *a* may be received, so that it may be pointed directly toward the sun.

The cylinder is blackened in order to absorb all the heat possible, and is filled with water in which the bulb of a thermometer is placed. The instrument, at the atmospheric temperature, is first shaded from the sun, but exposed to the sky for five minutes, and, the difference of temperature noted, the shading screen is then withdrawn, and the cylinder exposed to the direct action of the sun's rays for five minutes, and the temperature noted, when it is again shaded for five minutes, and the fall of the thermometer observed.

The formula $T + \frac{\theta + \theta'}{2}$ indicates the amount of heat received from the sun; θ being the difference of temperature due to exposure to the clear sky, T the increase on exposure to the sun, and θ' the fall in five minutes after being again shaded. To obtain the amount of heat actually radiated by the sun, that absorbed by the atmosphere must be added. This is roughly determined by observations when the sun is at different altitudes, so that his rays have to traverse different thicknesses of air. An *actinometer*.

Fig. 4056.



Pyrheliometer.

Py-rog′ra-phy. A mode of printing by a system of heated metallic cylinders, which burn into the wood any design required. A mode of Carving (see page 492).

Py-rom′e-ter. "Fire-measurer." An instrument for indicating temperatures above the boiling-point of mercury, 660° Fah. It was first employed by Muschenbroek in the form of a simple metallic bar, about 1730.

The first which ever came into extensive use was that of Wedgwood, about 1780; it was devised and used by him for testing the heat of his pottery and porcelain kilns.

No fewer than eleven different modes have been proposed or actually employed for measuring high temperatures.

1. By contraction, as in Wedgwood's.
2. " expansion.
3. " change of pressure in confined gases.
4. " the amount of heat imparted to a cold mass.
5. " fusing-point of solids.
6. " conduction and radiation of heat.
7. " color, as red and white heat.
8. " change in velocity of sound.
9. " resolution of chemical compounds.
10. " generation of electricity.
11. " change in resistance to electricity.

Of these methods the first was formerly extensively used, but is now generally conceded to be unreliable. The second has been considerably employed, but presents difficulties in its applications to practical use, especially where great delicacy is required. The third is reliable in those cases where it can be practically applied, but its principal use is as a standard of comparison for pyrometers constructed on other principles. The fourth, on account of the care and skill necessary to attain a correct result, is not generally available. The fifth is only available within certain limits. The sixth does not give satisfactory results. The seventh, though of great importance as indicating the proper heat for working and tempering metals, gives but a rude approximation to their actual temperature. The eighth, depending on the change of pitch in musical tones, is obviously not calculated for general use. The ninth and tenth methods are, in the present state of science, practically unavailable for common use. The eleventh, adopted by Siemens, appears better than any other to fulfill the conditions required in practice; his instrument is described farther on.

1. Wedgwood's pyrometer was of the first class. Its operation depends on the property of clay to contract on exposure to heat. The apparatus is very simple, consisting of a gage, by which the dimensions of the clay, made into small cylinders, are measured before and after its subjection to heat. The indications of the instrument are found to be very unreliable, owing, among other causes, to the fact that clay may contract when subjected to a comparatively moderate heat for a long time as much as when exposed to more intense heat of shorter duration.

2. The pyrometer *A* (Fig. 4058) is of the second class. One end of the bar is fixed in the post, and the other end is free to

move as the rod is expanded by the heat of the burning alcohol below it, the degree of expansion being marked by the pointer on the quadrant-index. Bars of different metals, but of the same size, being exposed for the same length of time to the flames, their relative increase of length under a given degree of heat is determined.

The mercurial thermometer has been used for temperatures up to 780° Fah , by filling the tube above the column with air under a pressure of four atmospheres.

Daniel's pyrometer has a platinum bar inclosed in a black-lead tube, closed at the bottom. When exposed to heat, the platinum expands more than the inclosing cell, and projecting upward moves a lever, which drives forward an index upon a graduated arc.

Achard proposed using a ball and tube of semi-transparent porcelain, highly baked, containing a fusible alloy of bismuth, 1; lead, 1; tin, 1. In the temperature of the air this remains solid in the tube, but becomes fluid about 212° Fah. Its expansion by increment of heat is visible within the graduated tube, and the temperature is thereby indicated.

Bréguet's pyrometer consists of two thin strips of gold and platinum or silver and platinum soldered together, the compound strip being bent into a helix for portability and concentration. The upper end is fixed, and to the lower end is attached a horizontal index. Change of temperature in the surrounding air changes the length of one side of the compound strip more than the other, and the helix twists or untwists through an angle very nearly proportional to the change of temperature. This is on the principle of the compensation-balance.

The pyrometers generally employed in England are sticks of lead or zinc. These are only available up to temperatures approaching the fusing points of those metals.

Gauntlett's pyrometer has a stem composed of tubes of refractory clay, inclosed in an iron stem 3 feet long This is employed for temperatures of 1000° to 1200° Fah. A brass stem 4 feet long, inclosing an iron rod, is used for temperatures below 800° Fah. In either, the degree of heat is indicated by the difference of the expansions of the two materials, the rate of which is known. Gauntlett's can only be depended on up to about 850°, as above this the copper rod employed does not contract to its original length on cooling. Krauss's, which depends on the expansion and contraction of a palladium spring, can only be trusted up to about 100°.

The pyrometer for ascertaining the temperature in the flues of boilers consists of an iron rod fixed at the back of the flue, and connecting at front to a lever whose oscillations indicate the expansion and contraction of the rod by heat.

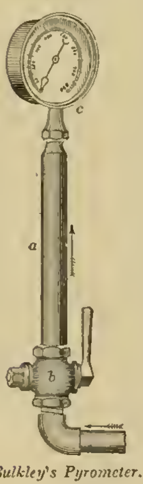
Bulkley's blast-furnace pyrometer (Fig. 4057) has an upright tube *a* with perforations near its upper end, connected with the blast-pipe of the furnace, and provided with a valve *b*. A copper expansion-rod is inclosed within the tube and connected with the index of a dial *c*. On opening the valve the hot air from the blast-pipe enters the tube *a* and escapes through the perforations, expanding the copper rod, which indicates the temperature on the dial.

The valve is opened only when it is desired to ascertain the temperature, saving the expansion-rod from the distortion occasioned by constant exposure to heat, which soon affects the correctness of its indications.

3. M. Lamy devised a means of ascertaining the temperature of furnaces up to red heat by measuring the tension of carbonic-acid gas developed from marble when heated; it has an indicating apparatus which may be placed at a distance from the meter, so that those from a number of kilns or furnaces may be brought together directly under the eye of the superintendent. This instrument is of the third class.

4. In Siemens's instrument of the fourth class the temperature is inferred from the heat imparted to a pint of water inclosed in a copper vessel, by a ball of copper or iron weighing $\frac{1}{50}$ part as much as the water; this should raise the temperature of the water 1° for every 50° of heat in the ball.

Fig 4057.



Bulkley's Pyrometer.

5. See Alloys.

6. Depends upon observations with thermometers of moderate range, at relative distances. See Pyroscope.

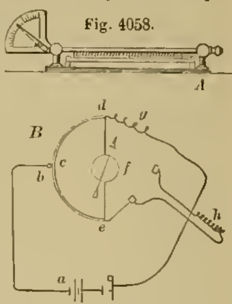
7. The workman's test by observation.

8, 9. Laboratory tests.

10. Becquerel devised a thermo-electric pyrometer of the tenth class, consisting of two wires of platinum and palladium of equal length connected together at one end, their other ends being connected to the binding screws of a galvanometer. The palladium tube is passed through a tube of porcelain, and this, with the platinum wire, is introduced into a larger porcelain tube, which is exposed to the heat of the furnace. A scale of temperatures corresponding to the intensities of the electric currents developed was constructed by comparison with an air pyrometer, each division of the scale corresponding to 10° Centigrade.

11. Siemens invented a pyrometer of the eleventh class, depending on the increased resistance offered by an iron or platinum wire to the passage of electricity. This may be adapted to measuring either high or low temperatures, and was used by Dr. Carpenter for ascertaining the temperature at great depths in the Atlantic Ocean. That for high temperatures (*B*, Fig. 4058) consists of a coil of fine platinum wire, about 3 yards in length, wound around the circumference of a grooved clay cylinder. The ends of the coil are connected with two thicker platinum wires, which are in turn connected with copper conducting-wires; the whole are protected by clay pipes and inclosed in an iron tube. The end at which is the platinum spiral is closed, and the other end is provided with a wooden cap containing two contact screws connected with the battery wires, thus including the spiral in the circuit.

Fig. 4058.



Pyrometers.

For temperatures above the melting-point of iron, this end of the tube is made of platinum; and a part between the spiral and outer end of the tube is made much thicker than the rest, in order to prevent too rapid cooling, which would impair the accuracy of the indications.

When the closed end is pushed into a furnace, the coil becomes heated, and its conductivity is diminished. The amount of diminution is measured by a galvanometer in the following manner. The current from the zinc-pole *a* of the battery goes to the movable contact-wheel *b*, which may be adjusted to any part of the platinum arc *c* on the edge of a disk of ebonite. When the wheel is in the position represented, the current is divided, one part passing to *d*, and the other to *e*; midway between these points the galvanometer *f* is fixed; from the two ends of the platinum wire the current on one side passes into the constant resistance *g* and into the galvanometer; on the other side it passes into the other terminal of the galvanometer, and at the same time into one of the leading wires of the spiral *h*. The currents passing respectively through the spiral and the resistance meet at a given point in their passage to the other pole of the battery.

So long as the electric forces at *d* and *e* are equal, the galvanometer needle remains at rest, but when their relations are disturbed, the needle is deflected: the balance may, however, be restored, and the needle brought back to zero by the movement of the wheel *b*, the position of which, on the arc *c*, indicates the degree of heat.

For reading, the astatic galvanometer needle is brought to zero of its scale; on pressing the contact key *k*, the circuit is closed, deflecting the needle; the wheel *b* is then moved until the needle is again brought back to zero and the reading on the arc noted.

Many of these instruments register up to 1000° Centigrade (2218 Fah), and they are sometimes constructed to indicate double this temperature.

Pyr′o-phone. A musical instrument, invented by M. Kastner, in which the various notes are produced by the burning of hydrogen gas within glass tubes of various sizes and lengths. Its principle depends on the fact that if two or more separate flames are placed at a distance from the base of the tube equal to one third its hight, uniform vibrations will be produced, which cease when the flames are brought together. These results are effected by attaching to the pipes conveying the gas collars connected to rods operated by a series of keys arranged like those of an organ, by which the flames, normally in contact, are separated when it is desired to emit a note.

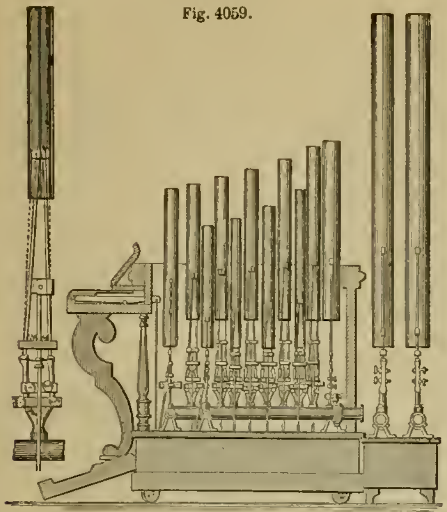
Py-roph′o-rus. Mechanically considered, an apparatus for kindling fire. See also Electrophorus.

Chemically considered, a substance which takes fire when exposed to the air.

Homberg's pyrophorus depends upon the heat spontaneously developed by the association of alum, sugar, and flour.

Brande recommends a mixture of equal parts of alum and brown sugar stirred over a fire in an iron ladle till quite dry. It is then put into an earthen or coated glass bottle, and heated red-hot so long as a flame appears at the mouth. It is then removed, carefully stopped, and allowed to cool. The

Fig. 4059.



Pyrophone.

black powder which it contains becomes glowing hot when exposed to air. The experiment succeeds best in a damp state of the air, and may be accelerated by breathing upon the powder.

Two other recipes are given by Brande: —

Mix 3 parts of lampblack, 8 parts of carbonate of potassa, 4 parts of dried alum. Calcine as before.

Or, 27 parts of sulphate of potassa, 15 parts of calcined lampblack. Heat to redness in a crucible, and keep in a stoppered bottle.

Or, heat tartrate of lead red-hot in a glass tube and seal hermetically. Break the tube and shake out the powder, which inflames spontaneously by contact with the air.

See Cooley's "Cyclopædia," page 1084.

A pyrophorus for cigars is described as follows: Neutral sulphate of iron is treated with diluted nitric acid and precipitated; the resulting oxide is reduced by heat in a tube through which a current of hydrogen is passed. This is combined with a sulphide of aluminium and potassium and a small amount of carbon. A portion of this is placed on the end of a cigar, the breath is inhaled, and by the affinity of certain particles of the composition for oxygen the iron is heated and the cigar lighted.

Pyr′o-pho-tog′ra-phy. A term including those processes in the photographic art in which the heat of a furnace is used to fix the picture. Enamel photography.

The picture copied must be on some transparent substance, or, if on paper, must be made transparent by the application of oil. The glass plate is covered with a coating of a certain gummy compound, which becomes hard under the action of light. The impression, when taken, is brought out by the application of a flux, and by heating the plate to a white heat is made permanent.

Pyr′o-scope. An instrument, invented by Leslie, to measure the intensity of heat radiating from a hot body or the frigorific influence of a cold body. The instrument is like a differential thermometer, one ball being covered with thick silver-leaf; the other ball is naked and forms the pyroscope.

Pyr′o-ster′e-o-type. A process in which a block of wood is prepared as a matrix for a fusible metal by burning away portions of its surface. The burning-tool is a delicate blade heated by a jet of flame, and is thrust down into the wood, making an incision of a given depth. A cast is then taken in type-metal; the lines being salient afford a printing surface.

Pyr′o-tech′nics. Preparations of inflammable material are used in making cascades of fire or explosions for signals or as expressions of rejoicing.

Fire-works are of Oriental origin. The Chinese and Japanese still excel in their production. The "Yokohama Herald" describes the effects produced at an exhibition of Japanese daylight fire-works These consisted principally of bombs which, exploding high in the air, discharged variously colored jets of smoke, and sometimes large parachutes which assumed the figures of fishes, snakes, or birds, which hovered kite-like and motionless in the air for an incredibly long time. Occasionally they took the shape of cottages, temples, human beings, trees, and flowers, and various other forms. The smoke figures were, however, the most amusing. One of those most frequently attempted was a cuttle-fish, with a body of thick black smoke, and arms of lighter hues. Though the smoke was soon dissipated by the wind, the resemblance for a few moments was very striking.

Our artificers do not possess the secret of making fire-works such as these, their efforts being confined to the production of variously colored fires for exhibition at night. The basis for nearly all pyrotechnic compositions consists of niter, sulphur, and charcoal in varied proportions pulverized and mixed with some material which imparts color to the flame. The nitrate of strontia produces a red light; nitrate of soda, yellow; sulphate of copper, blue; nitrate of baryta, green. Steel, iron, copper, and zinc filings are used for producing brilliant sparks of various colors.

Besides these, numerous other substances are used for producing different tints, most of which may be found in works on pyrotechny, though many artists in this line claim to have secret compounds or processes for producing peculiarly brilliant flames. The compositions are formed into small pieces called stars, for insertion in rockets and bombs, or are driven into paper cases which are attached to light frameworks of wood or bamboo for stationary fire-works. See under the following heads:

Automatic fire.
Bengal-light
Blazing-comet.
Blue-light.
Brilliant.
Carcass.
Cascade.
Catherine-wheel.
Chinese fire.
Colored fire.
Congreve-rocket.
Cracker
Detonating-powder.
Fire-ball.
Fixed star.
Fixed sun.
Fulminating-powder.
Fuse.
Gold-rain.
Greek fire.
Incendiary compound.
Incendiary shell.
Lance.
Leader.
Light-ball
Marroo.
Match.
Mosaic.
Palm-tree.
Pitched fascine.
Portfire.
Quick-match.
Revolving sun.
Rocket.
Rock-fire.
Roman candle.
Serpent.
Shell.
Shower.
Signal-rocket.
Silver-rain.
Slow-match.
Squib.
Star.
Stink-ball.
Sun-case.
Tarred link.
Tourbillon.
Wheel-case.

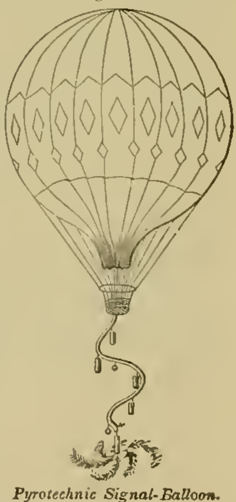
Pyr′o-tech′nic Bal-loon′. One for carrying aloft pyrotechnic signals.

Py-rox′y-line. From πυρός (fire) and ξύλον (wood). Gun-cotton. An explosive obtained by immersing vegetable fiber in nitric and sulphuric acids and subsequent drying. Invented by Schonbein, 1846. See Gun-cotton.

Gun-cotton dissolved in ether or chloroform forms *collodion*, and when this is evaporated a horny material is the result. This is used for many purposes and in various combinations, as a scale to protect objects, in combination with gums, resins, vegetable fiber, bone-dust, asbestus, etc.

It is used as a substitute for hard rubber, as an artificial horn or ivory, a composition for knife and tool handles, for dental plates, veneers, buttons; liquid, as a varnish or size.

Fig. 4060.



Pyrotechnic Signal-Balloon.

Hyatt's process for obviating the difficulties attending the production of articles made of pyroxyline by pressing in porous molds consists in subjecting the articles to pressure in close vessels for a certain length of time; compressed air is preferred as the medium for effecting the pressure, on account of economy and the rapidity with which it removes the solvent. The article, after being molded or coated with the compound, is placed in a receiver and subjected to a pressure of twelve atmospheres; a greater pressure may, however, be employed without injuring the material. The receiver has an aperture for removing the vapor-charged air; the time occupied in absorbing the moisture from the material depends on the amount of air passed through the receiver; usually it is ready for removal to the drying-chamber in about 36 hours.

In the process of Deitz and Wayne, ramie fiber is employed; this is treated in a manner similar to cotton.

A smaller quantity of solvent is required for making collodion from this fiber than from cotton, the proportions being about 3 pounds of ether and 12 fluid ounces of alcohol to each pound of prepared ramie. By the addition of 2 to 10 per cent of gum sandarach (dissolved) and 15 per cent of castor oil, the compound is rendered more elastic and less subject to shrinkage in drying. The substances are thoroughly incorporated by grinding, colored with any suitable pigment, if desired, and evaporated to proper consistency for molding.

Pierson combines with mineral and vegetable substances; uses for moldings. He also uses it to render woven goods air and water tight.

English patent 536 of 1868 makes dental plates by combining with shellac; grinding, moistening with solvent, and molding by pressure.

McClelland, 1869, also makes dental plates.

Streeter, 1869, applies it as a veneer to dental plates; molds by heat and pressure.

Hunt, 1874; Newton, 1872; Pursell, 1872; Troutman, 1871, refer to the use of pyroxyline with dental plates, for attaching teeth.

Hill, 1869, combines with coloring-matter and asbestus; covers layers of cotton, felt, woolen, wire gauze, etc.

McClelland, 1868, adds gum-copal, coloring-matter, and phosphate of ammonia. Dry by gentle heat, pulverize.

Seeley, 1868, adds nitro-glucose to gun-cotton in solution.

Hyatt, 1869, adds ivory-dust, bone-dust, paper, flock, or asbestus. Heat, press, and evaporate solvent.

Spill, 1869, protects insulated telegraph-wires. Uses a compound of xyloidine, oil-camphor, gutta-percha, and pigments.

Hyatt, July 12, 1870, grinds pyroxyline into a pulp, mixes it with finely comminuted gum-camphor, dissolves the components by heat, and continues the pressure upon the mold until the contents are cooled.

McClelland, July 22, 1870; a mode of coating articles with collodion compounds by molding it upon them in flasks or shells.

Hyatt and Hyatt, March 28, 1871, describe the making dental plates of pyroxyline dissolved in camphor (celluloid) by means of heat, and then molded to form while in a plastic state.

Brockway, April 18, 1871 (No. 113,735), is for compressing, straining, and molding plastic pyroxyline. No. 113,736 is for a dental plate of pyroxyline, made by first forming the sheet by molding it, then boarding, pressing, and shrinking it.

Winsborough, April 25, 1871, bleaches pyroxyline by chlorine, to render it transparent. He also introduces camphorated pyroxyline into the molds, and then expels the camphor or other solvent by heat or chemical means.

Hyatt, May 16, 1871, describes a mode of holding centrally in a mold articles to be coated

Troutman, October 17, 1871, describes a mode of attaching artificial teeth to the base by solid pieces of the same material as the base.

Hyatt and Hyatt, December 5, 1871, describe and exhibit an apparatus for molding dental plates, consisting of a flask press and an oil bath, heated by a lamp.

Newton, April 23, 1872, describes a mode of attaching pyroxyline backing to artificial teeth, by softening, shaping, and puncturing the backing, and then pressing it upon the pins of the teeth.

Pursell, May 7, 1872, describes a flask, clamping-attachment, and case, forming an apparatus for attaching artificial teeth to the pyroxyline base.

Hyatt and Hyatt, November 19, 1872, describe process and apparatus for manufacturing celluloid. The mixture of pyroxyline and gum-camphor is pressed into cakes and then pressed in a pile with alternating layers of paper. The combined materials are pressed by a plunger in a heated cylinder, dissolved, and discharged at a nozzle in a continuous rod or sheet.

Jones, March 11, 1873, makes truss-pads of pyroxyline.

Hyatt, April 29, 1873, has a means of subjecting newly coated articles to pressure, which absorbs the solvent, but does not allow expansion of the coating or formation of air-cells.

McClelland, October 21, 1873, describes modes of removing the solvents from xyloidine and pyroxyline compounds.

Smith, May 12, 1874, makes an artificial coral.

Hyatt and Hyatt, October 27, 1874 (No. 156,352) dissolve the pyroxyline in camphor and alcohol, which remains latent till heat is applied; (No. 156,353) apply mastication previous to heating and converting; (No. 156,354) make factitious ivory by combining ivory or bone-dust, pyroxyline, powdered camphor, and nitric ether.

When gun-cotton or pyroxyline is heated with powdered gum-camphor it is dissolved, and this material, under the name of *celluloid*, is extensively used as a substitute for hard rubber for combs, billiard-balls, dominos, knife-handles, dental plates, truss-pads, coating metallic articles, and for the manufacture of imitation coral, ivory, tortoise-shell, horn, and the like.

See the following United States patents: —

65,267.	Pierson	1867.	105,338.	Hyatt	1870.
79,261.	Seely	1868.	105,823.	McClelland	1870.
77,304.	McClelland	1868.	113,055.	Hyatt *et al.*	1871.
90,765.	McClelland	1869.	114,945.	Hyatt	1871.
90,766.	McClelland	1869.	121,522.	Hyatt	1871.
96,132.	McClelland	1869.	113,272.	Dietz *et al.*	1871.
3,777.	McClelland	1869.	114,242.	Winsborough	1871.
3,778.	McClelland	1869.	120,130.	Troutman	1871.
88,228.	Streeter	1869.	113,735.	Brockway	1871.
88,229.	Streeter	1869.	113,736.	Brockway	1871.
88,260.	Streeter	1869.	125,979.	Newton	1872.
89,253.	Streeter	1869.	126,575.	Pursell	1872.
89,254.	Streeter	1869.	133,229.	Hyatt	1872.
93,086.	Hill	1869.	133,969.	Dietz *et al.*	1872.
88,633.	Hyatt	1869.	138,254.	Hyatt	1873.
88,634.	Hyatt	1869.	143,772.	McClelland	1873.
89,582.	Hyatt & Blake	1869.	136,735.	Jones	1873.
91,341.	Hyatt & Blake	1869.	150,722.	Smith	1874.
91,377.	Spill	1869.	156,352.	Hyatt	1874.
91,378.	Spill	1869.	156,353.	Hyatt	1874.
97,454.	Spill	1869.	156,354.	Hyatt	1874.
91,393.	Whitehouse	1869.	153,196.	Hunt	1874.

English patents: —

2,359	of 1855.	2,666	of 1867.
653	of 1857.	536	of 1868.
2,740	of 1859.	3,984	of 1868.
2,249	of 1860.	3,102	of 1869.
1,129	of 1867.		

Pyx. A box. The word is derived from the Latin *pyxis*. The Greek word is similar. The box-tree (Latin, *buxus*) was then, as now, a favorite material for boxes of superior quality, as is evidenced by the common derivation of the name of the thing, and of the material of which it is made. The pyxis of the Greeks and Latins was a jewel-box, and when the great fusion of the two systems took place under Constantine the pyxis became a reliquary.

While the word *box* has with us a generic signification, the older form of the word *pyxis*, shortened to *pyx*, has certain specific meanings: —

1. The box in which the sacramental host is kept in the order of the Roman Church.

2. The box in which sample coins are placed in the English mint. A triannual test by assay for purity is held, and is termed the *trial of the pyx*. Two pieces are taken from each bag of newly coined money, — one for trial in the mint, the other deposited in the *pyx*. The Lord Chancellor summons a jury of goldsmiths, who test by weight and assay in comparison with certain standard *trial-plates* deposited in the Exchequer.

3. The binnacle-box in which a compass is suspended.

4. The *acetabulum* which receives the trochanter at the head of the femur.

Q.

Quad'rant. 1. An instrument for making angular measurements. So called from its embracing an arc of 90° or somewhat more. Formerly much employed in making astronomical observations. When fixed to a wall it was called a *mural quadrant;* this is now superseded by the *mural circle.* See MURAL CIRCLE; MURAL QUADRANT.

The quadrant appears to have been used for solar observations about 290 B. C.; and we learn that the Arabian astronomers, about 995 A. D., had a quadrant of 21 feet 8 inches and a sextant of 57 feet 9 inches radius.

Hipparchus and Ptolemy used *diopters,* in which the distance of a star from the zenith was observed by looking through two sights fixed in a rule, annexed to a second rule, which was kept vertical by a plumb-line, the angular distance between the two rules being measured.

Among the Alexandrian astronomers it was noticed that it was not necessary to use a whole circle (see ARMIL), and Ptolemy says that he found it more convenient to observe altitudes by means of a square flat piece of stone or wood, with a *quadrant* of a circle inscribed on one of its flat faces, about a center near one of the angles. The extreme radii of the quadrant represented the horizon and the zenith lines, and, a peg being placed at the center, the observation was made by reference to the point of the arc upon which the shadow of the peg fell.

The quadrantal form was adopted, as it secured the maximum length of radius in an instrument which could measure the greatest altitude of any celestial body.

The Chaldeans asserted that a man walking without stopping might go round the circuit of the earth in a year. The Alexandrians recognized the rotundity of the earth, and Eratosthenes attempted to determine its size by observing the difference between the altitude of the sun at Alexandria and at Syene on a given day Syene was found to be on the tropic, for a vertical gnomon at noon on the summer solstice cast no shadow. Alexandria was observed to be distant from the zenith by a fiftieth part of the circumference, and the measured distance between these two cities, which were in the same longitude, was found to be 5,000 stadia. This gave a circumference of 250,000 stadia to the earth, and a radius of about 40,000. This differed considerably from the *opinion* of Aristotle, and slightly from that of Posidonius, the friend of Cicero. The length of the *stadium* used was 202¾ yards. See ARMIL; ASTRONOMICAL INSTRUMENTS.

Under the Khalif al Maimun, a measurement of two degrees of the meridian was made in the plain of Sind-jar, in Mesopotamia (elsewhere stated to have been on the shore of the Red Sea). The Arabian astronomers divided themselves into two bands, one proceeding north and the other south, applying their measuring-rods to the ground till each reached a point distant one degree from the starting-point The respective measurements were 56 miles and 56¾ miles, of 4,000 cubits each. The cubit is stated to have been the "black cubit" = 27 inches, each inch "the thickness of six grains of barley "

The *dhoneys* of the Coromandel coast are navigated by the natives with the assistance of a little instrument for ascertaining the latitude. It consists of a little square board, with a string fast to the center, at the other end of which are certain knots. The upper edge of the board is held by one hand, so as to touch the north star, and the lower edge the horizon. Then the string is brought with the other hand to touch the tip of the nose, and the knot which comes in contact with the nose tells the latitude.

A quadrant was constructed by Copernicus at Thorn in 1510.

In 1590, Davis dispensed with the plumb and adapted the quadrant for use at sea.

Previous to this the astrolabe and mariner's cross had been universally employed by seamen for determining the latitude; the longitude was derived from dead reckoning or guess-work.

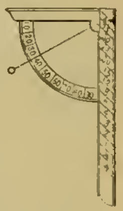
The telescope was adapted to the astronomical telescope by Picard.

All these old forms were superseded for nautical purposes by the reflecting quadrant, invented by Sir Isaac Newton, 1670. He communicated the invention to Dr. Halley, who failed to give it publicity, and it was reinvented by Godfrey of Philadelphia, and also by Hadley in England. An instrument constructed on Hadley's plan was submitted to the Royal Society in 1742, and from having been first made known by Hadley, the reflecting quadrant has been generally called Hadley's.

This and all similar reflecting instruments are based on the fact that the angle between the first and last directions of a ray which has undergone two reflections in the same plane is equal to twice the inclination of the reflecting surfaces to each other. Such instruments, therefore, measure angles double the extent of their arc, the degrees and subdivisions being halved; thus, the quadrant, having an arc of 45° only, measures angles up to 90°, the reflecting circle measures two circumferences, and the sextant, which has now largely superseded the quadrant at sea, having a limb of 60° arc, will measure angles of 120°. See SEXTANT.

All measure either vertical or horizontal angles; the quadrant is, however, seldom employed except for taking altitudes of the sun for latitude or local time. The image of an object reflected from a mirror fixed on a pivoted arm is reflected to the other mirror on a fixed arm, where it is again reflected, and by moving the pivoted arm the image is brought into apparent coincidence with the sea horizon, which is viewed through a part of the fixed mirror left unsilvered for that purpose. The movable limb is provided with a vernier, which indicates the degrees and minutes of elevation on the graduated fixed limb.

Fig. 4061.



Gunner's Quadrant.

Graham, Bird, Ramsden, and Troughton are the great names in the history of this instrument, their celebrity being especially due to their great successive improvements in GRADUATING INSTRUMENTS (which see).

2. An instrument used by gunners for giving a cannon or mortar the angle of elevation necessary to attain the desired range. It has a graduated arc and a plumb-line, which indicates the angle of elevation upon the arc when one arm is placed within the bore or the other against the face of the piece in a perpendicular position.

In a more finished and accurate form, a spirit-level is substituted for the plumb, and one of the branches of the instrument is pivoted and slides over the face of the arc so as to show the elevation.

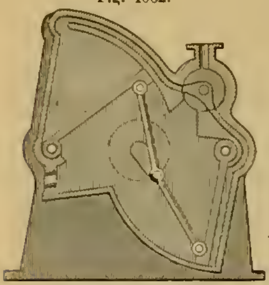
Quad'rant-com'pass. A carpenter's compass, with an arc and a binding-screw.

Quad'rant-e'lec-trom'e-ter. An instrument for estimating the force of an electric current by means of an oscillating needle which traverses against a graduated arc of 90°.

Quad'rant Steam-en'gine. This is a modification of the oscillating-piston engine.

Root's double-quadrant engine has a pair of oscillating single-acting pistons connected by links to one crank. The steam is admitted to act on the outer sides of the pistons alternately by means of one in-

Fig. 4062.



Quadrant-Engine.

duction-valve, and is exhausted through the space between the pistons. The piston and crank connection is such that the steam acts on each piston during about two thirds of the revolution of the crank, and thus there are no *dead-points.*

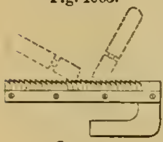
Quad′rat. 1. A mathematical instrument, formerly known also as a *geometrical square* and line of shadows. It is a rectangular frame two of whose sides are graduated; another side carries two sights. At the corner opposite to the graduated sides is the center of an oscillating index-finger, and from the same point hangs a plummet.

2. (*Printing.*) A block of type-metal lower than the type, and used for filling out lines, spacing between lines, etc. Commonly called a *quad.*

Quad′rels. A kind of artificial stone made of chalky earth dried in the sun. So called from their square shape.

Quad′ru-plex Tel′e-graph. An amplification of the duplex system by which four messages may be sent over a single wire, two in each direction, at the same time. See DUPLEX TELEGRAPH.

Fig. 4063.



Quannet.

Quan′net. The flat file of the comb-maker, having the handle at one side, so as to use like a plane. The teeth incline 15° forward, and are made by a triangular file, not by a chisel. In the illustration, the teeth are made by pieces of saw-teeth inserted into inclined kerfs in a beech stock.

Quant. A bargeman's pole with a flat cap to prevent its penetration of the mud.

Quar′rel. 1. A glazier's diamond.

2. A pane of glass of a diamond or rhombal shape. The term is derived from *quadrum,* something square. The *quarry* or bolt of the cross-bow had a square head and pyramidal point. A *quarry.*

3. A graver, four-sided. A stone-mason's chisel of similar form.

Quar′ry. A diamond-shaped pane of a lead-light window. The *quarries* are fixed in *cames,* which are tied by leaden strips to *saddle-bars* running transversely across the iron frame of the casement window.

Quar′ry-ing. The stones for building the obelisks and colossi of Egypt were taken from the limestone hills which border and inclose the valley of the Nile. The Egyptians then chose the sandstone of Silsilis, where they excavated enormous quantities. Afterward, the granite of Syene was chosen, and of this were the obelisks of Thebes and Heliopolis. The modes of quarrying may have differed somewhat, according to the material and the position. One granite obelisk was broken after it was cut and before it was removed. From the size of the opening it would be impossible to turn the stone, which would require to be lifted bodily, like other stones removed from the same quarry. Bronze was the usual metal of the tools.

The largest stones in any known building are those of the temple platform at Baalbek.

The Egyptian mode of quarrying was by uncovering the stratum of stone, leveling the surface, and marking out an area sufficient to yield the amount of stone required. Around this was cut a deep trench, and cross-trenches at right angles divided the whole area into squares of such a size as was required. Layer after layer was then removed.

Another mode was by working on a perpendicular face, forming a series of steps on the side of the mountain, from which the blocks were lowered by machinery analogous to that which afterward hoisted them into position on the pyramids.

The masses of granite may have been detached from their beds in the same manner as is now practiced in the East. After the stone is surrounded by a trench, it is heated by fire built upon it. The ashes being swept off, water is poured into the groove by a large number of men simultaneously, when the fracture takes place through the whole line.

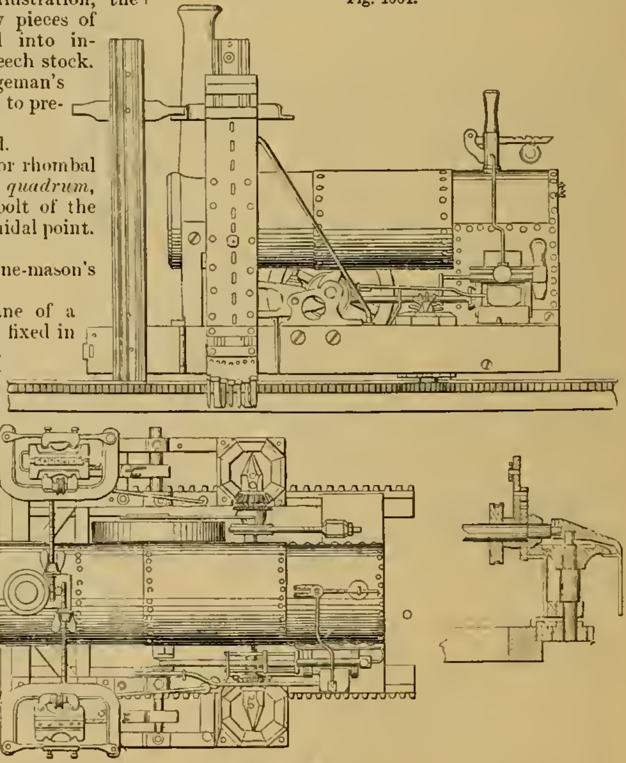
Another mode was to bore perpendicular holes, 18 inches apart, on the desired line of fracture; into these holes small chisels were driven persistently from one end to the other by a number of men, which resulted in a fracture along the line.

Metallic wedges inserted at a number of places and simultaneously driven, was another mode.

Wooden pins inserted into a row of holes and swelled by water, was yet another method.

Quar′ry-ing-ma-chine′. The machine (Fig. 4064) is designed for cutting vertical or inclined channels in the stone preparatory to cutting under and separating the blocks. The boiler, engine, and cutting mechanism are all mounted on the same carriage, which is moved by toothed wheels gearing with a rack upon the rails. By means of a reversible pawl, the carriage may be caused to travel in either direction without reversing the engine. A friction

Fig. 4064.

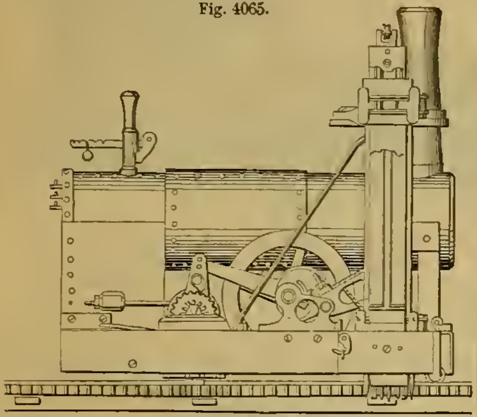


Quarrying-Machine.

brake with an adjustable weight limits the motion of the carriage to the positive distance fed. The chisels are attached to solid stocks moved by vibratory segment-levers. The standard guides between which the chisel-stocks work may be reversed to secure equality of wear and admit of angular adjustment to suit varying inclinations. A balance-wheel serves to equalize the motion of the various parts.

Fig. 4065 is designed for cutting vertical or inclined channels in beds of stone preparatory to undercutting and removing the blocks. The engine and cutting mechanism are carried on a single truck, which is advanced by spur-wheels gearing with a rack on the rails. The chisels are reciprocated by segment-levers; a brake limits the motion of the machine, and a reversible pawl permits its direction to be changed without reversing the engine.

Fig. 4065.



Quarrying-Machine.

Quar'ry-stone Bond. Rubble masonry.

Quar-ta'tion. (*Metallurgy.*) The process formerly employed of separating gold from silver by means of nitric acid. This would not act effectually upon an alloy containing less than ¾ silver, so that when the mixture was richer in gold, silver was added to make this proportion.

Quar'ter. 1. (*Nautical.*) *a.* The side of a ship, aft, between the main channels and stern. *On the quarter*, 45° abaft the beam. *Quarter*-boats are abaft the mizzen. *Quarter*-deck, abaft the mainmast.

b. Portions of a ship belonging to or at the quarter, as, *quarter-boat*, *quarter-gallery*, *quarter-ladder*, *quarter-nettings*, *quarter-posts*, *quarter-rails*, *quarter-timbers*, etc.

c. That portion of a yard from the slings outward; hence, *quarter-block*, *quarter-slings*, *quarter-tackle*, etc.

d. A point of the compass between the line of the keel and abaft the beam.

e. The stations of a ship's company in time of exercise or action.

2. (Plural, *quarters.*) The apartments assigned to officers and soldiers in a barrack.

3. (*Milling.*) A section of a millstone dress, consisting of a *leader* and its branches; the term is used irrespective of the number of degrees embraced in the sector. See MILLSTONE.

4. (*Coopering.*) The portion of the side of a cask intermediate between the *chime* and the *bulge*.

5. (*Cork-cutting.*) A parallelopiped of cork, blocked out and ready for rounding into a cork shape.

6. (*Carpentry.*) *a.* An upright stud or scantling in a partition which is to be lathed and plastered. The English rule is to place the quarters at a distance not exceeding 14 inches.

b. A section of a winding stairs.

7. The rear or heel portion of a horseshoe.

8. (*Architecture.*) A portion of a Gothic arch.

9. (*Shoemaking.*) The portion of a boot or shoe upper behind the ankle-seams.

Quar'ter-blan'ket. (*Menage.*) A small blanket generally used under the harness, covering the horse's back from the shoulders to the hips, though in some cases it extends no farther forward than the front of the pad.

Quar'ter-block. (*Nautical.*) A double block iron bound, secured swivel fashion by a bolt near the middle of a yard. Through it passes the *clew-garnet* or *clew-line*, as the case may be.

Quar'ter-boot. (*Menage.*) A leathern boot designed to protect the heels of the horse's fore-feet from injury by overreaching with the hind feet.

Quar'ter-deck. (*Nautical.*) A deck raised above the waist and extending from the stern to the mainmast. It is especially a privileged portion of the deck, being the promenade of the superior officers of the vessel or of the cabin passengers in vessels of that character. The windward side is the place of honor.

Quar'ter-gal'ler-y. (*Shipbuilding.*) A small balcony on the quarter of a vessel.

Quar'ter-hol'low Tool. (*Wood-turning.*) A chisel (*c*, Fig. 4066) for making convex moldings.

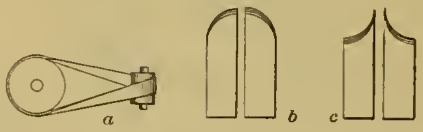
Quar'ter-hung. (*Ordnance.*) Said of a gun whose trunnions have their axis below the line of bore.

Quar'ter-ing. 1. (*Machinery.*) The adjustment of cranks on a single shaft at 90° distance apart, or the boring of wrist-pins in locomotive driving-wheels at right angles with each other.

2. (*Nautical.*) Sailing large but not before the wind.

Quar'ter-ing-belt. (*Machinery.*) A belt or band (*a*) connecting pulleys whose axles are at right angles to each other.

Fig. 4066.



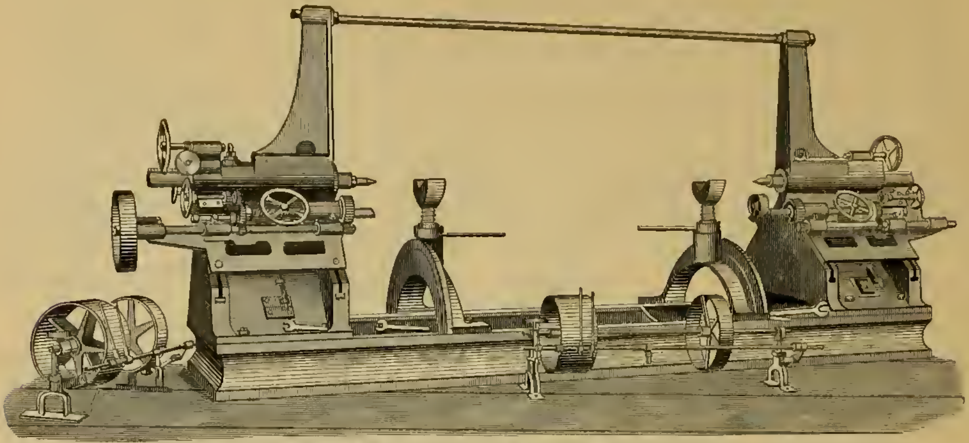
a, Quartering-Belt. b, Quarter-Round Tool. c, Quarter-Hollow Tool.

Quar'ter-ing-ma-chine'. A machine for quartering car driving-wheels on their axles, that is, boring the wrist-pin holes at 90° distance apart. A pair of wheels mounted on their axle is placed in the machine, the axle resting upon a pair of vertically adjustable rests, which take the weight off the centers. The boring-heads are adjustable radially from the center of revolution, so as to bore the holes for the wrist-pins at a distance equal to one half the stroke of the piston; a range of adjustability of, say, from 12 to 26 inches stroke. The machine is built for right or for left hand quartering, but, by being fitted with four boring-bars, is adapted for both kinds of quartering. See Fig. 4067.

Quar'ter-pace. (*Building.*) A stair embracing a quarter-turn at the winding of a stairs.

Quar'ter-pie'ces. (*Shipbuilding.*) Timbers in the after part of the quarter-gallery near the *taffrail.*

Fig. 4067.



Quartering-Machine (*New York Steam-Engine Company*).

Quar′ter-round. A plane used for molding framework. An *ovolo.*

Quar′ter-round Tool. (*Wood-turning.*) A chisel (*b*, Fig. 4066) for making concave moldings. They are *right* and *left.*

Quar′ters. 1. (*Carpentry.*) Vertical scantling in wooden partitions, forming a foundation for lath and plastering.

2. *a.* The apartments assigned to officers and soldiers in a barrack.

b. The stations of a ship company on duty.

Quar′ter-stuff. (*Carpentry.*) Plank one quarter inch thick.

Quar′ter-tim′ber. (*Carpentry.*) Scantling from 2 to 6 inches deep.

Quar′to. (*Printing.*) A book formed by folding a sheet twice, making 4 leaves, 8 pages. The term, by modern usage, refers to a book of a nearly square form. The proportions vary according to the sizes of the sheets folded, but may be from 8½ × 10 to 10 × 12, and probably both below and above said dimensions.

Quartz-crush′er. A machine for breaking or grinding auriferous quartz. Also used for breaking other ores; or stones for cement, to mix with asphalt for paving, etc. See QUARTZ-MILL.

Quartz-liq′ue-fi-er. An apparatus for dissolving comminuted quartz in order to set free the gold. By converting the quartz into a silicate of an alkali, it may be washed away, the gold being collected by precipitation and decantation of the supernatant solution. It is a process which depends in part on the facilities for using the soluble glass, and requires great volume of water.

See the patent of Hardinge, May 8, 1855. The powdered mineral is exposed to high-pressure steam and alkali in a closed chamber of a spheroidal form, a rotary stirrer mixing the ingredients. See also Vanderburgh's patent, May 29, 1860; and Fleury, July 7, 1868.

Quartz-mill. (*Ore.*) A machine for crushing quartz, to bring it down to a size suitable for the stamps, or to a fineness for the amalgamator. See also ORE-MILL.

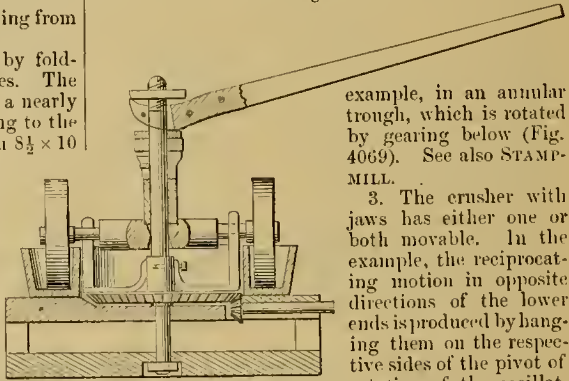
The following are typical forms, of each of which there are many varieties: —

1. The *Chilian-mill*, consisting of edge-stones traveling in a trough.
2. The stamp-battery.
3. Vibrating jaws.
4. Rotary beaters.
5. Horizontal runner.
6. Vertical runner.
7. Bell-shaped runner
8. Conical mill.
9. Inclined disks.
10. Rolling-ball.
11. Gyrating-pan.

1. Fig. 4068 is an edge-mill, the stones traveling in an annular trough, the weight increased by a lever. See also CHILIAN-MILL.

2. The stamping-mill has a battery of stamps, either each acting in its own mortar, or, as in the example, in an annular trough, which is rotated by gearing below (Fig. 4069). See also STAMP-MILL.

Fig. 4068.



Edge-Wheel Quartz-Mill.

3. The crusher with jaws has either one or both movable. In the example, the reciprocating motion in opposite directions of the lower ends is produced by hanging them on the respective sides of the pivot of rotation of the oscillating levers, and their upper ends are caused to approach by the rear supporting links, which are vibrated by the reciprocation of the jaws. Fig. 4070. See also ORE-MILL.

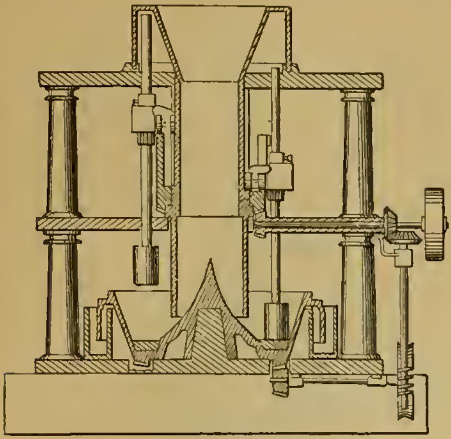
4. The rotary beater. The ore passes from the hopper into the first cylinder, the beaters on the shaft forming a partial vacuum. The beaters strike the ore, which is carried by the peripheral force of the current through the connecting passage into the second chamber, through which it receives the same treatment, and passes to the connecting-pipe, which deposits it in the dust-chamber. Fig. 4071.

5. Horizontal runner. The stone is suspended above the bed, and is fed through the eye, as with grist-mills. Fig. 4072.

6. The runner on horizontal shaft. The cylinder surrounds the grinding-wheel, which is eccentrically journaled in respect to it, and revolves at different

speed thereto. The matter to be crushed enters one end of the cylinder, and passes out beneath the shields and gauze-covered openings near the periphery of the same. The cylinder runs on anti-friction rollers. Fig. 4073.

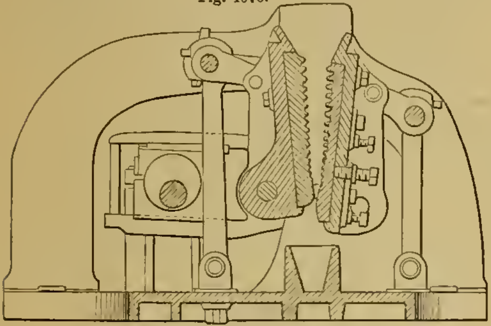
Fig. 4069.



Stamping-Mill.

7. Bell-shaped runner in conical case. This has two revolving toothed surfaces, one within the other, the interior in the shape of a cone, and the other one formed around the interior; both of these parts revolve in the same direction, but the interior one much faster than the outer. Fig. 4074.

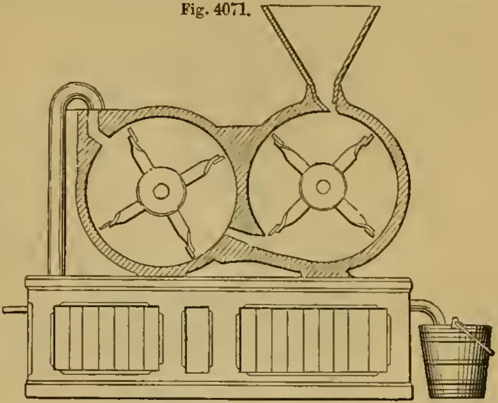
Fig. 4070.



Quartz-Mill with Vibrating Jaw.

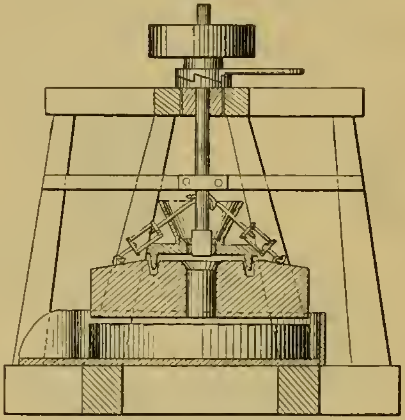
8. Conical mill. The ore is broken and thrown into the hopper, and passes between the vertical compound wheel of the hopper and the concave, which is formed of segmental blocks. From thence it passes to the final reducing stones. Fig. 4075.

Fig. 4071.



Quartz-Mill with Rotary Beaters.

Fig. 4072.

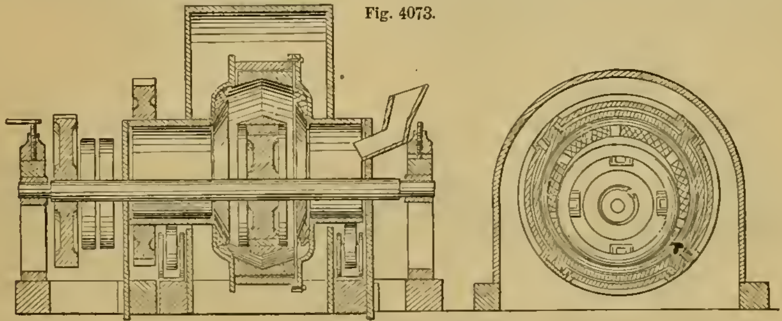


Quartz-Mill with Horizontal Runner.

9. Inclined disks. This has two revolving disks with conical-shaped surfaces revolving in different directions, and hung upon shafts placed diagonally to each other, so as to bring the two faces of two grinding disks parallel with each other. Fig. 4076.

10. The rolling ball. This has a stationary mor-

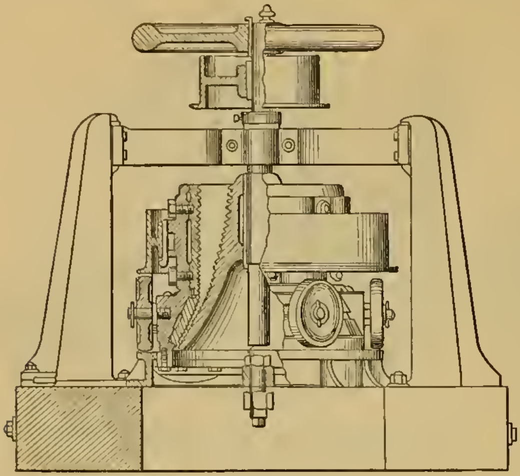
Fig. 4073.



Quartz-Mill on Horizontal Shaft.

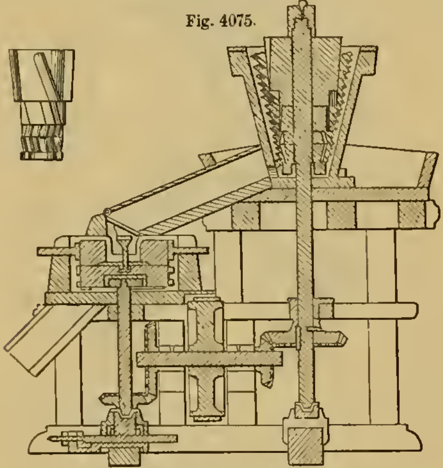
tar or kettle, of a partly spherical form in the interior, with a spherical concentrical ball operated by a diagonal shaft connected, by means of an arm and forked joint and bush, with a vertical driving-shaft.

Fig. 4074.



Quartz-Mill with Bell-Shaped Runner.

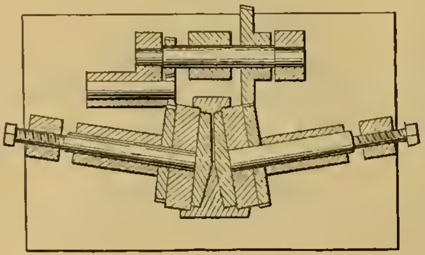
Fig. 4075.



Conical Quartz-Mill.

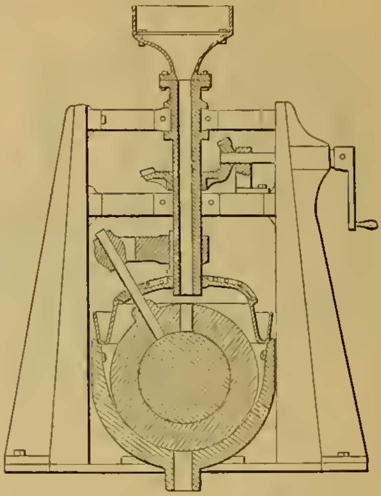
The ball, mortar, or basin is combined with the vertical hollow shaft, so that ores that are pulverized are carried down continuously, without intervals for charging or discharging, the falling ores being equally distributed on all sides of the ball and basin. Fig. 4077.

Fig. 4076.



Inclined Disk Quartz-Mill.

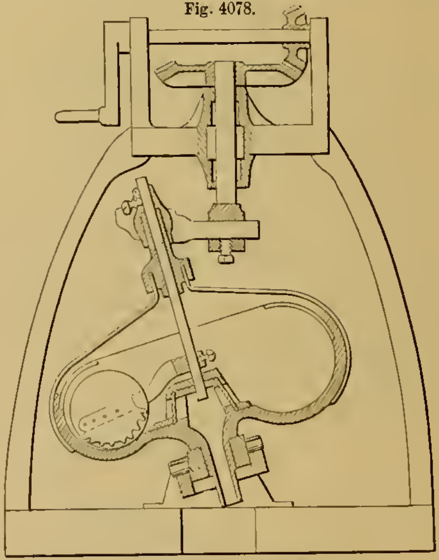
Fig. 4077.



Rolling-Ball Quartz-Mill.

11. Gyrating pan. This has an oscillating basin, the lower end of whose shaft is connected with and rotates in the hub of the machine. Upon the axle or shaft is adjusted the ring or bush, which is fitted with slots to receive and hold firmly the iron bands or straps; the object of which is to support and strengthen the basin. Within the basin is placed the ball which is to pulverize the ore. Fig. 4078.

Fig. 4078.



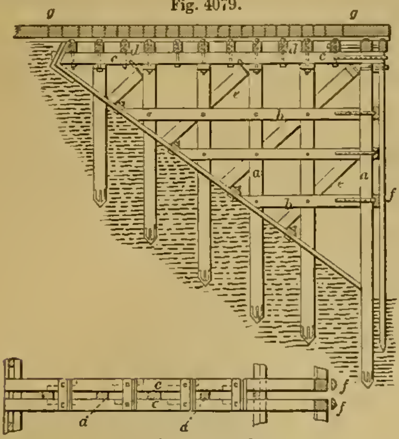
Gyrating-Pan Quartz-Mill.

Quay. A wharf projecting into a stream, harbor, or basin, to which vessels are moored for the purpose of receiving and delivering freight.

In Europe, quays are generally formed by retaining walls of stone, supported by counterforts and backing; in this country, wood is generally employed. The quays of Montreal are the best on the continent. See SEA-WALL, where the mode of construction of the New York harbor-quays is represented. See also FLOATING-DERRICK.

Fig. 4079 is a section and plan of a timber quay as constructed in England.

Fig. 4079.



English Timber Quay.

a a, side piles.
b b, side wales.
c c, cross beams.
d d, top beams.
e e, side braces.
f f, fender piles.
g g, planking.

The details and nomenclature are somewhat different in this country. See WHARF.

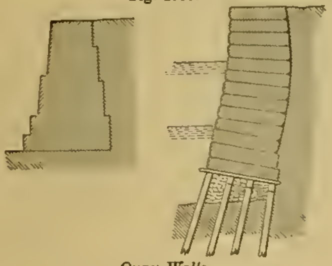
Cast-iron piling has been successfully employed at Deptford and Blackwall, England.

A *quay* occupies the same relation to a *harbor* that a *wharf* does to a *river*.

Harbors and docks are provided with *quays*, and their construction involves some of the precautions incident to the building of jetties, sea-walls, retaining walls, etc. The quay, however, is not subjected to the violent action of the waves incident to the construction first mentioned and to *breakwaters*. The thrust of the soil is, perhaps, the greatest force tending to its destruction.

The quay-wall of the outer harbor of Havre has a mean thickness equal to 0.40 of its hight, and batters on both sides by a series of steps.

Fig. 4080.



Quay-Walls.

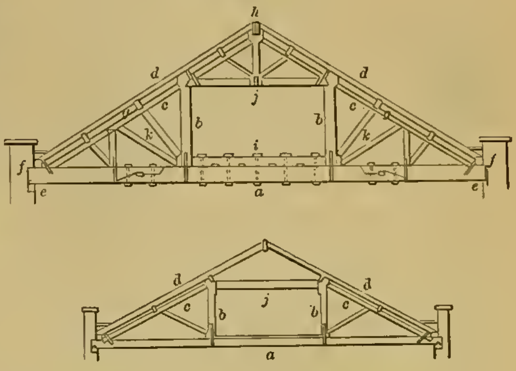
Havre. *Rennie's.*

Rennie advised a curvilinear batter on both sides, laying the courses normally to the curve. This entails the necessity of using inclined piles, which introduces an element of insecurity. The face of the quay-wall forms the intrados of an arch and makes the ashlars mutually sustaining. Whether the latter advantage overbalance the detrimental effect of inclined piling is doubtful.

The Dutch are said to run the sides of the walls parallel, that is, make them of equal thickness, so that the batter of the outside causes an overhang of the inside. This seems indefensible.

Queen-post. Queen-posts are mortised or attached by iron straps to the tie-beam of a roof-frame, supporting it and the rafters at points between the *ridge* and *eave*. *Purlins* rest upon the principal rafters, and common *rafters* rest upon the *purlins*. The former are let into the tie-beam, and the latter butt against the pole-plates.

Fig. 4081.



Queen-Post Roof.

a, tie-beam.
b, queen-posts.
c, principal rafters.
d, common rafters.
e, wall-plates.
f, pole-plates.
g, purlins.
h, ridge-plate.
i, straining-sill.
j, straining-beam.
k, struts.

Queen's-met'al. An alloy intermediate between Britannia metal and pewter. Used for spoons, teapots, and other table-ware.

Tin	9	Antimony	1
Lead	1	Bismuth	1

Or, —

Tin	100	Bismuth	1
Antimony	8	Copper	4

Quench'ing. The process of producing a hard scale or crust upon the surface of molten metal in a crucible or cistern, for the purpose of removing it in successive rondles or disks, instead of allowing it to congeal into a solid mass.

Rose-copper is thus removed from the crucible of the refining-hearth, the disks being known as *rosettes*.

Quench'ing-tub. (*Blacksmithing.*) The vessel in which the heated iron or steel from the forge is plunged, in order to cool or temper it.

Quern. A hand-mill of the ancient pattern. See GRINDING-MILL.

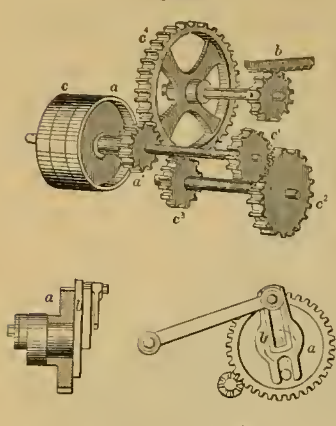
A Roman *quern* dug up in Yorkshire, England, about 1710, was found to be 20 inches in diameter. One stone was somewhat dished, and the other slightly conical. The face had a *dress* of notches.

Quick-match. Cotton-wick is boiled in saltpeter and rain-water for 1 hour; alcohol is added to the mixture while warm, and it is simmered for 15 minutes. Mealed powder is then added, and the whole left for 24 hours. The cotton-wick is wound on a reel, and mealed powder sifted over it. It is then dried.

Quick-re-turn' Gear'ing. (*Planing-machine.*) Gear for causing the rapid return of the bed after the tool has completed each cut.

This is effected (see upper figure) by the pulley *a*

Fig 4082.



Quick-Return Gearing.

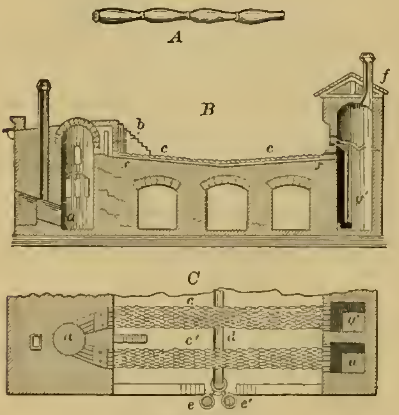
and pinion a'. The bed is moved from left to right, presenting the work to the cutting edge of the tool by the rack b, operated from the pulley c through the gears $c^1 c^2 c^3 c^4$. On arriving at the end of its motion, a stud on the lathe-bed strikes a horn, which shifts the driving-belt from c to a, causing the pinion a' to reverse the movement of the gear c^4, and turn the bed in the opposite direction, until the belt is shifted back to its original pulley by a similar device at the other end of the machine.

Whitworth's quick return for shaping-machine (lower figures). A spur-wheel a, revolving freely upon a large fixed overhanging shaft, is attached to a convenient part of the head. Through, but not concentric with, the shaft, runs a spindle, having a slotted crank-piece b on its extremity, by which it is kept in contact with the face of the wheel, and connected therewith by a pin engaging in the slot; the velocity of the crank varies as the pin approaches or recedes from the center, supposing that of the wheel to be uniform. The end of the connecting-rod may be set at any point in the dovetail groove in the face of the crank-piece, for adjusting the length of stroke.

Quick'sil-ver. See MERCURY.

Quick'sil-ver-fur'nace. (*Metallurgy.*) Fig. 4083 illustrates the furnace employed at Almaden, Spain, for obtaining metallic mercury from cinnabar. A shows part of a chain of aludels, B is a vertical longitudinal section, and C a horizontal section of the furnace, the part $x\,x$ being in plane. This consists of two upright cylindrical shafts $a\;a'$, separated by an arched space $x\,x$. The fire is made in the shaft a, and immediately over it is placed a quantity of sandstone containing a small proportion of cinnabar; over this is laid the richer ore, and the openings in the shaft are covered with tiles and tightly luted.

Fig. 4083.



Quicksilver-Furnace.

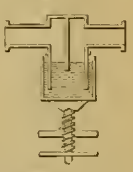
The mercurial vapors evolved are conducted into the space b, and thence pass through the rows of aludels $c\,c'$, 12 in number and 20 to 22 meters in length.

The metallic vapors condensed in the aludels run into the gutter d, and are collected in stone cisterns $e\,e'$, while those which are not condensed pass into the chamber a', where the mercurial portion passes into the liquid state, the smoke escaping from the chimney f. As the mercury thus obtained is contaminated with soot, it is caused to flow down an inclined plane, to which the smoky impurities adhere. The matters condensed in the chamber a' are redistilled to extract the metal. The quantity of ore employed at each operation is 250 to 300 cwt. See also MERCURY.

Quick'sil-ver-valve. A valve in which the lower edge of a descending plate becomes submerged in quicksilver to close a passageway.

It resembles the hydraulic valve, except in the substitution of metal for water or glycerine. The two pipes meet in a box having a descending plate and a circular flange, the lower edge of which latter is constantly submerged in a box of quicksilver.

Fig. 4084.



Quicksilver-Valve.

The box has a capacity for vertical adjustment by a screw beneath, so that the middle plate may dip into the quicksilver and close the communication between the pipes; or the box may be lowered so as to allow the communication to proceed.

Quick-wa'ter. (*Gilding.*) A dilute solution of nitrate of mercury (10) and gold (1), used in the process of *water-gilding* (which see).

Quick-work. (*Shipbuilding.*) Inside planking or skin, between ports.

Quill. 1. (*Seal-engraving.*) The hollow mandrel of the lathe or engine used by the seal-engraver. See SEAL-ENGRAVING.

2. A small spindle, pirn, or rod upon which thread is wound to supply the shuttle with the *woof*, *weft*, or *filling*, as it is variously called, and which crosses the *warp*, or *chain*.

Quill-bit. A long pod-bit of small diameter.

A wood-boring tool used in a brace. It is of a semi-cylindrical form, terminates in a sharp edge, and is hollow, to contain the chips. See BIT.

Quill-nib. A small pen of quill to be placed in a holder.

Quill Pen. The quills of birds came into use as pens about the 6th century A. D., according to Isidore and others. (See PEN.) We read of the use of quills of the swan, eagle, goose, duck, and crow. After the discovery of America the quills of the turkey were so used. This very American bird was absurdly named after the country of the Turks. The turkey-quill was perhaps the first whose nibs were furnished with metallic points. This was early in the present century.

Goose-quills are assorted into qualities determined by the character of the barrel They are plunged into heated sand, to make the exterior skin peel off and the interior membrane shrivel up. This may be performed by alternate soaking in water and drying before a charcoal fire. They are hardened by soaking in a hot solution of alum.

The yellow color is conferred by a quick dip into nitric acid.

Bramah probably first suggested quill-nibs, and patented a machine for making them. These nibs were the precursors of the steel nibs Iron pens were mentioned by Chamberlayne in 1685. Not like the iron pen of Job, which was a chisel or graver. See STEEL PEN.

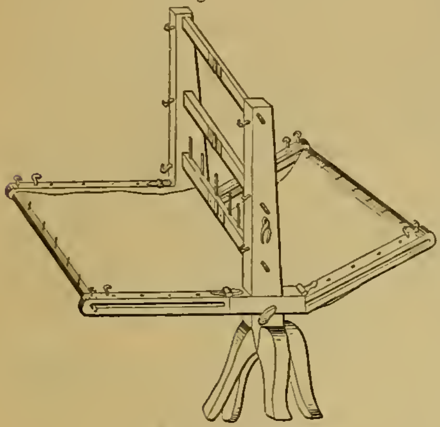
The barrels of the quills were first slit longitudinally into halves; these were subdivided into blanks for nibs, and the latter were formed and slit in a third operation. See PEN-MAKER.

Quilt'ing. 1. Loom-made quilts appear to be two distinct cloths, tied, as it were, together by stitches which go through both cloths, and by the crossing and interchange of warp-threads from the lower to the upper set, and *vice versa*, in the manner of the two-ply carpet. In some quilting a third shuttle throws in a quantity of coarsely spun cotton, to serve as a kind of wadding.

2. (*Nautical.*) Braided or plaited sennit over a bottle, etc.

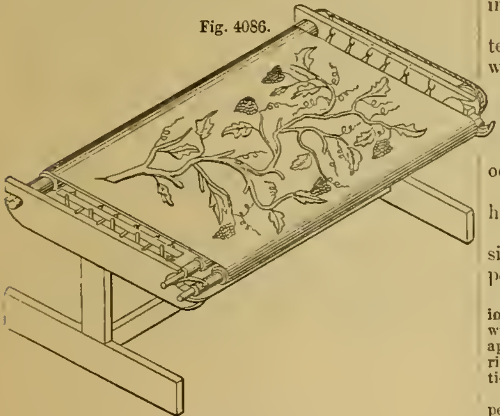
Quilt'ing-frame. A frame on which fabric is stretched for quilting. The old-fashioned frame was as large as the quilt, and the modern conveniences are to secure compactness and facility of exposure of that part on which work is proceeding, the other portions being covered from the dust.

Fig. 4085.



Folding Quilting-Frame.

Fig. 4086.



Roller Quilting-Frame.

Fig. 4085 is a frame with jointed leaves, which fold up against the standard.

In Fig. 4086, two rollers are journaled in the front ends of the frame and one in the rear. On the outer front roller is wound the outside portion of the article to be quilted, and on the inner roller is wound the lining. The part quilted is wound on the rear roller.

Quire. *a.* A collection of 24 sheets of paper. Wrapping, envelope, flat-cap, printing, and many other papers are not folded. Newspaper has 25 sheets to the *quire*; 10 quires to a *token*; 2 tokens to a ream. When work is calculated by the 1,000 sheets, 250 sheets are usually known as a *token*.

b. A collection of one of each of the sheets of a book laid in consecutive order ready for folding. The sheets are *gathered* into a *quire* or *book*, which is folded along the middle.

Quirk. 1. A sudden turn; applied to a form of molding in which an acute recess separates the molding proper from the *fillet* or *soffit*.

It is much used between moldings in Gothic architecture; in Grecian architecture ovolos and ogees are usually quirked at the top, and sometimes in Roman.

2. A projecting fillet on the sole or side of a grooving-plane, which acts as a *fence* or a gage for depth or distance.

Quirk-float. (*Plastering.*) The plasterer's tool for finishing off angles. An *angle-float.*

Quirk'ing-plane. A molding-plane for working on convex surfaces.

Quiv'er. An arrow-case.

They were strapped to the sides of the Egyptian chariots, but are usually carried on the back, so that the arrows may be grasped by the hand when reached over the right or the left shoulder. The Apache Indians carry it over the right shoulder, so that the heel of an arrow may be grasped by the least possible reach of the right hand. The arrows are so quickly drawn and thrown into position upon the left hand, which grasps the bow, that the man will keep four or five arrows flying in the air at the same time. Much care and ornament are bestowed upon this article by barbarous nations.

Quoin. 1. A wedge-shaped block. Specifically: —

a. (*Gunnery.*) A wedge-shaped block of wood, having a handle inserted in its thicker extremity; used in some cases for giving the proper elevation to mortars, howitzers, and naval guns.

b. (*Printing.*) One of the wedges by which the pages or columns of type are locked in a *chase*, ready for printing.

c. (*Nautical.*) A wedge used as a chock in stowing casks, to prevent rolling.

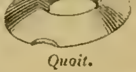
2. (*Masonry.*) An external angle of a wall. The term particularly refers to ashlar or brick corners which project beyond the general faces of the walls which meet at the angle.

Rustic quoins are rusticated ashlars forming external projecting corners, the remainder of the wall being of ordinary masonry, rubble, or brick, with occasional piers of masonry. See RUBBLE-MASONRY.

Quoin-post. (*Hydraulic Engineering.*) The heel-post of a lock-gate. See Fig. 1386, page 594.

Quoit. An annular disk beveled roundly on each side, thrown by hand at a stake or peg in playing the game of quoits.

Fig 4087.



Quoit.

This game is of unknown antiquity, throwing the *discus* having been a favorite sport with the ancient Greeks, and in some form appears to have existed from time immemorial, among even the most uncivilized nations

The ancient quoit was a heavy circular mass of iron, sometimes perforated in the middle: and the effort was not one of skill, to throw it as nearly as possible to the mark, now called the *hob*, but to throw it to the greatest possible distance, as in the modern Scotch games of *putting the stone* or *hurling the hammer* Homer mentions the throwing of the δύσκος among the sports at the funeral games of Patroclus (Iliad, II , XXIII. See also Odyssey, VIII., XVII.). Sometimes a thong was passed around it to form a handle; in the Cabinet des Antiquites of Paris is preserved a *discus* with hole for the thumb and fingers. Pindar celebrates the skill of Castor and Iolaus in this exercise. In the British Museum is the famous statue of the *discobolus* in the act of throwing the *discus*. Quoit-pitching was a favorite pastime in England. Notices of it are found in 1453. The horseshoe is a common substitute in America.

R.

Rab. A stick used in mixing hair with mortar.

Rab'at. A polishing material formed of potter's clay which has failed in baking.

Ra-bat'ment. (*Shipbuilding.*) The draft of the real shape of the molding edges of pieces of the frame in any required position.

Rab'bet. 1. (*Carpentry.*) A rectangular groove made longitudinally along the edge of one piece to receive the edge of another. A *rebate.*

It is common in paneling, and in door-frames for the door to shut into.

2. (*Shipwrighting.*) That part of the keel, stern, and stern-post of a ship which is cut for the plank of the bottom to fit into.

Rab'bet-ed Lock. (*Locksmithing.*) A kind of lock whose face-plate is sunk within a rabbet cut in the edge of a door.

Rab'bet-ing-ma-chine'. A machine for forming rabbets. Rabbeting-machines for wood, as well as other kinds of planing and molding machines, were supplied by General Sir Samuel Bentham to the British Admiralty before 1800. Many *planing*-machines and all *matching* and *molding* (wood) machines may be set to cut rabbets.

Rab'bet-joint. (*Carpentry.*) A mode of joining wooden stuff in which rabbets are made upon the contacting edges of the boards, so as to overlap each other. See JOINT.

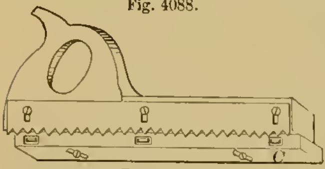
Rab'bet-plane. (*Joinery.*) A plane for plowing a groove on the corner edge of a board. According to their shape, which is such as to adapt them to peculiar kinds of work, they are known as *square-rabbet*, *side-rabbet*, *skew-rabbet* planes.

The *square-rabbet* plane has its cutting edge square across the sole.

Skew-rabbet plane; the bit obliquely across the sole. *Side-rabbet* plane; having the cutter on the *side*, not the *sole*.

Rab'bet-saw. A saw adapted for forming grooves in the edges of plank, etc. That illustrated has an adjustable fence or gage *C* attached to a handle similar to a plane-stock, so as to cut at variable distances from the edge.

Fig. 4088.



Rabbet-Saw.

Rab'ble. (*Metallurgy.*) An iron bar with an end bent at a right angle, used for stirring the molten iron in the puddling or boiling furnace, for removing slag from the surface, and for gathering the metal into *loops* or *balls* for the tilt-hammer or squeezer.

A *mechanical rabble* is used in some forms of puddling-furnaces. See page 1815.

Rab'bler. (*Metal.*) A scraper.

Ra'bot. (*Marble-working.*) A hard-wood rubber used in rubbing marble to prepare it for polishing.

Race. 1. (*Hydraulic Engineering.*) The canal or course by which water is conducted to a water-wheel from the mill-pond or stream above, and is conveyed away after having done its work. The water reaches the wheel by the *head*-race and leaves it by the *tail*-race.

2. (*Loom.*) The path or guiding trough for the shuttle in the *lay* or *batten.*

Race-cloth. (*Menage.*) A cloth used in connection with race-saddles; it has pockets to hold the weights needed to meet the requirements of the rules of the race-course.

Race-glass. (*Optics.*) A common name for a lorgnette or binocular field-glass.

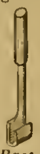
Race-knife. A tool with a bent-over, sharp lip for scribing. It is used in laying down on the floor the lines on the body plan, by which the smith bends his bars in forming iron frames for ships.

It is also used for marking, numbering, and other purposes.

Race-sad'dle. (*Menage.*) A very small light saddle, used only for racing purposes.

Rach'i-o-tome. (*Surgical.*) A post-mortem or dissecting instrument for opening the spinal canal.

Fig. 4089.



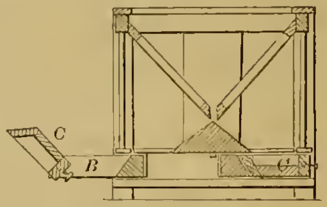
Race-Knife.

There are two kinds: one, a saw with double blades, which are caused to approach or recede from each other by means of set screws, making two parallel cuts at once; the other, an axe-like chisel with a round, projecting point, which is inserted into the hollow of the vertebræ and guides the chisel while the operator holds it by the handle with one hand, striking on it with a hammer held in the other hand.

Rac'ing-bit. (*Menage.*) A jointed-ring bit, made very light, the loose rings varying in size from 3 to 6 inches.

Rack. 1. (*Husbandry.*) A frame of open-work to hold hay or other feed for cattle, horses, or sheep. The example is a sheep-rack; has a grain-trough *B C* pivoted in a drawer beneath the bars of the hay-rack, so that it may be folded and slid in, rendering the arrangement more compact and preventing the animals having access to the food except at stated times. A *feed-rack.*

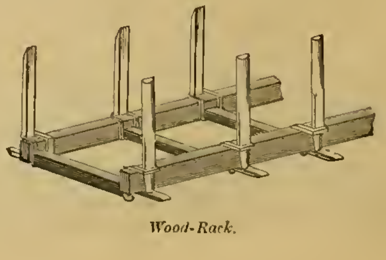
Fig. 4090.



Sheep-Rack.

2. (*Wagon.*) A frame to carry hay or grain, placed on a wagon-gears instead of a box-bed, for hauling in the harvest. Sometimes it is laid upon the wagon-bed; but this is not so good, as the bed makes the load too high and too short, and adds unnecessary dead-weight.

Fig. 4091.



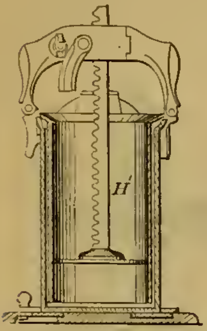
Wood-Rack.

The device is also placed on a wagon-frame for hauling wood and other materials.

Fig. 4091 is a wood-hauling rack in which the sleepers, sills, and stakes are united by the bent stirrups, and are disunited by raising the stakes.

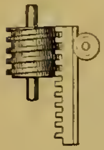
3. (*Gearing.*) A toothed bar whose pitch-line is straight, or, if curved, embraces but a fraction of the circle and is called a segment-rack, for imparting rectilinear motion, and operated by a toothed pinion or segment or by a pawl.

Fig. 4092.



Rack-Movement (Lard-Press).

Fig. 4093.



Rack and Worm.

In the example, where it works the piston of a lard-press or sausage-stuffer, the rack H′ is raised or lowered by a pinion, and may be held at any desired hight by a pawl engaging a ratchet-wheel on the pinion-shaft.

The rack and worm (Fig. 4093) may in some cases be substituted with advantage for the rack and pinion. The teeth of the rack are oblique, to correspond with the threads of the endless screw or worm.

4. (*Metallurgy.*) An inclined frame or table, open at the foot, and upon which metalliferous slimes are placed and exposed to a stream of water, which washes off the lighter portions. It is to the *slimes* what *buddling* is to the *ores*. The operation is known as *racking*, *recking*, and *framing* in different districts of Cornwall, and particularly applies to tin ores. See FRAME.

5. (*Horology.*) A steel piece in the striking part of a clock. It consists of a bar attached radially to an axis, and having a lower and an upper arm. The former is called the *rack-tail*, and is in contact with the snail on the center arbor, which determines the number of strokes. The upper arm is indented with 12 notches, to act in concert with the *hawk's bill* in effecting the striking of the right number.

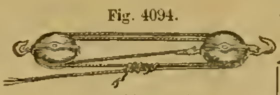
6. (*Lace.*) A certain length of lace-work, counted perpendicularly, and containing 240 meshes.

7. (*Nautical.*) *a.* A frame of wood with belaying-pins, or a row of blocks for fair-leaders, or a row of sheaves for reeving the running-rigging.

b. A frame with holes for round-shot.

c. A box in which the halyards are coiled away.

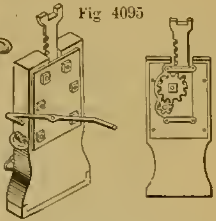
Fig. 4094.



Racking a Fall.

d. To *frap* or *seize* a *fall*. That is, to bind together two ropes of a tackle to retain it at a tension and prevent the ropes reeving back through the blocks.

Fig 4095



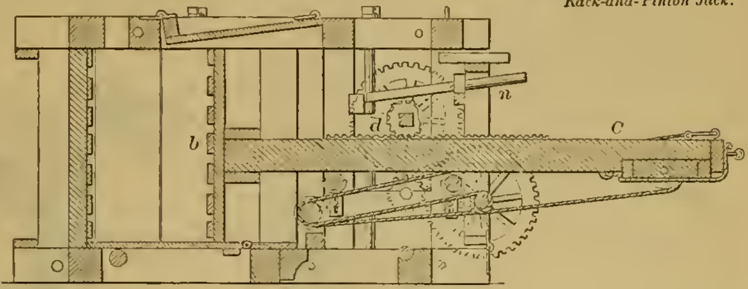
Rack-and-Pinion Jack.

Rack-and-pin′ion Jack. A lifting-jack, in which a rack and pinion is employed for gaining power. In the example, a pinion turned by a two-armed crank engages a gear-wheel fixed on the same shaft with a pinion meshing with the rack. Greater power may be obtained by increasing the number of wheels in the train or the difference of their radii.

Rack-and-pin′ion Press. In this the force is transmitted, as the name indicates, through a pinion to a rack which is connected with the follower. In the faster movements of the follower, during the return-stroke, the gearing acts directly on the rack-beam; but during the heaviest compression the gearing operates through a windlass and rope.

A sliding pinion *d* operated by shifting lever *n* is the means of direct motion of the rack-beam *C*, when retracting the follower *b*.

Fig. 4096.

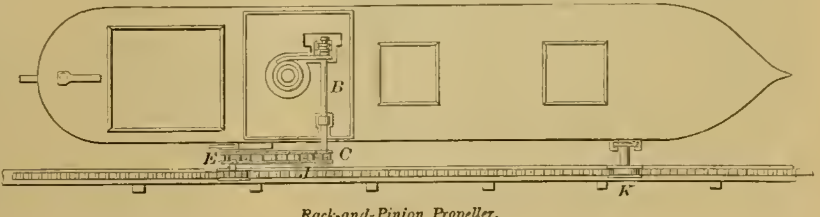


Rack-and-Pinion Baling-Press.

Rack-and-pin′ion Pro-pel′ler. In order to obviate the inconveniences attending the use of horse-power and the injurious action of the ordinary paddle-wheel or propeller on the banks of canals, various devices in which wheels actuated by a motor on board the boat engage a continuous rack or rail at or above the canal bank, have been proposed.

Fig. 4097 shows one contrivance. A shaft *B*, driven by the engine, turns a cog-wheel *C*, connected by an endless chain with the spur-wheel *E*, on whose shaft is a pinion meshing with a rack *J* on the canal-bank. The bearings of the shaft *B* move freely in a vertical direction, so as to correspond with the variable immersion of the boat depending on the amount of her cargo. The boat is maintained in line with the con-

Fig. 4097.



Rack-and-Pinion Propeller.

tinuous rack by a roller *K* having flanges, which hold thereto while passing over the teeth. This also has vertical self-adjustment.

Rack-cal′i-pers. Calipers whose legs are opened and closed by rack-and-pinion motion.

Rack-com′pass. A joiner's compass, with a rack adjustment.

Rack′et. 1. A stringed battledore.

2. A snow-shoe.

3. A wooden sole for a man or horse to support the body when treading on soft or swampy ground.

Rack′et-wheel. A wheel toothed to receive a click or pawl. A *ratchet*-wheel.

Rack-hook. (*Horology.*) A device in the striking part of a repeating clock, which successively engages the teeth of the *rack* when the hours are struck. The *gathering-piece* or *pallet.*

Rack′ing. 1. (*Mining.*) Washing impurities from the ore.

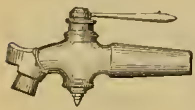
2. (*Nautical.*) Seizing two ropes together by a number of cross-turns. Spun yarn is used for *seizing.*

3. Decanting wine from the lees in a cask, after fermentation or fining.

Rack′ing-can. (*Metal-working.*) A can filled with sour beer, in which wire is steeped before *drawing.*

Rack′ing-cock. A form of faucet used in the cellar for racking off wines or ale.

Fig. 4098.



Racking-Cock.

Rack-rail. One laid alongside the bearing rails of a railway, and having cogs into which meshes a cog-wheel on the locomotive.

Blenkinsop's English patent, 1811. This had a toothed rail laid down on one side of the railway, from end to end. A cog-wheel was rigged out from the locomotive so as to engage with the rack and propel the train. It was at that time supposed that the adhesion of the driving-wheels to the track would not be sufficient under ordinary circumstances to enable the locomotive to draw the train See LOCOMOTIVE, Fig. 2984.

Chapman, in 1812, substituted four pairs of drivers connected by gearing, so as to multiply the frictional contact.

Snowden, in 1824, had a hollow trunk between the two rails and depressed below the surface. On one side of this trunk was a rack, and the trunk itself had rails traversed by a carriage, which the inventor termed the "mechanical horse." On the horse was a vertical shaft with a horizontal cog-wheel at its lower end gearing into the rack, and a bevel-wheel above engaged by a similar wheel on the front of the locomotive, and driven by the engine. As the wheel on the locomotive rotated, the upright shaft conveyed motion to the cog-wheel beneath, and this acting on the rack drew along the mechanical horse and the train connected thereto.

Easton's English patent, 1825, specifies a central rack, placed between the two rails, and a toothed wheel on the locomotive. Guide-rollers bear laterally against the smooth sides of the central bar, in order to keep the carriages from swerving from the track.

The rack-rail is now only to be found in some forms of inclined-plane railways. See also CENTER-RAIL.

Rack-saw. A saw with wide teeth.

Rack-tail. (*Horology.*) A bent arm connected with the toothed segment-rack, by which the striking mechanism of a repeating clock is let off. It has a pin on its end, which falls into that one of the 12 notches of a snail on the star-wheel whose depth and position relative to the center of the star-wheel allows the rack to turn a number of teeth corresponding to the hour which is to be struck.

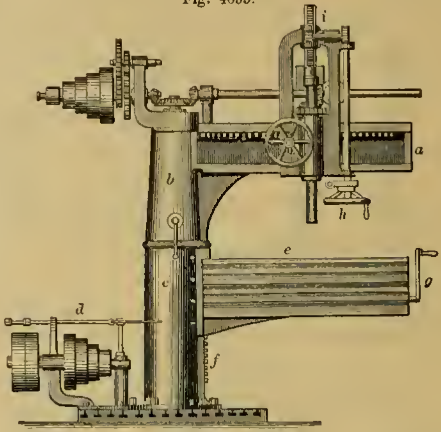
Rad′dle. 1. (*Nautical.*) Interlacing yarns to make flat gasket.

2. (*Weaving.*) A bar with upright pegs, used by weavers to keep the threads in place when winding the warp on to the beam.

3. An iron bar with an end bent at right angles, used by puddlers in stirring the iron in the furnace, and also in making up the balls for the tilt or squeezer. A *rabble.*

Ra′di-al Drill′ing-ma-chine′. An upright machine, designed for drilling a series of holes without changing the position of the work. In Thorne, De Haren & Co.'s, the arm *a* carrying the drill and its gearing is rotatable on the collar *b* surrounding the upper part of the fixed post *c*, on which are the driving-pulleys. The counter-shaft is at the base, and the belt by which they are driven is changed from the loose to the fast pulley and *vice versa* by the belt-shifter *d.* The table *e* is slotted at top and sides, and can be raised or lowered to suit the work, by a pinion working in the rack *f* and operated by the crank *g.*

Fig. 4099.

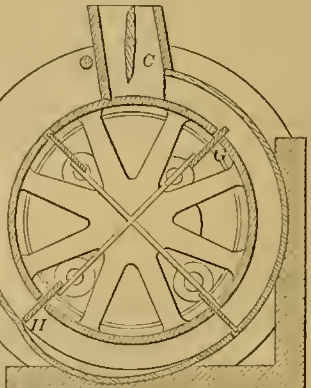


Radial Drilling-Machine.

The drill may be traversed back and forth on the arm *a* by a rack and pinion, and is provided with automatic changeable feed-gears; or the feed motion may be controlled by the hand-wheel *h* through a worm on its shaft, which gears with a worm-wheel whose shaft carries a pinion meshing with the feeding-rack *i.* See also HORIZONTAL LATHE; BORING-MACHINE; DRILL.

Ra′di-al-pis′ton Wa′ter-wheel. One having floats which are projected from the periphery against the breasting. The wheel receives its water a little past the meridian, where the sliding pistons *G H*

Fig. 4100.



Radial-Piston Water-Wheel.

begin to protrude to receive the force of the water admitted through the gate *C*, and before the arm becomes vertical; it extends all the way to the inner periphery of an apron which confines all the water behind. The sliding arms have friction-rollers to facilitate their movement, which is directed by an interior arrangement of cams.

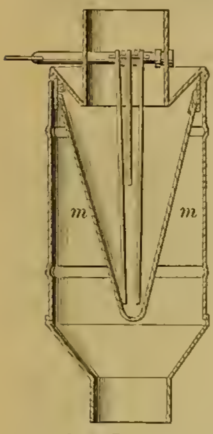
Ra′di-al Plan′ing-ma-chine′. (*Wood-working.*) A machine for chamfering or cornering the edges of timbers. It has a conical cutter, which ordinarily chamfers the edge to an angle of 45°. A pair of such cutters on an axis, at a regulated distance apart, to adapt the machine to given dimensions of timber, will chamfer both edges at one operation.

Ra′di-a′tor. (*Heating.*) A chamber or drum in an apartment, heated by steam or hot air and *radiating* warmth into the apartment.

It may be placed above a fireplace, stove, or furnace, and be heated by the volatile products of combustion on their way to the chimney; or it may form a part of a steam circulation, deriving its heat by steam-pipes from a boiler. See HEATING-APPARATUS.

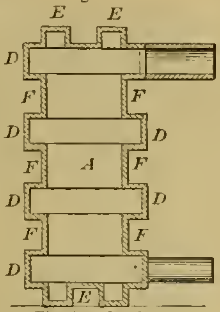
In Fig. 4101 segmental wings *m m* forming an inverted cone are arranged in a stove-pipe drum, and adjusted by links or rods connecting with a crank. When opened, the products of combustion pass freely through the drum, and when closed they flow through a narrow opening between the base of the cone and the case of the drum.

Fig. 4101.



Stove-Drum.

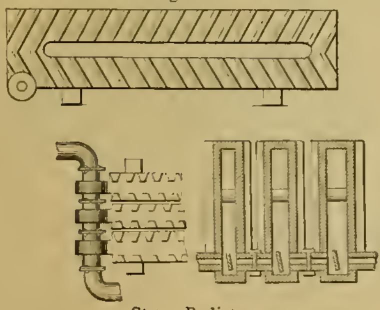
Fig. 4102.



Fireplace-Radiator.

In Fig. 4102, the chamber *A* is made of cast-iron or other suitable material, with alternate projections *D E* and recesses *F* placed within the fireplace. A pipe at the bottom communicates external air to it, and from the top a pipe leads off the heated air as desired.

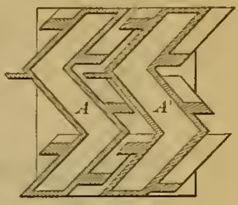
Fig. 4103.



Steam-Radiator.

In Fig. 4103 the radiator is made in sections, each of which has a circuitous passage, and at one end is associated with a series of similar sections, their coincident openings making a continuous pipe with inclined plates to direct the flow into the chambers consecutively. The projections on the outside of the heater force the air into a tortuous course and increase the radiating surface.

Fig. 4104.



Steam-Radiator.

Fig. 4104 has a number of steam-heated hollow sections *A A′* having a zigzag form; the spaces intervening between the sections are air-passages made tortuous by inclined ribs projecting from the sections.

Ra′di-om′e-ter. A *fore-staff.* An instrument for taking the altitudes of the celestial bodies.

Ra′di-us. The movable limb of a sextant or other angular instrument.

Ra′di-us-bar. (*Steam-engine.*) *Radius-rod. Bridle-rod.* One of two duplicate rods, which, pivoted at one end to a beam and at the other to one of the hanging links, serve in the parallel motion of Watt to guide the piston-rod in a vertical direction by counteracting the vibratory motion communicated by the beam. See PARALLEL MOTION.

Ra′di-us-rod. (*Steam-engine.*) One of the guiding-rods in a parallel motion, jointed to the connecting-links, to counteract the vibratory motion communicated by the beam, by guiding the links so that the head of the piston-rod may reciprocate in a line sensibly straight.

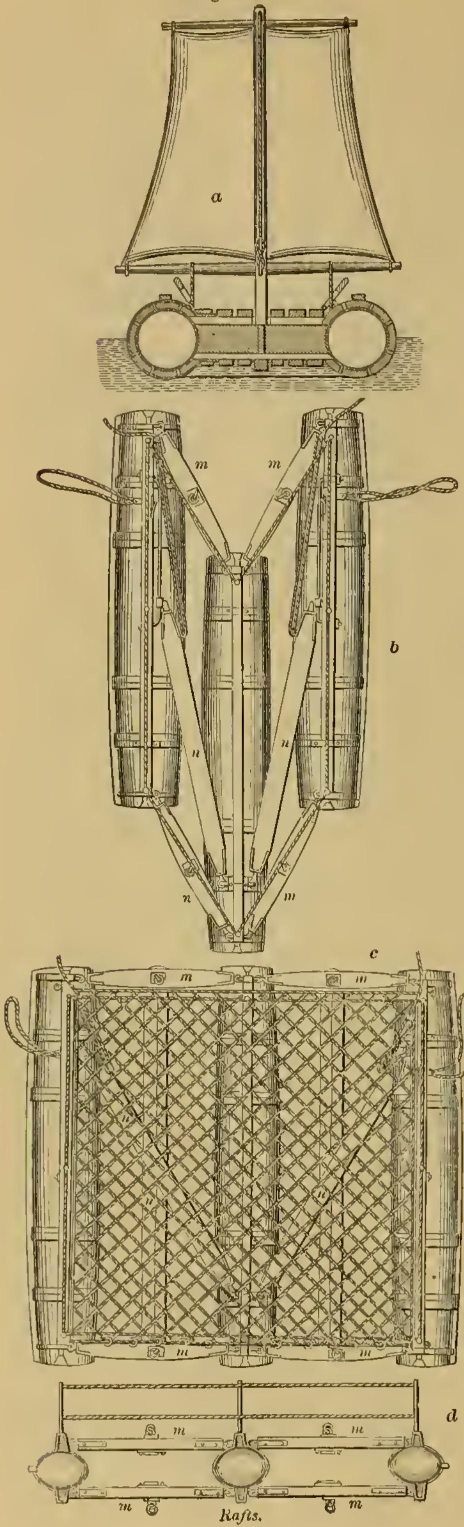
Raft. A structure depending for its capacity for carrying persons or freight upon the lightness relatively to water of the materials of which it is composed. Excepting as to lumber-rafts, which are made up of logs and sawed lumber attached together in order to be floated to a shipping port or to market, rafts are usually a device made and used in an exigency; such are those made in the emergency of shipwreck, among the most notable instances of which is the loss of the French frigate "Medusa."

This melancholy event occurred in the year 1816. The "Medusa," having on board, in addition to her crew, a detachment of soldiers designed to garrison the fort at St. Louis River, Senegal, Africa, which had been given up by the English under the treaty of the preceding year, struck unexpectedly on the Arguin bank a dangerous shoal, lying some twelve or fifteen leagues from the African coast, in latitude 20° north; a large raft was hastily constructed by lashing together such spars and other materials as were at hand, and on this the majority of the persons on board were embarked, the boats of the ship sufficing for only a comparatively small number. When all were on the raft it was submerged until the water came nearly up to their waists. There was consequently little room for provisions or water; a small quantity of bread, wine, and brandy was, however, taken.

It had been arranged that the boats were to tow the raft to shore, which it was supposed could be done in two or three days, but during the night succeeding the disaster, they inhumanly cast off the towing lines, leaving those on the raft to their fate. A frightful scene of disorder and bloodshed then ensued. Maddened by thirst, rendered desperate by the appalling hopelessness of their situation and by the liquor which some of them had succeeded in surreptitiously obtaining, all discipline was lost, and part made a combined attack upon the rest, with the object of forcing them overboard. This riot was finally quelled by the captain, who had remained on the raft, with the assistance of some of the more self-possessed portion of the crew and soldiers; but when day dawned, it was found that one third of their number were missing, having been killed in suppressing the disorder, washed off the raft, or thrown overboard by others.

Successive frays occurred, resulting in loss of life among the remainder; more were washed off by the sea, and many died

Fig. 4105.

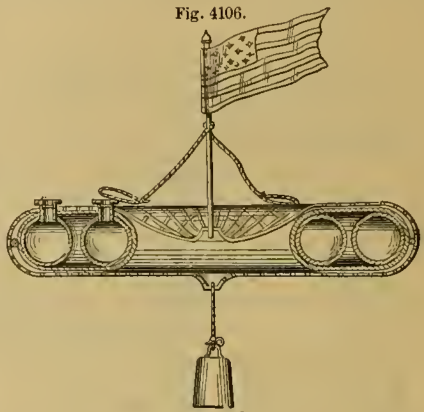


Rafts.

from thirst and exhaustion. When, after drifting for nearly two weeks almost within sight of land, the raft was finally discovered by a passing vessel, scarce a half-score of survivors remained.

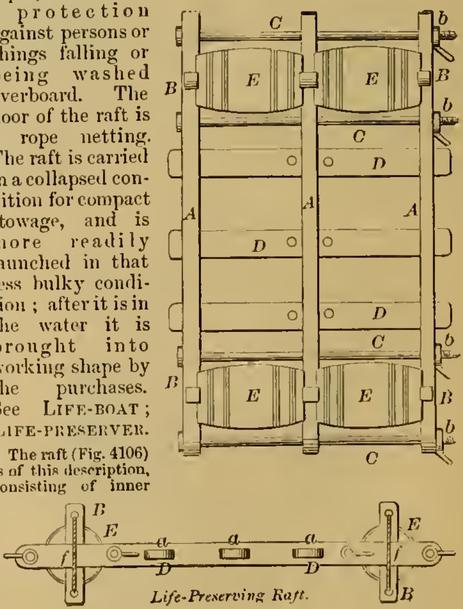
Rafts are made of materials usually accessible on shipboard, spars lashed together by ropes, the flotative power being increased by empty casks lashed in the structure. When made and furnished as a part of the ship's equipment, they are constructed with pontons, as in the illustrations annexed. In the upper one (*a*), two pontons are united by a frame on which is a grating for the passengers and means for stepping and supporting a mast. The other figures represent a raft in different conditions. *b* is a top view, showing the raft in a partially collapsed condition, the three pontons being united by hinged bars *m*, which are operated by tackle, so as to extend the structure into the form shown in the view *c*. The bars *n* in this latter condition form diagonal braces, while the bars *m* are transverse. The view shown at *d* is a transverse vertical section, and exhibits the stanchions and ropes, which form a protection against persons or things falling or being washed overboard. The floor of the raft is a rope netting. The raft is carried in a collapsed condition for compact stowage, and is more readily launched in that less bulky condition; after it is in the water it is brought into working shape by the purchases. See LIFE-BOAT; LIFE-PRESERVER.

Fig. 4106.



Life-Raft.

Fig. 4107.



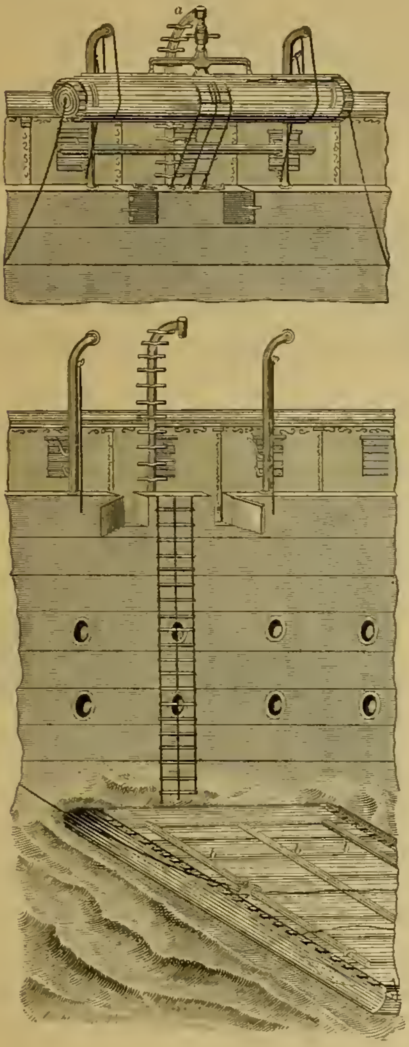
Life-Preserving Raft.

The raft (Fig. 4106) is of this description, consisting of inner and outer india-rubber tubes, which are separately inflatable, and surrounded by a connecting network, from the lower part of which a weight may be suspended to prevent capsizing.

The frame of the life-preserving raft (Fig. 4107) is composed of side-bars *A A*, held together by screw-threaded rods *C*, having tightening-nuts *b* at their ends, and by cross-bars *D D* tenoned to fit mortises *a a* in the side-bars; standards *B B* are grooved to receive the chimes of barrels *E* halved into the side-bars, and have holes through which lashing ropes are passed. The detached parts are stowed in any convenient part of the ship, so that they may be immediately assembled in case of emergency. Special barrels may be provided, or ordinary water-tight casks may be used.

The raft (Fig. 4108) consists of a large air mattress, having a number of wooden slats on its upper side, and covered with a canvas deck. It is ordinarily kept rolled up and suspended from a pair of davits. For use it is unrolled by casting off the end supporting ropes and inflated through the hollow pillar *a* from a reservoir below, kept constantly full of compressed air. After being launched it is stiffened by pushing iron rods through the three flexible tubes *b b b* longitudinally to the mattress.

Fig. 4108.

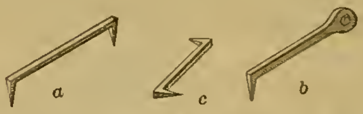


Raft

Raft-bridge. (*Hydraulic Engineering.*) A bridge of expediency, where rafts are used as pontons to support the beams and the track. The rafts are anchored by guys, shore-ropes, or moorings, according to the nature of the case. The general construction of the roadway is similar to that of the PONTON-BRIDGE (which see).

Raft-dog. (*Lumbering.*) A bar *a*, with bent-over and pointed ends, for securing logs together in a raft.

Fig. 4109.



a, *Raft-Dog.* *b*, *Raft-Hook.* *c*, *Raker.*

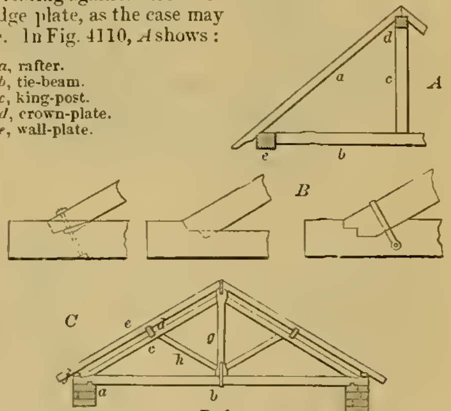
A *dog-hook b* is for securing a rope to a log or raft.

In the lumber regions, trees, after being cut down and deprived of their limbs, are hauled to the nearest available stream and deposited close to the water's edge. This work is done in winter, as the logs are then easily hauled over the snow-covered ground, and deposited where they can be readily floated off when the spring freshets occur. Dogs and similar appliances are used to launch such logs as are not floated by the stream, and when all are fairly under way the timber-cutters follow the run of logs down to push off any which may become lodged, or, in case they become jammed in a gorge, to disentangle the mass, — often a difficult and perilous operation. On arriving at the point where they are to be converted into squared timber or boards, as the case may be, they are intercepted by a boom stretched across the stream, and are caught and arranged according to ownership by men stationed there for the purpose, the logs belonging to each proprietor having been marked so as to be readily identified.

Raft'er. (*Building.*) One of the pieces of timber which follows the slope of the roof, and to which is secured the lath into which the shingle or slate nails are driven. The rafter, in one or more lengths, extends from the eave to the ridge of the roof; at its lower end resting on the wall-plates, and at its upper end abutting upon a corresponding rafter rising from the opposite side of the roof, or resting against a crown or ridge plate, as the case may be. In Fig. 4110, *A* shows:

a, rafter.
b, tie-beam.
c, king-post.
d, crown-plate.
e, wall-plate.

Fig. 4110.



Rafters

The foot of the rafter is mortised or otherwise secured to the tie-beam, as shown at *B*.

In some roofs heavy scantling are framed between the tie-beam and shoulders on the king-post, and are called *principal rafters*. The ordinary rafters then rest upon a pole-plate, purlin, and ridge-plate. See KING-POST.

Rafters, though all performing the same general duty, have specific names according to their particular functions, as, —

Arched rafter. One of segmental form in an arched roof.

Auxiliary rafters are timbers framed beneath the *principal rafters*, to support them. They are known also as *cushion rafters*, or *principal braces*.

A *binding* rafter is one which acts as a tie. *Chief* rafter, a *principal* rafter.

Common rafters are those on which rest the sheeting or lathing, to which the slates or shingles are secured. *C* (Fig. 4110) shows a mode of forming a king-post truss : —

a, wall-plate.	*e*, common rafter.
b, tie-beam.	*f*, pole-plate.
c, principal rafter.	*g*, king-post.
d, purlin.	*h*, purlin-post or strut.

Curb rafter. One of the pair forming the truss in an ordinary curb roof.

Hip rafter. That which occupies the angle of a *hip roof*, and into which the upper ends of the short rafters of the sides and ends are framed.

Intermediate rafter. One between principals or common, to strengthen at a given place.

Jack rafter. A short rafter let into the hip rafter at the angles of a hip roof.

A *principal rafter* is one of a pair in the sides of a truss which have the slant of the roof and support the purlins on which the common rafters rest.

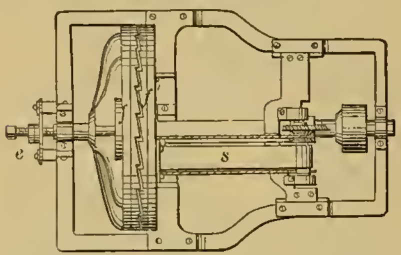
Raft-port. (*Shipbuilding.*) A square port in the sides of a vessel for passing cargo.

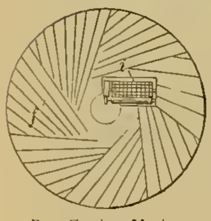
Rag-bolt. A bolt having backwardly projecting barbs or jags to prevent it from being easily withdrawn after having been driven. A *barbed* bolt.

Rag-car′pet. A carpet with a cotton or hempen chain and a filling or weft of strips of rags or cloth, sewed together end on end.

Rag-cut′ting Ma-chine′. (*Paper-making.*) A machine for comminuting rags preparatory to pulping. Fig. 4111 has a rotating disk *f* with cutters on its face, and a stationary disk *f′* with an aperture through which rags placed on the endless apron *s* are fed in between the two to be operated on by means of a roller *i*; the two disks may be separated for cleaning, etc., by means of a screw device *e*. See RAG-ENGINE; PULPING-MACHINE; PULP-GRINDER.

Fig. 4111.





Rag-Cutting Machine.

Rag-dust′er. (*Paper-making.*) A machine for removing the dust, etc., from rags previous to washing them.

Debit's (1829) is a wire-cloth cylinder having a rotating axis provided with spokes.

Burt's (1836–38) has a wire-cloth revolving cylinder containing rotating longitudinal shafts armed with beaters.

In Carriel's (1831) the wire-cloth cylinder in which the rags are placed has exterior longitudinal radial wings to carry off the dust.

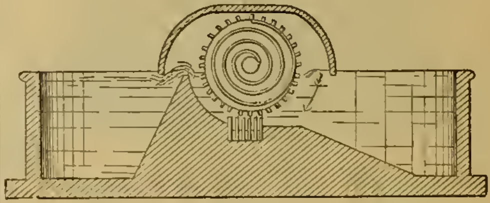
Rag-en′gine. (*Paper-making.*) The machine in which rags are partially comminuted.

Until the present century, rags were reduced to pulp for paper by means of mashing and incipient fermentation. Stamping-mills were then introduced, but the iron stamps in oak mortars are stated to have been so slow that 40 pairs working 24 hours would only reduce 112 pounds of rags. The rag-engine was invented in Holland, about 1750, but it was many years before it reached England.

It consists of an oblong trough containing one or more rotating cylinders having cutters on their peripheries, which work against similar cutters fixed in the bottom of the trough, which is curved to correspond with the cylinder and form a partition over which the stuff passes and repasses during the process of comminution.

Fig. 4112 has a spiral flange on each end of the cylinder, to prevent the collection of rags around the cylinder and avoid choking; its action tends to throw off the pulp from the center to the circumference.

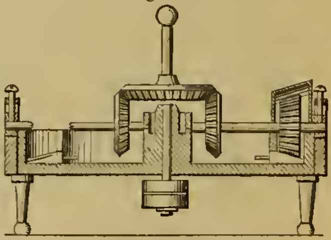
Fig. 4112.



Rag-Engine.

Fig. 4113 has an annular stationary trough with knives in the bed and conical rollers, which rotate above. The place of the roller on the left is vacant.

Fig. 4113



Rag-Engine.

Another form of engine has a series of circular saws on a mandrel operating in the notched end of a feed-board. (Clarke and Albertson, 1838.)

Still another form has a drum armed with prongs revolving in a cylinder with internally projecting bars.

Rag′ging. 1. (*Metallurgy.*) The rough breaking of ore to reduce its size and enable the rejection of the poorer portions.

2. Also termed *straggling*. Rough-dressing the surface of a grindstone to clear its face of imbedded metallic particles. The stone is turned as usual, while a piece of ¼-inch soft iron is worked against it, as if turning off the stone, a rocking motion being imparted to the tool.

The same plan is adopted in evening the face of a stone which has worn into holes, owing to inequality of hardness in its various parts.

A better plan is to hang two stones so that the surface of each may turn against that of the other, thus preventing the formation of ridges and hollows.

Rag′ging-ham′mer. (*Metallurgy.*) A steel-headed hammer, weighing 6 to 8 pounds. It is used in rough-dressing ores.

Rag-wheel. Another name for the SPROCKET-

WHEEL (which see). The periphery has pins or projecting portions, which are caught by the links of the chain.

Rag-work. (*Masonry.*) Wall laid with undressed flat stones of about the thickness of a brick, and leaving a rough exterior from whence the name is derived.

Rail. A horizontal or inclined piece of wood or metal connecting two posts or uprights; as, —

1. (*Joinery.*) *a.* One of the pieces connecting the *posts* of a bedstead. Known as *head-rail*, *foot-rail*, *side-rail*, according to position.

b. A horizontal piece in a frame, as of a door, sash, or other paneled work. In a door, the *rails* are mortised into the *stiles*, and together with the latter surround the *panel*. In *sash*, the *panel* is absent or may be said to consist of a pane or panes of glass.

c. The upper piece into which the balusters of a stair or balustrade are mortised.

2. (*Shipbuilding.*) *a.* The top of the bulwarks proper; that part continued around the stern is the *taffrail*. When it crowns the top-gallant bulwarks it is the *top-gallant* rail.

b. A curved timber extending from the bow of a ship to support the knee of the head.

3. (*Railway.*) The bar supported on sleepers and affording a track for car-wheels.

The history of the *rail* commences with paving and tramways, the latter being smooth stone blocks for the wheels on each side of a rougher track for the horses. These ways came to be made of timbers, and eventually of iron, being at the first but flat strips laid on continuous sleepers, but eventually of bars which are sufficiently strong to span the distance between transverse sleepers. The work of improvement began in earnest in the English collieries.

Wooden railways were laid at Newcastle in 1602. These were laid parallel and imbedded in the ordinary road. "The rollers of the carts were made to fit the rails." (NORTH, 1676.) After a while the rails were laid on cross-ties and pinned thereto

In 1716 flat plates of malleable iron were nailed to the wooden rails. (*a*, *flat rail.*)

In 1767 the Coalbrookdale works laid down flat cast-iron rails

In 1776 cast-iron rails, with an upright flange, were laid on wooden sleepers and used at the Duke of Norfolk's colliery, near Sheffield. (Carr's patent, *b*.) They were spiked down. The flange was put on the rail before it was put on the wheel.

In 1789 Loughborough's cast-iron edge-rail, with flanges on the wagon wheels

In 1793 stone bearers were substituted for wooden sleepers at Little Eaton, in Derbyshire.

Wrought-iron bars, two or three inches in thickness, spiked to longitudinal sleepers, were then used in connection with flanged wheels.

Wyatt's cast edge-rail of oval section (*c*) was then used in connection with grooved wheels at Peorhyo slate quarries, in 1800.

Jessop used this rail in 1789, and added the chair (*d*), a block of iron slotted to receive the ends of adjacent rails. The wheel had a tread of 2½ inches, and a flange to keep it on the rail. The sleepers were of wood.

Woodhouse's hollow rail (*e*), with a channel for the rounded edge of the wheel, 1803.

The fish-bellied rail at Penrhvn, 1805.

Bleokinsop's rack-rail (*f*), 1811. See Fig 2984, page 1344.

A square-bodied cast rail (*g*), 1810.

Losh and Stephenson's flanged rail (*h*), 1816. This was a lapping continuous rail

Hawk's cast-iron face upon a wrought-iron base, 1817.

Birkenshaw's malleable face upon a cast base, 1820.

Birkenshaw, of Bedlington, Durham, invented the rolled rail; the iron, while hot, being passed between grooved rollers of the required pattern (*i j k l*).

m n o p are respectively the Spanish, Marseilles, Strasburg, and Great Western (England) patterns.

q, Durham and Sunderland, England.

r, Berlin and Potsdam, Prussia.

s, London and Blackwall, England.

t, Manchester and Birmingham, England.

u, Saint-Etienne to Lyon, France.

v, Wilmington and Susquehanna, United States.

w, Great Western (Old), England

x, London and Croydon, England, which first dispensed with longitudinal sleepers and chairs.

y, Morris and Prevost, England.

z, Birmingham and Gloucester, England.

a', London and Birmingham, England.

b', London and Brighton, England.

c', Midland counties, England.

d', contractor's rail.

e', street-car rail.

f', locomotive street-rail.

g', continuous rail.

h', tubular rail.

j', King's rail, with steel cap.

k', Potter's rail, with steel facing rolled in.

l', Hymer's rail, with a steel upper section, iron foot, and fish-plates.

m', Ashcroft's rail, with a steel tread and double foot.

n', Jones's rail, with a steel tread and forked foot.

o', Booth's rail, with an overlapping steel tread-plate See FAGOT: Fig. 1914, page 823.

p', Losh's fish-bellied rail and chair (1816); the rail fastened with keys.

q' Brunton and Shield's rail and chair

r', English rail and chair, 1840.

s', Samuel's cast-iron sleeper.

t', Barlow's rail (English).

u', tubular socketed rail.

v', Seaton's saddle-rail.

w', elastic rail.

x', Pierce's rail, on high standard.

y', Greave's pot-sleeper.

z', Reynold's continuous bearing.

o'', Stephenson's chair and rail

b'', Adams's rail.

c'', Button's rail, with steel top.

d'', Brooks's steel-capped rail.

e'', Lewis's rail.

f'', Hanmer and Grim's steel-topped rail.

g'', Hagan's rail

h'', Chamber's rail, on elastic webs

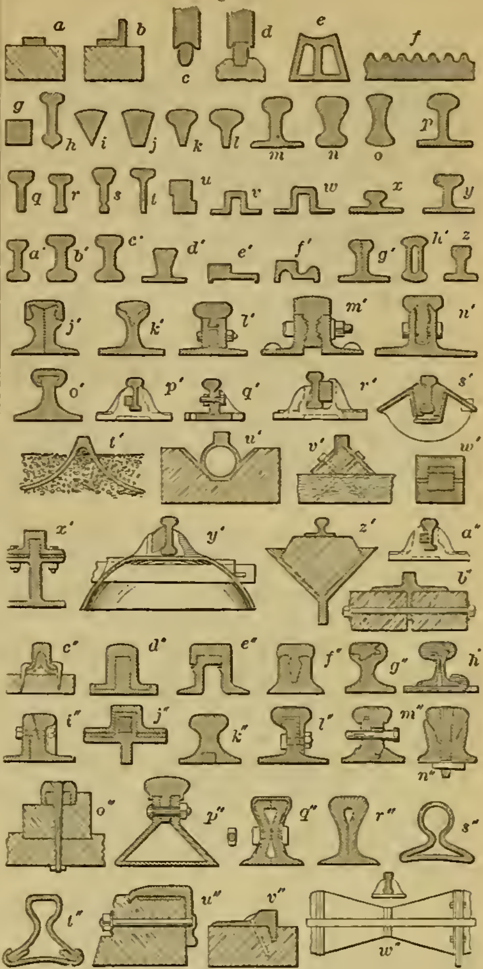
i'', Robinson's double rail.

j'', Pierce's rail.

k'', Peckham's rail.

l'', Perkins's rail

Fig. 4114.



Railway-Rails.

m'', Shephard's steel-top rail.
n'', Day and Mercor's rail.
o'', Dwight's rail.
p'', Zahn's rail.
q'', Johnston's rail.
r'', Stephens and Jenkins's rail.
s'', Sanborn's tubular rail.
t'', Sanborn's rail.
u'' Angle's L-rail on continuous sleeper.
v'', Dean and Coleman's street-car rail.
w'', rail and sleeper, for the East Indies. The sleeper is bent from a plate of wrought-iron to resist the attacks of insects which destroy wooden sleepers.

Parkin's vitrified sleeper, patented in England in 1835, consists of hard sleepers of molded and baked blocks laid in continuity, tongues and recesses on adjacent blocks serving to lock them together. A timber strip was interposed between the row of blocks and the rail.

Grime's English patent, 1831, specified a hollow rail charged with steam from stationary boilers at intervals of two or three miles, and intended to keep them clear of ice and snow.

The first steel rail was made in 1857, by Mushet, at the Ebbw-Vale Iron Co.'s Works in South Wales. It was rolled from cast blooms of Bessemer steel and laid down at Derby, England, and remained sixteen years, during which time 250 trains and at least 250 detached engines and tenders passed over it daily. Taking 312 working days in each year, we have the total of 1,252,000 trains and 1,252,000 detached engines and tenders which passed over it from the time it was first laid before it was removed to be worked over.

The substitution of steel for iron, to an extent rendered possible by the Bessemer process, has worked a great and abiding change in the condition of our ways, giving greater endurance both in respect of wear and in resistance to breaking strains and jars.

Two steel rails of twenty-one feet in length were laid on the 21 of May, 1862, at the Chalk Farm Bridge, side by side with two ordinary rails. After having outlasted sixteen faces of the ordinary rails, the steel ones were taken up and examined, and it was found that at the expiration of three years and three months, the surface was evenly worn to the extent of only a little more than a quarter of an inch, and to all appearance they were capable of enduring a great deal more work. These two rails had, during the period of little more than three years, been exposed to the traffic of 9,550,000 engines, trucks, and carriages, and 95,577,240 tons. It is an amount of traffic equal to nearly ten times that which destroyed the Great Northern rails in three years. The result of this trial was to induce the London and Northwestern to enter very extensively into the employment of steel rails.

Railway rails are made of puddled steel at the Höerdér Iron and Steel Works, Westphalia. The process consists in bringing a number of balls together to a heavy hammer (say a 12-ton steam-hammer), which welds them together into a homogeneous bloom. The faces of the hammer and anvil are hollow, so as to keep the metal together, and the bloom is sent at the same heat to the rolls.

A number of puddled steel balls are welded into one, in a furnace, as a single puddled ball is not large enough to make a rail.

Weight. The tendency to increase the stability of the track by increasing the weight has led to a deterioration in the quality of the rail, and the lamination and wear have more than compensated for any immobility due to weight.

Mr. Holley, after the great wear endured by the 45-pound rails made by the Ebbw-Vale Company for the Philadelphia and Reading Railway Company, in 1837, and comparing the long life of the 45-pound rail with that of the 64 and 68 pound rails which replaced them, goes into a consideration of the substitution of lighter for heavier rails on many of the English railways.

"The true course," he remarks, "is in the use of the best of iron in moderately light rails. The cost per ton is increased but by a comparatively small amount. while the durability may be doubled. One advantage of a light rail is, that its very size ensures more work being expended upon it."

The reduction in weight has been in the head and stem of the rails. The same depth is preserved, about five inches.

Length. Rails are made in England from 15 to 21 feet long, the latter being usual. One railroad is said to be furnished with rails of 30 feet. A Welsh rolling-mill furnished a Barlow rail 52½ feet long, but it was done as a trophy. Wrought-iron rafters were rolled at Phœnixville, Pa., for the United States Capitol, having a length of 51⅙ feet. Iron plates for the Collins steamers were rolled at Troy, N. Y., 60 feet in length, from piles of 700 pounds weight.

Depth. The depth of the most lasting English rails is stated to be from 4½ to 5½ inches, mostly 5 inches.

The Sandwich rail is made with a depth of 8 inches, the web being very deep, and from ¼ to ⅜ inch thick. It is prevented from lateral deflection by side sleepers which clamp the web, and the head of the rail rests on the side supports.

The great depth saves the rail from vertical deflection, and the longitudinal sleepers preserve it laterally. The rail is *double-headed*.

A rail is an iron beam, and the stiffness is as the cube of the depth; the result being modified by the flanges.

Width. The width of rails is from 2¼ to 3 inches. The top has a curve of a radius of 5 to 5¼ inches.

Form. The resistance of wrought-iron to extension and compression is as 90 of the first to 66 of the second. These proportions should therefore exist in a rail when it is not to be reversed.

"The life of iron rails of best quality has been found to be 35,000,000 tons over a double line, or 17,000,000 over each single rail, and many from the best makers stand only 5,500,000 to 15,000,000 tons, the greatest wear being in cuttings and tunnels where there is the least elasticity. The average life of an iron rail being 15,000,000 tons, or equal to 100,000 trains of 150 tons each, independently of the length of time of the traffic, the wear may be estimated as the 1-100000th part of the value of the rail each time a train goes over it; and if the value of a mile of iron rails be taken at $5,000, the wear would be 5 cents per train mile.

"On the Great Northern Railway, at Barnet, the life of an iron rail was 5 years, with 13,484,661 tons of fast trains, and 38,303,028 tons slow traffic. Steel rails were only half worn out with 95,577,240 tons traffic. As the life of an iron rail is but 1-6th of a steel rail, it must follow that a great excess of mechanical work, represented in destruction of the iron rails by the rolling stock, must ensue. Locomotive power depending mainly on the resistance to traction (due to the deflection of track and abrasion) costs 25 cents to 31 cents per train mile, and anything which will reduce this by 1-5th or 1-6th will soon effect a saving equal to the whole cost of the rails.

"On falling gradients, with the traffic, the wear is greatest, owing to the momentum acquired; on a falling gradient of 1 in 130, a mixed traffic of 62,399 trains, gross tonnage 12,451,784 tons, wore out the best samples of iron rails in 7½ years; on a level, with a heavy all-one-way traffic, same description of rails required 203,122 trains, and 38,803,128 tons, to wear them out in 7½ years.

"The destructive effects of high speed, with the same engine and everything similar, were such that the same rails required more than three times the traffic to wear them out at the lower speeds; and for equal quantities of traffic the wear of the rail is in the ratio of the square of the velocity (the matter in front compressed by the weight of the wheel is in proportion to the shortness of the time of passage, the resistance being as the square of the velocity).

"On mineral roads, with heavy up and down grades, with diminished speed up grade and accelerated speed down grade, the wear and tear is considerably greater than if the same space is traversed at a uniform speed equal to the average speed.

"The wear of a rail placed upon a chair upon a tie was similar to the effect of pounding a rail upon an anvil, the end flattens into a fan shape, while, if suspended, being sustained by fish-plates, the hammering action of the train, being over a void, falls harmless on the ends of the rail." — *Engineering.*

Allowance for expansion of joints of a 20-foot rail: —

At 100° Fah. place them in contact.	
90° Fah. at a distance of	.016 inch.
80° Fah. at a distance of	.032 "
70° Fah. at a distance of	.049 "
60° Fah. at a distance of	.065 "
50° Fah. at a distance of	.082 "
40° Fah. at a distance of	.098 "
30° Fah. at a distance of	.104 "
20° Fah. at a distance of	.131 "
10° Fah. at a distance of	.147 "
0° Fah. at a distance of	.163 "
—10° Fah. at a distance of	.179 "
—20° Fah. at a distance of	.212 "
—30° Fah. at a distance of	.296 "

See under the following list, which includes other than railway rails: —

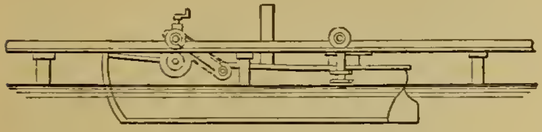
Barn-door rail.
Belly-rail.
Bridge-rail.
Capped rail.
Center-rail.
Champignon-rail.
Compound rail.
Continuous rail.
Crossing-rail
Double-headed rail.
Edge-rail.
False rail.
Fish-bellied rail.
Flange-rail.
Flat rail.
Foot-rail.
Frog.
Guard-rail.
Guide-rail.
Hand-rail.
Head-rail.
Hollow-rail.
I-rail
Lock-rail.
Plate-rail.
Rack-rail.
Rail-coupling.
Rail-guard.
Rail-jack.
Railway.
Railway-rail.
Saddle-rail.

Safety-way.
Sash-rail.
Side-way.
Slide-rail.
Splice.
Steel-headed rail.
Steel-topped rail.
Switch.
Three-headed rail.
Track-rail.
T-rail.
Tram-plate.
Tubular rail.
Wing-rail.
Wooden rail.

Rail and Trav'ers-ing-wheel Pro-pel'ler. A device for propelling canal-boats.

Fig. 4115 comprises a continuous rail supported by posts upon the bank, and its upper and lower surfaces are traversed by wheels upon an arm extending from the boat, the wheel being rotated by a motor on board.

Fig. 4115.



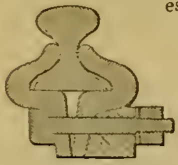
Rail and Traversing-Wheel Propeller.

Rail-bend'er. (*Railway Engineering.*) An implement for bending or straightening rails, or for breaking steel rails to such lengths as may be required. It has two curved branches on which the rail rests, while a powerful screw or a plunger operated by hydraulic pressure is brought to bear against it at a point midway between them. The hydraulic form affords the greater power, and is more convenient and expeditious. Frequently called a JIM-CROW (which see). See also *E F*, Plate XXV.

Rail-chair. (*Railway.*) A socket for a rail, where it rests upon the sleeper. See RAILWAY-CHAIR.

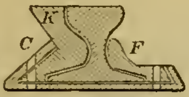
Rail-clamp. (*Railway Engineering.*) A device designed for firmly holding rails on lines of track so as to prevent any shaking motion. Scott's clamp truss-joint (Fig. 4116) is in two parts, the upper curved branches of which are caused to bind the rail by means of a screw-threaded pin passing through their lower branches and a nut. See RAILWAY-CHAIR.

Fig. 4116.



Rail-Clamp.

Fig. 4117.



Rail-Clamp.

In Watkins's (Fig 4117), the rail is held between a brace-key *K* and tightening-key *F*. These are drawn together to hold the rail, and at the same time secured to the sleepers by wedge-shaped spikes driven through them and through the flanged clamp *C*.

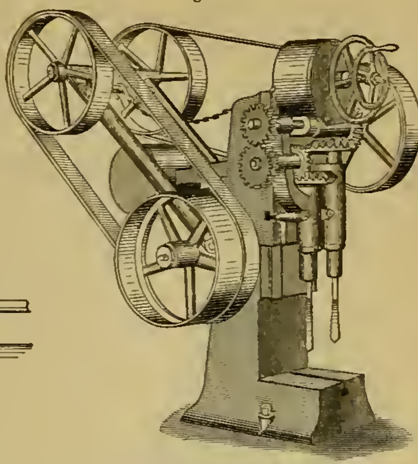
Rail-coup'ling. (*Railway.*) *a.* A bar which ties the two rails of a track together, to prevent spreading at critical points, switches, etc.

b. A fastening plate for the abutting ends of two rails in a track. A *rail-chair* sometimes acts as such.

Rail-drill'ing Ma-chine'. For drilling the holes near the ends of steel rails in which the fish-bar bolts are inserted.

The feed is positive and invariable, though slow, while a rapid rotation is given to the drill, this method being found more advantageous with steel than a comparatively slow rotation with quicker feed. The lubricant is animal oil.

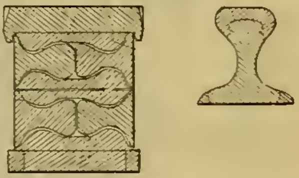
Fig. 4118.



Sellers's Rail-Drilling Machine.

Rail-fag'ot. (*Metal-working.*) The built-up mass from which rails are rolled to proper section and length. In Fig. 4119, the top and bottom plates are wider than the intermediate filling, which consists of two pairs of old rails, cut to length, laid on their sides, their treads in contact, with two B-plates between the pairs and one on top and bottom of the filling and next to the exterior plates. See PILE; FAGOT; BEAM.

Fig. 4119.



Rail-Fagot.

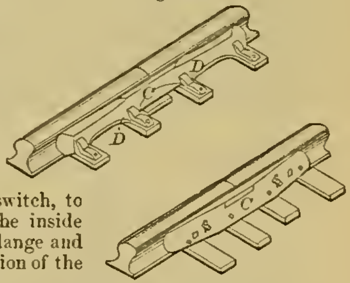
Rail-guard. (*Railway Engineering.*) A device for throwing aside obstructions on the track.

a. In England, the rail-guards are attached to the front of the frame of the locomotive, and reach down within about two inches of the rail, to catch and throw to one side any obstruction which may be on the rails.

b. In America, the *cow-catcher* or *pilot* is a substitute, and is somewhat efficient for the whole width of the track.

c. A guard-rail, as at a switch, to bear against the inside of the wheel-flange and prevent deviation of the wheel.

Fig. 4120.



Rail-jack. (*Railway Engineering.*) An apparatus for lifting railway rails to ballast beneath the ties and level the track. See TRACK-RAISER.

Rail-joint. A device for firmly holding the abutting ends of two adjacent rails. Different arrange-

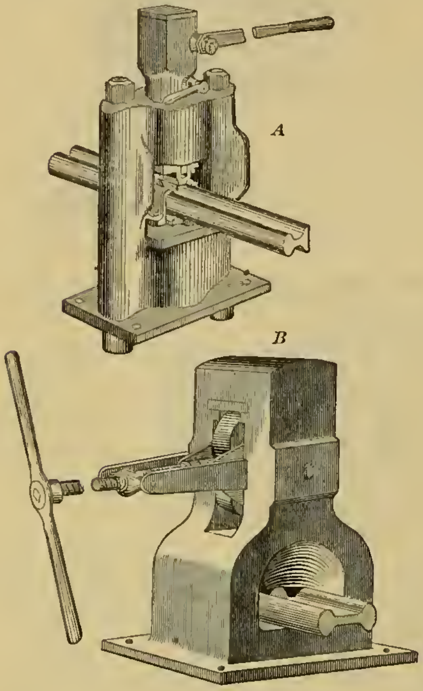
Rail Joint.

ments have been contrived for this purpose. Fig. 4120 consists of a fish-piece *C* of metal or wood plated with metal, sufficiently long to extend over several ties and held to the sleepers by the chairs *D D*. Bolts through the rails may be dispensed with.

Rail-post; Rail′ing-post. (*Building.*) A newel post for a staircase or balustrade.

Rail-punch. For punching the web of railway rails, etc. That shown at *A* is worked by hydraulic pressure, being a slight modification of the Punching-bear (which see). *B* is operated by turning a screw, which causes the surfaces of an upper and a lower cam to roll in contact with each other, imparting a powerful pressure to the lower, which acts on the head of the punch.

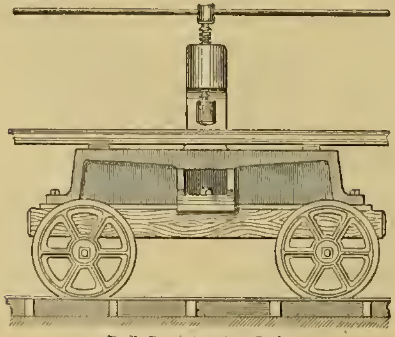
Fig. 4121.



Rail-Punch.

Rail-straight′en-ing Ma-chine′. (*Railway Engineering.*) A machine for straightening crooked rails or iron bars. The illustration shows a portable device of this kind, consisting of a massive cast-iron table mounted on a truck, and having a presser-head operated by a lever which turns a screw working through a box in an upright standard. See also *F*, Plate XXV.

Fig 4122.



Rail-Straightening Jack.

Rail′way. A way or road provided with rails, upon which the wheels of the carriages roll.

Roads with wooden rails (*tramways*) were first laid down by Mr. Beaumont at or in the vicinity of Newcastle, England, 1602. Between this and 1650 they began to become common in the Newcastle coal-fields, and were employed in transporting coal from the pits whence it was extracted to the *staiths* or discharging-places on the Tyne.

Their arrangement was thus described in 1676: —

> "The manner of the carriage is by laying rails of timber from the colliery to the river, exactly straight and parallel; and bulky carts are made, with four rollers fitting those rails, whereby the carriage is so easy, that one horse will draw down four or five chaldrons [1 chaldron = 36 bushels] of coals." These "rails of timber" were laid upon transverse timbers or sleepers, and secured with pegs of wood, the sleepers being imbedded in the material of the roadway.

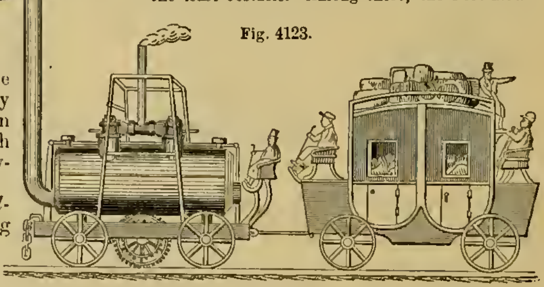
About 1716, the wooden ways were capped by thin plates of malleable iron. Cast-iron bars were substituted in 1767. In 1776, Carr took out a patent for cast-iron rails of L-shape to retain the wheels on the rails without flanges on the wheels. In 1800, stone props instead of timber for supporting the junctions of the rails were invented in Derbyshire by Mr. Outram. The name *tram*-road has been fancifully derived from Outram, but comes from *tram* (Prov. Eng., Sw., and Ger.), a beam; and the *trams* were the wagons which ran thereon. Birkenshaw, in 1820, invented and patented the rolled rail. See Rail, page 1857.

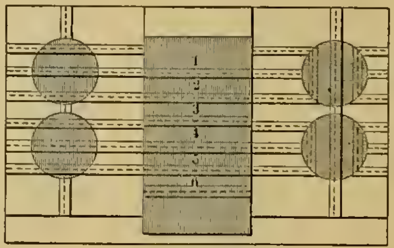
For the history of the Locomotive, see under that head, to avoid repetition.

The following announcement was published in a London periodical, dated August 1, 1802: —

> "The Surrey Iron Railway is now completed over the high-road through Wandsworth town On Wednesday, June 8, several carriages of all descriptions passed over the iron rails without meeting with the least obstacle. Among these, the Portsmouth

Fig. 4123.





Railway Traveling, 1823.

wagon, drawn by eight horses and weighing from 8 to 10 tons, passed over the rails, and did not appear to make the slightest impression on them."

Fig. 4123 illustrates the locomotive, carriage, and track proposed in 1823 for a railway between London and Edinburgh. The locomotive was to have a toothed-wheel gearing with corresponding teeth on the rails, in order to insure sufficient traction. The rails were to be grooved, and carriages shifted sideways from one track to another by means of turntables and by series of rails 1 2 3 4 5 6 laid upon a movable platform. See LOCOMOTIVE.

The locomotive had previously been employed to a limited extent in the mining districts, and engines designed for running on common roads had been constructed as early as the beginning of the century; but it was first used with an encouraging degree of success for ordinary purposes on the Stockton and Darlington Railway, opened September 25, 1825.

Four years later, even a majority of experts were in favor of the use of stationary engines on the Liverpool and Manchester road, and it was not until after George Stephenson with his "Rocket" had practically demonstrated the capabilities of the locomotive, that the project of using the stationary engine was abandoned. This road was publicly opened September 15, 1830.

The first railway in the United States was one of two miles long from Milton to Quincy, in 1826; cars drawn by horses.

The Baltimore and Ohio Railway was commenced July 4, 1828, and was the first passenger railway in America, 15 miles being opened in 1830. The cars were drawn by horses till the next year, when a locomotive was put on the track, built by Davis of York, Pa. It had an upright boiler and cylinder.

The Mohawk and Hudson, 16 miles, from Albany to Schenectady, was the next line opened, during the same year, and the cars were drawn by horses till the delivery of the locomotive "De Witt Clinton," which was built at the West Point Foundry, N. Y. This was the second locomotive built in the United States; the first was made at the same shops for the South Carolina Railway.

The second locomotive on the Baltimore and Ohio Railway was built by James in 1832. It had a spark-arrester. It was the first to use four eccentrics. Its life terminated by explosion.

Baldwin, of Philadelphia, made a locomotive, "Old Ironsides," for the Philadelphia and Germantown Railway, in 1833.

The completion of the Baltimore and Ohio Railway was delayed for many years, largely on account of the difficulty of surmounting the elevation of 2,620 feet, the highest elevation above tide-water attained by that road at Altamont. When finished, this was considered a wonderful achievement; grades of 116 feet to the mile having been deemed insurmountable obstacles: now, however, they are considered but slight impediments, except so far as interfering with speed.

The Union Pacific crosses the summit ridge of the Rocky Mountains at an elevation of 8,460 feet; and the highest point on the railroad between Arequipa and Puno in Peru is 14,586 feet above the sea.

The length of the Panama Railway from the Atlantic to the Pacific Ocean is nearly 48 miles; the summit ridge is 287 feet above the mean tide of the Atlantic. The distance from New York to Hongkong via Cape Horn is more than 17,000 miles, but by this railway across the Isthmus it is less than 12,000, — a saving of 5,500 miles. This railway was opened in January, 1855. Starting from Aspinwall, on the Atlantic side, for Panama, on the Pacific, the traveler is soon in the midst of a scene of tropical beauty hardly to be surpassed in the world. Cocoa-palms and bread-fruit trees wave their branches on either side, and from the fastnesses of murky swamps richly colored aquatic plants rise in luxuriant wildness. The cries of gorgeously plumaged birds are heard on all sides, and now and then the discordant notes of monkeys, parrots, and other natives of the woods. On the low muddy banks of streams can be seen the huge forms of alligators sunning themselves and awaiting some unlucky object of prey. The towering trees are clasped in the vice-like embrace of plants of parasitic growth, and many tottering trunks attest the effect of close companionship. Along the sides of the road and upon the woody banks of the streams passed over are to be seen the thatched habitations of the mongrel specimens of humanity that live on the Isthmus. The rainy season commences in May and lasts until October, and it rains "hot water," according to the statement of the residents The wires of the Isthmus Telegraph Company run alongside the tracks. The dampness of the earth is guarded against by setting the telegraph-poles in concrete: the railroad-ties are made of lignum-vitæ, laid on a stone ballast. The telegraph-poles cost $5 each, and the railroad-ties $1.50 and $2 each. The railroad and rolling-stock have probably cost $12,000,000.

Stimpson's patents of 1831, 1835, describe the mode of turning curves in streets by raising the outer rail of the curve, so that the flanges of the off-wheels shall run above the rail, the tread of the inner wheels resting on the inner rail.

Among the *auxiliary devices to enable locomotives to ascend heavy grades* may be enumerated: —

A *center-rail*, grasped by horizontally rotating wheel or rollers, gripping the rail and driven by the power of the engine. See CENTER-RAIL

A *rack-rail*, laid along the track and engaged by a cog-wheel upon and driven by the engine. See RACK-RAIL

Converting each wheel of the train into a driver, by a temporary connection with the engine of the axles throughout the train.

James's English patent, 1825, has a horizontal shaft extended by couplings beneath the carriages the whole length of the train. This shaft was rotated by the engine when required, and connected by bevel-gearing with the axles of each car throughout the train.

The railway up the Rigi, in Switzerland, on the borders of Lake Lucerne, shown in Fig. 4124, is the work of three German engineers, Herren Riggenbach, Naeff, and Zschokke, the first-named gentleman having proposed the construction, an idea which was suggested to him by a visit to the Mount Washington Railroad, in this country.

The Rigi line starts from Vitznau, on the borders of the lake, and rises up the mountain-side to a station at Staffelhöhe, which is above the hotel and bath establishment, called Rigi Kaltbad, and well known to most travelers in Switzerland. The length of the line is 5,760 yards (about 3¼ miles), and the hight of the upper terminus above the lower is 3,937 feet, being an average ascending gradient of about 1 in 4½. After leaving Vitznau, the grades vary from 1 in 5.56 to 1 in 4. Among the instances of bold and difficult construction exhibited by this work is a bridge of three spans over a defile in the mountain, the track going into the side of a rock and through a tunnel. The bridge and tunnel together are 525 feet long, the grade being 1 in 4 and the direction a very sharp curve. The track is very solid and well built, and the locomotives have vertical boilers placed in the middle of their length. The boilers maintain their perpendicularity in ascending grades of 1 in 5¼.

The line was opened for public traffic on May 23, 1873.

Coleman's *device for ascending heavy grades*, English patent, July 30, 1845, consists of an endless screw beneath the locomotive and working into a line of rollers laid down midway between the rails. The screw is driven by bevel-gear fixed on the shaft of the driving-wheels and on the axis of the screw.

Parkins's *railroad* consists of a carriage traversing on rollers and drawn by a rope. It is said to have had a trial in the neighborhood of Paris, France. It is an absurd affair. The carriages have a bearing upon three or four sets of wheels at a time, and the rails are on the carriage, so to speak, a plated bar resting on the rails.

It is an inversion of the ordinary mode, wheels in pedestals at 6 feet apart all along the road and the carriage drawn thereon.

When, previous to the opening of the Liverpool and Manchester Railway, it was proposed to test the capabilities of the locomotive engine, it was made a requirement by the directors that a speed of 10 miles an hour should be attained The Rocket on her trial-trip made 29 miles an hour at times, and rates of speed equaling or surpassing this soon became common on English passenger trains.

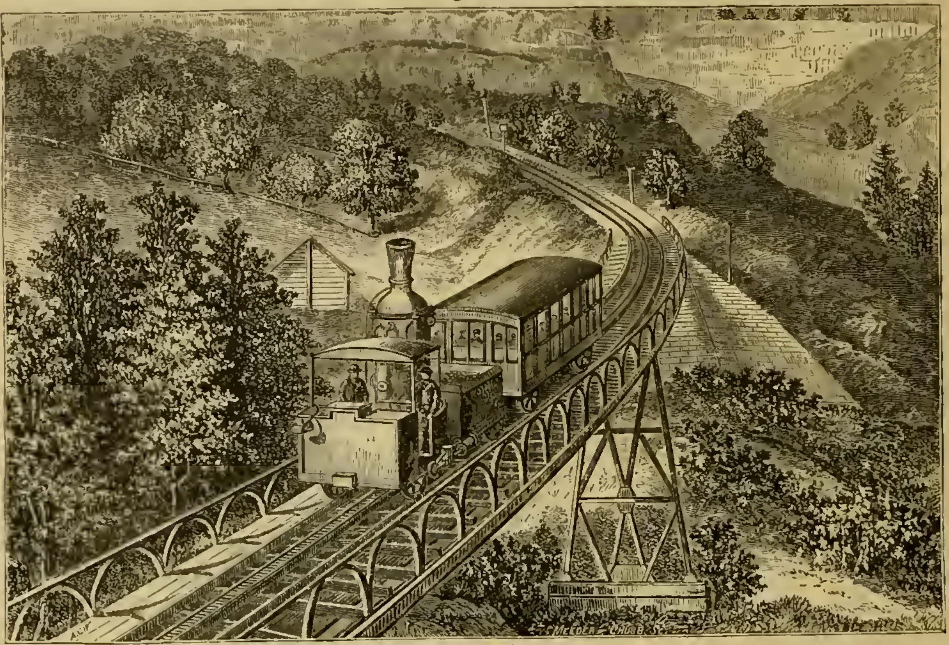
A train on the Chicago and Northwestern Railway recently ran 91 miles in 90 minutes. The quickest prior runs recorded in the United States are 14 miles in 11 minutes, by an engine and six cars, on the New York Central; 10 miles in 7¼ minutes, on the Pennsylvania Railway; 144 miles in 2 hours 49 minutes, on the Hudson River Railway: 84 miles in 90 minutes, from Indianapolis to Union City; 305 miles in 7 hours 42 minutes, from Albany to Niagara.

In ordinary running time, however, the English railways undoubtedly surpass all others. Between Paddington and Swindon, on the Great Western Railway of England, the distance is 77¾ miles, and both the up and down trains travel it in 87 minutes, including the starting and stopping, or at the rate of 53.62 miles per hour. At full pace, the speed is as nearly as possible a mile a minute.

The new express-train from Plymouth to London is probably the fastest train in the world in the part of its journey which lies over the Bristol and Exeter and Great Western Railways. Leaving Exeter at 10 30, it is timed to reach Paddington at 2.45; including a stoppage of five minutes at Bristol, and the inevitable and vexatious ten minutes at Swindon, the journey of 194 miles occupies 4½ hours.

The speed of 70 miles an hour sometimes attained upon railways is equivalent to about 35 yards per second. At this rate 35 stakes one yard apart would be undistinguishable from each other; if painted red, they would appear as a continuous flash of red light. Two trains passing each other with this speed would have a relative velocity of 140 miles an hour, nearly equal to ¼ that of a cannon-ball; each train would pass the other in a single second; their united momentum would be equal to that of a number of cannon-balls aggregating 1/16 their weight. The force of a collision under such circumstances may be imagined.

Fig. 4124.



Rigi Railway, Switzerland.

Supposing the driving-wheels of the locomotive in this case to be 7 feet, each will make 5 revolutions in a second; the piston traverses the cylinder 10 times in a second; as there are two cylinders there will be 20 puffs of steam in a second; the *coughs* produced by each single emission when the engine is moving at a comparatively low rate of speed being blended so as to produce an apparently continuous sound. See also

Atmospheric railway.
Elevated railway.
Pneumatic tube.
Portable railway.
Wire-way, etc.

Rail′way-brake. (*Railway Engineering.*) The old-fashioned hand-brake is still used on some lines of railway, but is gradually being superseded by power-brakes of various kinds.

A patent was granted in this country for a power-brake as far back as 1847, but the invention made slow progress, more patents having been granted for devices of this kind in the year 1872 than during the whole previous existence of the Patent Office.

Springs, electricity, steam, water, vacuum, and compressed air have been called into requisition in operating these brakes.

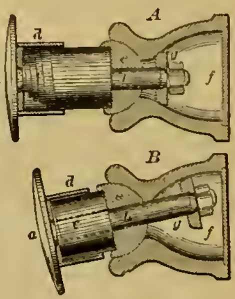
The total number of United States patents for power-brakes up to the close of 1872 numbered 59.

In England, from 1840 to 1866, there were patented 22 electric brakes; from 1835 to 1865, 20 hydrostatic brakes; from 1838 to 1866, 30 pneumatic brakes; from 1836 to 1866, 54 steam-brakes. Since 1869, seven companies for the manufacture of power-brakes have been organized in the United States, and more than one sixth of the 444 railroads in this country and Canada are now provided with them.

The principle, in all cases, consists in releasing, by means of devices at the hand of the engineer, a power stored up in some way, so as to permit it to push the brakes against the wheels of the cars; this involves a connection between the releasing mechanism, the source or sources of power, and the brake of each car in the train; these latter are, consequently, so arranged as to be readily coupled and uncoupled from one another. See BRAKE; AIR-BRAKE; CAR-BRAKE; STEAM-BRAKE; PNEUMATIC BRAKE.

Rail′way-buf′fer. A fender on the end of a car to receive the impact of another car and deaden the shock. In Fig. 4125, the head *a* is fixed on a rod *b* passing through the spring *c* in the collar *d*, and also through the semicircular block *e*, which fits a corresponding cavity in the box *f* attached to the end of a car. The rod has a collar *g* on its inner end, preventing its withdrawal from the box, but allowing free movement within it, so that while direct pressure on the buffer-head forces it directly backward, angular pressure, such as may be ex-

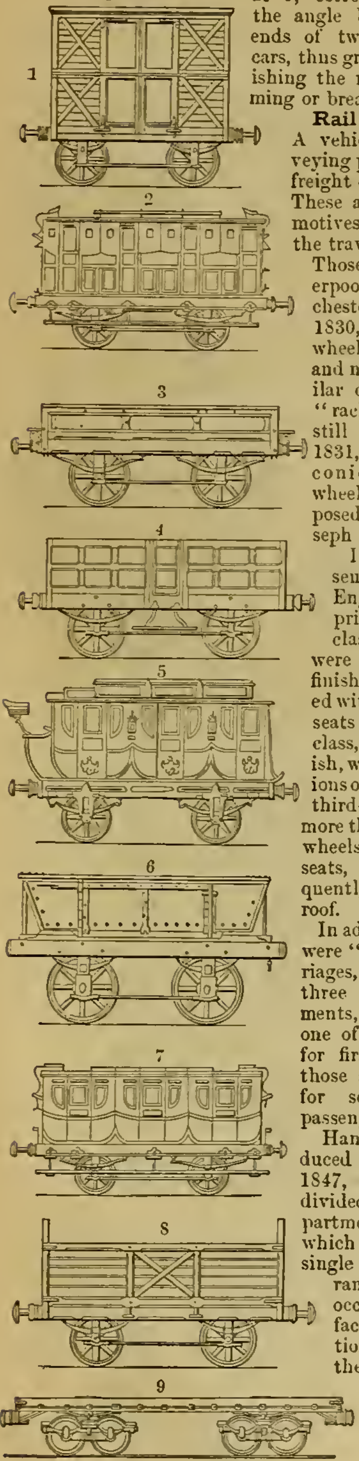
Fig. 4125.



Railway-Buffer.

erted in turning a curve, causes it to assume a position similar to that shown at *b*, corresponding to the angle between the ends of two adjoining cars, thus greatly diminishing the risk of jamming or breakage.

Fig. 4126.



English Railway-Carriages.

Rail'way-car. A vehicle for conveying passengers or freight on railways. These and the locomotives constitute the traveling plant. Those on the Liverpool and Manchester Railway, 1830, had four wheels, no springs, and no roof; similar cars, termed "rack-cars," are still in use. In 1831, springs and conical tread-wheels were proposed by Mr. Joseph Knight.

In 1839, passenger-cars in England comprised first-class, which were of superior finish and provided with cushioned seats; second-class, of plain finish, without cushions or ornaments; third-class, little more than boxes on wheels, having seats, but frequently without a roof.

In addition, there were "mixed" carriages, divided into three compartments, the center one of which was for first-class and those at each end for second-class passengers.

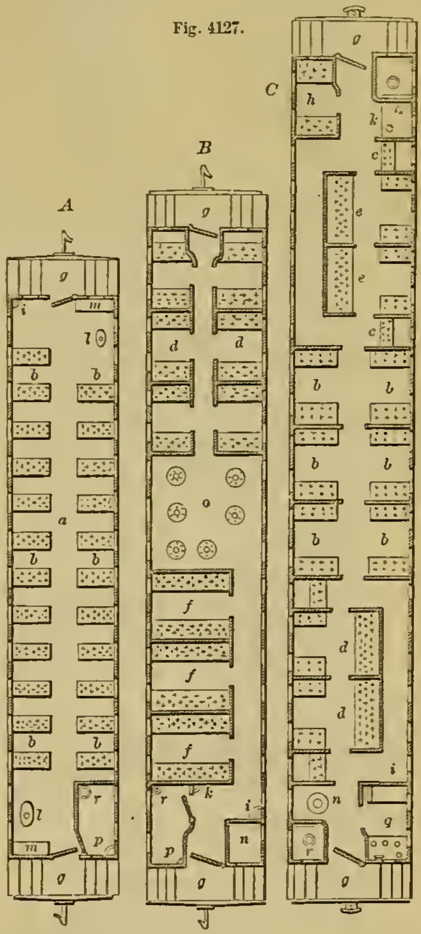
Hanson introduced in England, 1847, an iron car divided into compartments, each of which contained a single seat so arranged that the occupant would face the direction in which the train was moving. A double foot-board lined with sheepskins, between which the feet could be thrust to keep them warm, and a leather-covered head-board or cushion lined with sponge, to deaden shocks, formed appendages to each seat. The same inventor also introduced a similarly constructed freight-car with a sliding roof. In the same year, a wrought-iron car-wheel made in sections, united by tongues and grooves, and expanded to fit the tire, which was in one piece, by means of a conical ring in the hub, made its appearance in England.

The rolling-stock of English railways differs from that in the United States in many respects. The distinction of three classes is not usual with us, and, except on emigrant lines, a second class is not very common in the United States. The doors of British passenger-cars open at the sides. The interiors are divided into compartments. The furnishing of all but the first-class is mean, and intended to drive respectable people into the most costly carriages. The third-class is like a cattle-car, except that it has boards to sit on instead of boards overhead for protection. It also differs from a coal-wagon in having seat-boards, and in the fact that the passengers are expected to get out of themselves as there is no provision for dumping them. The traveling is (or was) safe, the police arrangements excellent, the baggage arrangements execrable.

The appearance of the cars or carriages will be better understood from the illustrations in Fig. 4126.

1, luggage-van.
2, second-class carriage.
3, carriage-truck.
4, third-class open passenger-carriage.
5, express or mail carriage.
6, coal-wagon.
7, first-class carriage.
8, goods-wagon
9, timber-carriage.

Fig. 4127.



Railway-Cars.

A, Passenger-Car. *B, Saloon-Car.* *C, Hotel-Car.*

American passenger-cars are constructed on a very different plan from those of Europe, where, with the exception of Russia, those of England served as a model.

The long car, consisting of a single apartment capable of containing many passengers, the bell-cord, the swinging truck, the stove, drawing-room, sleeping, and hotel cars, as well as the baggage-check system, are all of American origin.

The general arrangement of ordinary passenger-cars differs but little on American roads. All have a central passage with a row of double seats on each side, and conveniences for passengers at one end of the car.

The arrangement of what are known as saloon, palace, hotel, restaurant, and sleeping cars differs somewhat from these.

Fig. 4127, *A* represents an ordinary passenger car; *B* a saloon-car, with close compartments; and *C* a hotel-car.

a, central passageway.
b b, double seats, which may be turned face to face, or back to back.
c c, seats for the waiters or employés.
d d, close compartments, with seats for four persons.
e e, compartments, with seats for five persons
f f, compartments with seats for six persons
g, exterior platforms.
h, smoking compartment, four seats.
i, water-cooler.
k, wash-stand.
l l, stoves.
m m, wood and coal boxes.
n, special heating apparatus.
o, saloon, with five pivoted arm-chairs.
p, urinals.
q, kitchen.
r, water-closet.

Plate XLV. shows a modern Russian saloon-car, convertible into a sleeping-car. It presents an example of the best which has been done in Europe in the way of adapting railway-cars to the comfort and convenience of passengers. The car shown is about 40 feet long and 10 wide, outside measurement, to run on a road of 5-feet gage. The large compartment has seats for 12 passengers, the two smaller for 6 each. The windows are few and small, owing to the rigor of the Russian climate, which renders the heating of a car with many openings a matter of difficulty. The "platform" at each end of the car is inclosed, has side doors, and serves as a corridor.

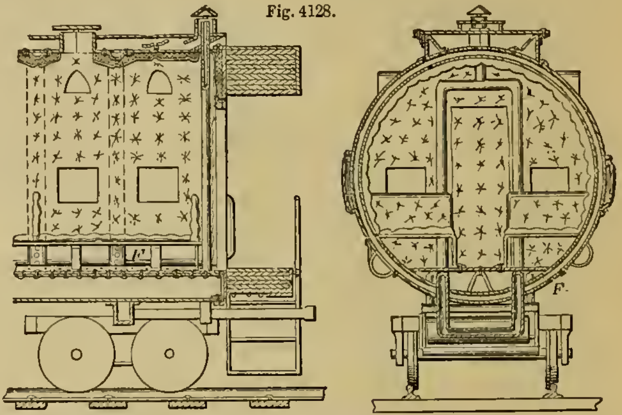
An upright boiler in the small compartment next the wash-room serves to heat several cars by steam-pipes under the floor. The water of condensation is returned in the same way to the boiler.

The car-body rests on three pairs of wheels, without trucks.

Taylor (English patent, May 11, 1841) proposed to make railway-cars of papier-maché.

Paper wheels have also been used for railway-cars. The paper is cut into disks the diameter of the wheel less the thickness of the tire, subjected to a pressure of one and a half tons to the square inch, and then secured by iron flanges held by bolts passing through them and the paper. The wheels then receive a steel or iron flagged tire. The advantages claimed for paper are, that it is noiseless, does not spring or shrink with the weather, affords a stay to the tire and a lateral support in turning curves, adapts itself to any trifling inequality of the inner surface of the surrounding tire, and is stronger than any other material of the same weight of which a wheel may be made.

Fig. 4128.



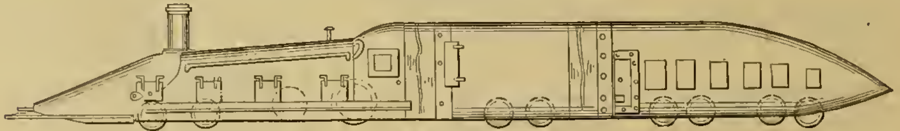
Cylindrical Railway-Car.

Robbins's car (Fig. 4128) is cylindrical and made of plate-iron. Hollow ribs *F* surround the interior of the body to stiffen it, and also to receive and discharge fresh air through different apertures; farther stiffening is likewise effected by semi-cylinders of sheet-iron and the wrought-iron floor. Attached to the roof-plate to support it are angle-irons, while an elastic platform serves to break the violence of collisions.

It has been proposed to construct cars of a tapering or spindle shape, so as to present less resistance to the air. The game is not worth the candle.

The Master Car-Builders' Association made public the following statistics relative to the number of steam-cars on all roads of four feet eight inches and wider gages in the United States and Canada at the close of the fiscal year ending with 1871, namely: —

Fig 4129.



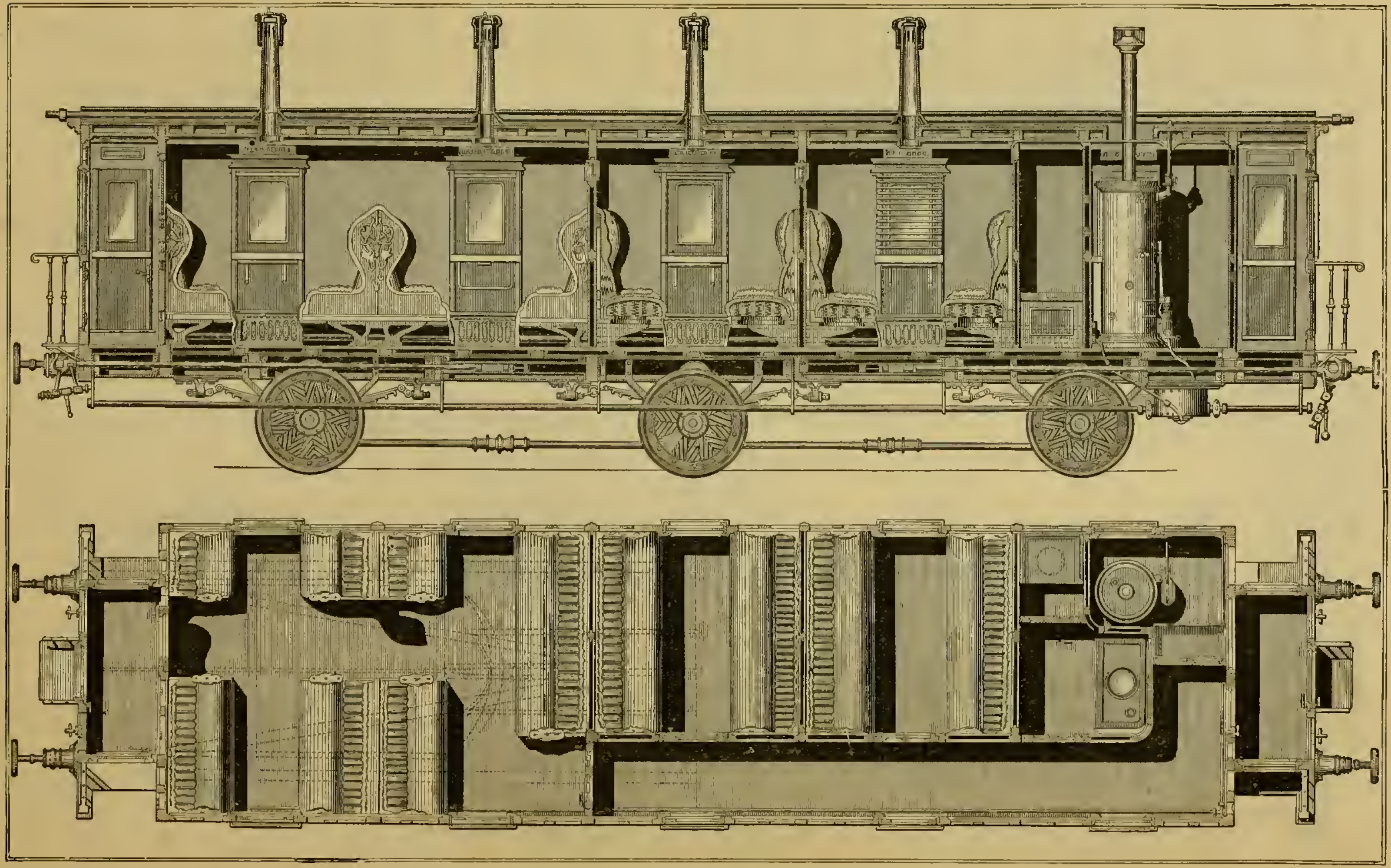
Monitor Car.

Whole number of 8-wheel cars	193,767
Whole number of 4-wheel cars	58,355
Total	252,122
Whole number of cars reported for 3-foot and 3½-foot gage roads	212

There are 103 car-manufacturing establishments in the United States and Canada, which built during the year ending May 31, 1873, the following cars: —

Palace, sleeping, and hotel cars	134
Passenger-cars, all classes	579
Smoking-cars	18
Baggage and smoking cars	15
Baggage and express cars	18
Baggage and mail cars	33
Baggage-cars	63
United States postal cars	3
Total number of cars for passenger trains	863

Paymaster	6	Grain combination	750
Caboose	78	Box or house	11,931
Fruit	734	Platform	5,694
Refrigerator	8	Gondola	6,733



FIRST-CLASS RAILWAY CARRIAGE, MOSCOW AND KOORSK RAILWAY, RUSSIA.

(Built at the Company's Works, Moscow.)

PLATE XLV.

Double-bot'm gondola.	125	Construction	162
Double deck	80	Steam shovels...........	52
Hay (box)	75	Derrick..................	8
Stock.................	2,415	Hand.....................	149
Ore and coal, 8-wheel..	3,126		
Ore and coal, 4-wheel..	3,226	Total.........	371
Oil-tank (60 barrels)...	250		
Oil-tank (64 barrels)...	300		
Total.........	35,531		

Making whole number of cars built by car-manufacturing companies during year ending May 31, 1873...... 36,765

Cars of the various classes as follows were also built by railway companies during the year ending May 31, 1873 : —

Day and night palace..	69	Milk	152
Passenger.............	281	Refrigerator	18
Smoking...............	14	Hay....................	132
Baggage and smoking.	43	Combination	407
Baggage and express...	84	Oil and coal, 8-wheel...	3,119
Baggage and mail.....	27	Oil and coal, 4-wheel...	3,201
Baggage..............	101	Stock..................	1,452
Postal................	19	Oil-tank (64 barrels)...	105
Paymaster............	6	Construction..........	385
Caboose	831	Hand..................	828
Box or house	5,673	Derrick	14
Platform	2,643	Snow-plows	19
Gondola..............	2,543	Service or pole........	50
Grain.................	129		

Whole number of cars built by railway companies... 22,345

The following cars were built for narrow-gage roads, namely, three feet to three and a half gage, during the same time : —

Passenger	16	Platform	37
Smoking	2	Oil-tank.................	48
Baggage and smoking....	1	Hand	3
Baggage	5		
Box and house...........	17	Total............	129

Cars constructed by railway companies.....................	40
Add 85 cars for six months intervening between close of fiscal year 1871 and June 1, 1872........................	85
Also number officially reported in 1871..............	212
Total for narrow-gage roads......................	466

Add to this the number of cars constructed by the car-manufacturing companies, and we have for the number of cars which were added to our rolling-stock during the year ending May 31, 1873, 59,110. Allowing six months for the time between the close of the fiscal year 1871 and the 1st of June, 1872, we will add one half the number of cars constructed during the year 1872 to the number officially reported in 1871, and we have for number of cars on the 1st of June, 1872, 281,667 Add to this the number manufactured during 1873, and it gives us for the total number of cars, 340,787.

The increase here stated is probably under the mark, as a few companies did not report. The figures indicate that the increase in the number of cars for the year 1873 was about twenty-five per cent.

For other cara, both passenger and freight, designed for particular purposes, and known by different specific names, see

Box-car.
Cattle-car.
Coal-car.
Freight-car.
Hand car
Petroleum-car.
Postal-car.
Sleeping car.
Street-car.
Tank-car.
Tool-car.
Wrecking-car

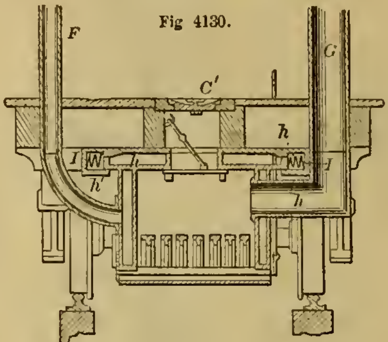
See also list under RAILWAY ENGINEERING AND PLANT.

Rail'way-car Heat'er. A device intended to obviate the dangers attending the use of the common stove in railway-cars.

Among other propositions for this purpose is one designed to utilize the heat of the boiler and fire-box of a railroad locomotive to warm a train of cars in cold weather, and to ventilate the cars with pure air free from dust or cinders in summer. The front of the locomotive is provided with a funnel-shaped mouth, from which a pipe leads down under the boiler and in close contact therewith. At the forward end of the fire-box it divides into two branches, one passing along each side and through the tender, at the rear of which they again unite. Each car is furnished with similar pipes passing along under the seats, and fitted with registers that may be opened and closed at will. The union between the pipes of the different cars is by means of a bell-mouth containing a packing for the end of the pipe, but sufficiently yielding to allow of lateral motion in rounding curves, etc. The front end of the pipe has a hood inside the funnel mouth, to prevent rain or snow from entering.

Beal's heater is supported beneath the car by flanges *h h* resting in cavities having spiral springs *I*, which ease the jar caused by the motion of the train. In case of collision or running off the track, the concussion releases the flanges from their supports and detaches the apparatus from the car. *F* is the air-supply pipe, and *G* the chimney ; *C'*, a covered aperture in the floor, through which fuel is introduced. See also CAR-HEATER.

Fig 4130.



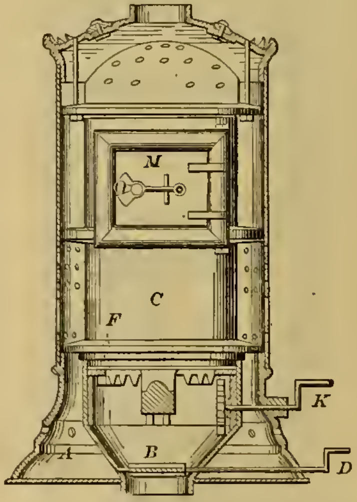
Car-Heater.

Rail'way-car Stove. The special requirements in a stove for use on railway-cars are that it shall not be readily upset, and that in case of an accident of this kind fire shall not be communicated to the wood-work. The absence of these requirements has been the cause of numerous frightful losses of life, some of which will, no doubt, be vividly remembered by our readers.

A number of arrangements have been devised to obviate or lessen the liability to this danger.

In Fig. 4131, the cylinder *C* rests upon a solid base *A*. The door *M* is depressed below the general surface, and has a sunken spring-latch *Q*, so that it cannot be accidentally opened. The revolving grate *F* has teeth meshing with a pinion turned by the crank *K*, and the ash-pit *B* is provided with a slide-valve and rod *D* for removing ashes and regulating draft.

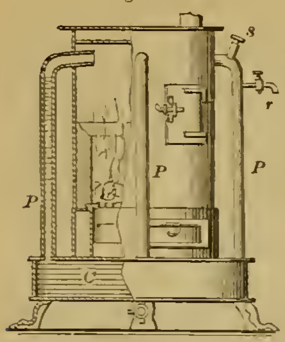
Fig. 4131.



Railway-Car Stove.

Wheelock's (Fig. 4132) is supported on a water-

Fig. 4132.



Car-Stove.

chamber *C* having pipes *P P P* around the stove-cylinder, with which their upper ends communicate. These and the chamber *C* are filled with water through the opening *s* to the hight of the overflow-cock *r*. In case of being overturned, the water flows into the cylinder and extinguishes the fire.

Rail'way-chair. (*Railway Engineering.*) *a.* A block or plate in which the foot of a rail is secured, so as to form a shoe, giving it a base of support upon the sleeper and securing it thereto.

It is especially needed with T and double-headed rails, which cannot be effectually spiked to the sleepers. The *foot-rail* and bridge-rail have a broad flange on each side and are readily secured by spikes.

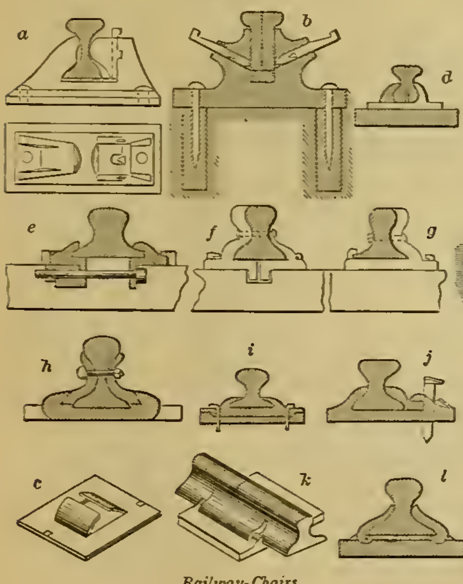
Broad chairs at the joints of rails are sometimes made to act as *fish-plates*, to secure exact continuity to the abutting rails and support their ends. The long lips of the chair embrace the webs of each rail. They are or were made 15 × 18, 16 × 13, 14 × 11, the length in the direction of the rail.

Rails are bolted or keyed to the chairs, many devices of each kind having been introduced in this country and in Europe.

Mr. Jessop of England first invented the rail-chair in 1789, and used it at Loughborough, in Leicestershire. The rail used by Mr. Jessop was a cast-iron rail, laid edgeways The chair was cast-iron, and was slotted to receive the ends of the rails, which had a bearing therein It was used in connection with a cast-iron, fish-bellied edge-rail which he introduced in the same year. He had previously pinned the rails direct to the sleepers.

A chair for railway rails was patented by Loch and Stephenson in 1816. The rail to which it was first adapted was a fish-bellied rail, whose ends were halved together and tied by a transverse bolt, which also passed through the flanges of the cast-iron chair The invention arose from the necessity of something to hold the reduced ends firmly together, so that they should spring neither laterally nor vertically.

Fig. 4133.



Railway-Chairs.

Brunton and Shield's *railway-chair* was also of cast-iron, and was secured by spikes to the sleeper. A single vertical flange gave a point of attachment for the web of the rail, which was bolted thereto.

Some other examples of the earlier forms of chairs may be seen by referring to RAIL

The chair *a* adopted by the London and Birmingham Railway was one of cast-iron, having a slot which admitted the rail laterally, a chock being afterward slipped in laterally between the outer abutment of the chair and the web of the rail, the chock itself being secured by a wrought-iron key, driven vertically

Robert Stevenson's patent railway-chair *b* had lugs, through which oblique keys were driven to hold the rail in the chair. In the double chair, at the joints, two keys were inserted. At intermediate points a single key sufficed.

Scrivenor's *wrought-iron railway-chairs* were made by rolling and pressing in 1832. The bar is run between rollers, on each passage receiving a form more nearly approximating that of the chair. The bar is then cut into sections by shears. The chair being heated red-hot, a mandrel of the size and shape of the rail is driven into the place it is to occupy, and the chair is then passed between a pair of rolls, which give it the final shape.

c illustrates a wrought-iron chair used on some American railways.

In *d* the two-part rails have lap-joints, and are held together in place on the track between the horns of the chair.

The rails in *e* rest in grooves in the parts of the chair which are held together by a bolt.

f is a rail and two-part chair, the latter rising high enough for a bolt which passes through the web of the rail, and as high as the rail on the outside.

g is a chair in one part

h has a base-piece and a pair of cheeks, with a bolt through the web.

i has two cheek-pieces, base-piece, and spikes.

j has a base-piece with a prong, a cheek-piece, and a spike.

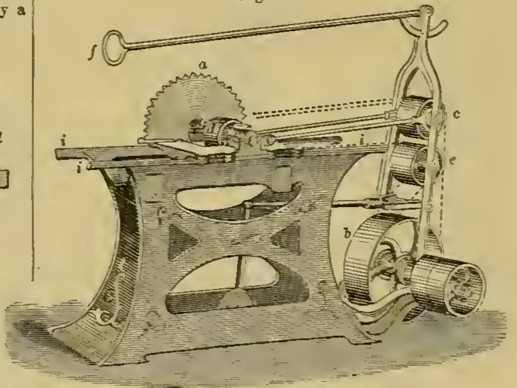
k l represent a chair having cheeks which grasp the rail by the pressure of the train.

b. A chair adapted for a railway-car. See CAR-SEAT.

Rail'way Cut-off Saw. A buzz (circular) saw, which may be fed back and forth to its work.

In Fig. 4134 the saw *a* is driven by a belt from pulley *b*, which passes over idler *c*, around saw-pulley *d*, then over a second idle-wheel *e*, and back to *b*. By this arrangement of pulleys the belt is maintained at an even tension, while the saw-carriage slides back and forth on tracks *i i*. A handle *f* controls the movement of the saw-carriage.

Fig. 4134.



Railway Cut-Off Saw.

Rail'way En'gi-neer'ing and Plant.

Adhesive car.
Aërial car.
Aërial railway.
Arcade railway.
Archimedean railway.
Atmospheric railway.
Axle.
Axle-box.
Axle-guard.
Ballast.
Ballast car or wagon.
Bed.
Bogie-frame.
Bottoming.

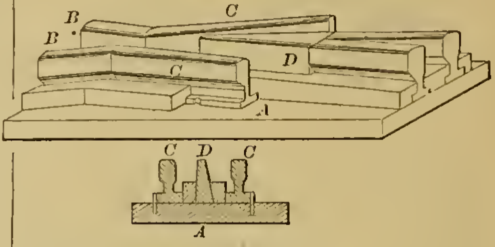
Box-car.
Brake. Railway-car
Broad gage.
Buffer.
Bumper.
Bumping-post.
Car. Railway
Car-axle.
Car-brake.
Car-cab.
Car-couch.
Car-coupling.
Car-heater.
Car-platform.
Car-register.
Car-replacer.
Car roof.
Car-seat.
Car-spring.
Car-stake.
Car-starter.
Car-truck.
Car-truck frame.
Car-truss.
Car-ventilator.
Car-wheel.
Car-window.
Car-window fastening.
Cattle-guard.
Chair. Railway
Claw-bar.
Climber.
Coal-car
Compound axle.
Construction-way.
Cow.
Cow-catcher.
Crank-axle.
Cross-sill.
Cross-frog.
Crossing. Railway
Cross-tie
Derailment.
Divided axle.
Drag bar.
Drag-link.
Draw-bar.
Draw-head.
Draw link.
Draw-spring.
Dummy-car.
Dumping-car.
Electric railway-signal.
Elevated railway.
Fender-stop.
Fish bar.
Fish-plate.
Fog-signal.
Freight-car.
Frog. Railway
Gage. Concussion
Gage. Railway
Goods-wagon.
Gradient.
Gradient-post.
Gravel-car.
Grease box.
Guard-rail.
Hand-car.
Head-rest.
Horn-plate.
Horse-railway.
Hotel-car.
Housing.
Hurries.
Inclined plane.
Jaw-wedge.
Joint-chair.
Joint-fastening.
Joint. Railway-rail
Locomotive-car.
Luggage-van.
Marine railway.
Narrow gage.
Palace-car.
Passing-place.
Pedestal.
Permanent way.
Petroleum-car.
Plant.
Plate-railway.
Platform-car.
Pneumatic railway.
Point.
Pointer.
Portable railway.
Postal car.
Provision-car.
Pullman-car.
Rail.
Rail-clamp.
Railway.
Railway car.
Railway-car heater.
Railway-car stove.
Railway-chair.
Railway-clamp.
Railway-crane.
Railway-gage.
Railway-gate.
Railway-jack.
Railway-joint.
Railway-plow.
Railway-rail
Railway-signal.
Railway-slide.
Railway-sweeper.
Railway-switch.
Refrigerating-car.
Restaurant-car.
Revolving-car.
Road-bed
Rolling-stock.
Rope railway.
Safety-car.
Safety-guard.
Saloon-car.
Sand-box.
Shunt.
Side cutting.
Side-space.
Siding.
Signal. Railway
Sleeper.
Sleeping-car.
Slope.
Snow-plow.
Spark-arrester.
Spike.
Splice-piece.
Spoil.
Staith.
Station-indicator.
Steam-brake.
Stopper.
Street-car.
Street-railway.
Stringer.
Subterranean railway.
Switch.
Switch-lantern.
Switch-signal.
Switch-stand.
Tank car.
Tank-locomotive.
Tender.
Tie.
Tongue.
Tool-car.
Track.
Track-clearer.
Track-layer.
Track-laying railway.
Track-raiser.
Traction-engine.
Trailer.
Tram.
Tramway.
Tram-wheel.
Traverser.
Traverse-table.
Traversing-jack.
Truck.
Trunk.
Turn-out.
Turn-table.
Underground-railway.
Uno-rail.
Water-crane.
Water-elevator for railways.
Wire way.
Wooden railway.
Wrecking-car.

Rail′way-frog. (*Railway Engineering.*) A device by which cars are guided from one line of rails on to another, when they form angles with each other.

A single V-shaped piece, or two such pieces, point to point, are fixed to or form part of a plate, their upper surfaces being in line with the rails of each track, so as to serve as a support and guide for the wheels as they pass from one track to the other. A guard-rail is also arranged on one or both sides of the angular piece or *point*.

In Fig. 4135, the frog-plate *A*, track-sections, guard-rails *C*, and frog-point *D* are separate from one another, and so constructed that the rail sections, guard-rails, and frog-point can be inserted in or attached to and detached from the frog-plate.

Fig. 4135.



Railway-Frog.

Rail′way-gage. The distance apart of the two lines of a railway, forming a track, measured between the inner edges of the tread-flanges.

The *gage* of a *carriage* is the distance between the wheels. It is ordinarily called the track. One of these generally prevails in a section of country, to the exclusion of the other. The broad track is 5 feet or more from center to center of tire. The narrow track is 4½ feet or less between the same points.

1. The wooden tramways of the collieries, before the invention of the iron rail, had a gage of 4 feet. The roadway was scantling, 5 × 7, pegged down to oak sleepers, 4 × 8, 6 feet long, and laid 2½ feet apart. The track for the horses was filled in with ashes above the sleepers.

The Stockton and Darlington Railway, one of the first on which the locomotive was used (1825), has a gage of 4 feet 8½ inches. This was adopted on almost all the British railways, and was called the *narrow* gage, in contradistinction to that of the Great Western Railway of England, which had a *broad* gage of 7 feet.

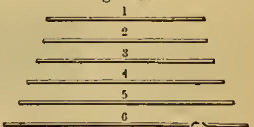
The usual gage in England and the United States, and now compulsory in England, Belgium, France, Italy, and Germany, is 4 feet 8½ inches, the gage common in the tramways of the collieries of England before the invention of the locomotive. Ireland retains its own gage. The 4 foot 8 inch gage was very sensibly retained by Stephenson; but Brunel, who could not condescend to copy, adopted 7 feet as the gage of the Great Western Railway of England. After this very expensive railway had been in operation for more than a score of years, the gage was changed to conform to the customary English practice. The same events have happened or will happen with the so-called broad gage — 6 feet — of this country; Erie, Atlantic and Great Western, Ohio and Mississippi, and Grand Trunk railways.

Brunel was "regardless of expense." His track of 7 feet between the rails involved other increased expenditures, such as wider tracks, bridges, tunnels, embankments, viaducts, heavier sleepers, rails, and chairs; a heavier expenditure in rolling-stock both as to first cost and wear and tear. He, however, had pitted himself against Stephenson, and the shareholders had to suffer for thirty years. The railway has now been brought to the standard gage, and the owners look for better times

In 1846, the English government determined to make the 4 foot 8½ inch gage the standard for all future works.

Brunel's objects in increasing the gage from 4 feet 8 inches to 7, an addition of 2 feet 3½ inches were to allow the employment of larger and more powerful engines with larger driving-wheels; to increase the stability and steadiness by placing the body of the carriage within the wheels,

Fig. 4136.



Railway-Gages.

lowering the center of gravity; to increase the carrying capacity of the cars.

The foregoing diagram affords a means of comparing the railroad gages.

1, Scotch, narrow	4 feet 6 inches.
2, common English and American	4 " 8½ "
3, Eastern counties and Blackwall, England, as originally constructed	5 "
4, Scotch, broad, Canadian Grand Trunk, East Indian	5 " 6 "
5, Irish	6 " 2 "
6, Great Western, as originally constructed (English broad)	7 "

Forty-two inches is to be the gage of the Nile Railway from Wady Halfa to Shendy, skirting between the Nubian and Libyan deserts, a distance of 560 miles.

Within the past few years a number of tracks have been laid of narrower gage even than this, varying from 3 feet even down to 1 foot 11½ inches, as the Festiniog Railway in Wales. See Fig. 3296, page 1512.

Mr. Fairlie, in a paper read before the British Association, asserts that the proportion of non-paying to paying weight which an engine has to draw on the English roads is as 29 to 1, and in freight-trains 7 to 1, while on the Festiniog road cars weighing 12 cwt. are made to carry 3½ tons at a speed of 12 miles an hour. Also, that a speed of 30 miles an hour may be attained on a road of 2 foot 6 inch gage, and of 40 miles on one of 3 feet. Higher speeds are not required in new and thinly settled countries.

While gages of 4 feet 8½ inches and upward are undoubtedly advantageous where great speed is necessary and large amounts of freight are to be carried, the advocates of the narrow gage appear to have the best of the argument, so far as its economy is concerned in cases where the traffic and travel do not justify the outlay of such a large amount as the broad gage and its rolling-stock demands. See NARROW GAGE.

In the English parliamentary commission for taking evidence as to the expediency of making the gage uniform for the Kingdom, the following expedients were cited as means of adapting trains or carriages to traverse variously gaged tracks: —

Telescopic axles.

Mounting carriages on trucks of different gages. That is, running car-wheels and all on to a sub-truck having the gage required.

Shifting the body from one truck to another.

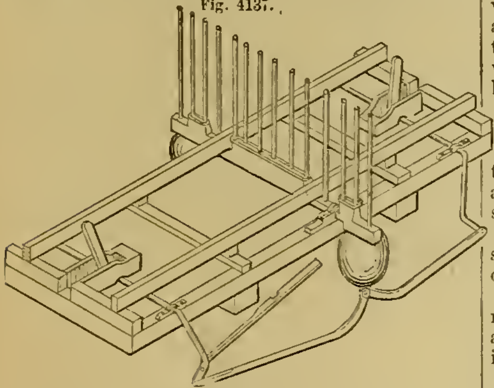
Carrying the freight in boxes which are shifted on to platform-cars having the gage required.

Combining the gages on one line.

2. A bar with shoulders, indicating the distance between the rails, and by which they are laid.

Rail'way-gate. A gate at a railway-crossing, on the level of a common road or street. Such are usually tended by guards or watchmen, but attempts have been made to operate them by means of the passing trains. In Fig. 4137 the gate is laid down by the pressure of the passing train upon the upwardly projecting arm of the rock-shafts to which the gate is connected.

Fig. 4137.



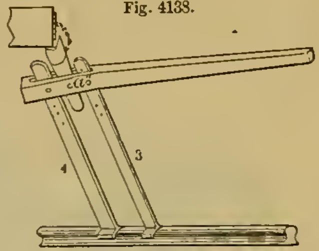
Railway-Gate.

Rail'way-jack. (*Railway Engineering.*) A lifting device for pulling up rails, raising cars, and other like purposes.

Fig. 4138 has two standards 3, 4, having holes near their upper ends, so that the lever *a* may be pivoted at various hights; the shoes resting on the rail.

The lifting-head is bolted in a slot in the lever between the standards which pass through the slot, and is placed beneath an angle of the object to be lifted.

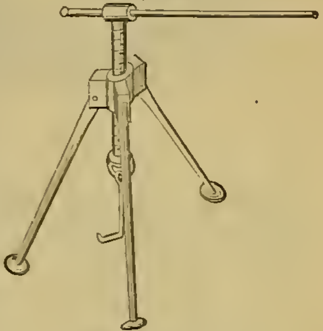
Fig. 4138.



Car-Jack.

Fig. 4139 is a tripod-stand, with a lever and screw, from whose lower part is suspended a hook, which is inserted beneath a rail for the purpose of tearing it from the tie.

Fig. 4139.



Railway Track-Lifter.

Rail'way-joint. (*Railway Engineering.*) The junction of two rails in the same line; it is usually a butt-joint, but in some cases the rails are halved together.

Rail'way-plow. (*Railway Engineering.*) See SNOW-PLOW.

Rail'way Print'ing-ma-chine'. (*Printing.*) One in which the bed is carried by a truck upon a railway, being usually driven by a crank motion.

In Fig. 4140, *d* is the type-bed which rests upon the truck and reciprocates beneath the cylinder upon the railway-track *b*.

The paper is fed to the under side of the cylinder *c*, which, after an impression is given, remains stationary while the bed *d* returns, and the fingers close on the next sheet before it starts again. The cylinder-wheel gears directly into a rack on the side of the bed, and register may be obtained without a pointing apparatus. The impression-cylinder is not shifted to suit forms of different sizes, but the forward edge of the type is always placed on the same line on the bed. The feed-board *e* is hinged to turn up and allow access to the form. Tapes *i i* carry the printed sheet to the fly *f*.

Rail'way-saw. A sawing-machine in which the saw-mandrel is mounted on a carriage which slides on ways. See RAILWAY CUT-OFF SAW.

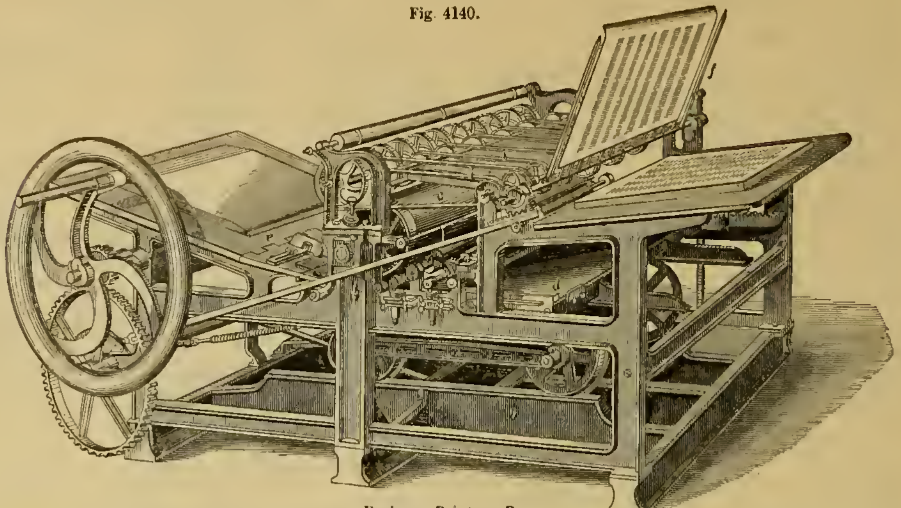
Rail'way-sig'nal. (*Railway Engineering.*) Signals are used on railroads to indicate safety, danger, approach to a station, that a switch is in place or is displaced, and for various other purposes.

Both audible and visible signals are employed, the former being produced by the engineer with the steam-whistle, by bells or by torpedoes.

The following code, though limited in expression, is universally understood, at least on American roads: —

One whistle of the locomotive means "down brakes": two whistles, "off brakes"; three whistles, "back up"; continued whistles, "danger"; a continued succession of short whistles is the cattle alarm. The conductor's signal, given by a sweeping parting of the hands on a level with the eyes, means "go ahead." A downward motion of the hand, "stop." A beckoning motion, "back." A lantern raised and lowered vertically,

Fig. 4140.



Railway Printing-Press.

"start"; swung at right angles or across the track, "stop"; swung in a circle, "back." A red flag waved on the track, "danger"; hoisted at a station, "stop"; stuck up by the roadside, "danger on the track ahead"; carried unfurled on an engine, "another engine is on its way."

The New York and Erie was the first road which constructed a line of telegraph to be used exclusively for transmitting messages in relation to the business of the road, and upon it was introduced the system now in general use of controlling the movement of the trains by telegraph.

In this system the whole of the trains are under the control of a superintendent at headquarters, who is notified by the operator at his station of the time when each train arrives at his station. Having the time-table of the road before him, he is enabled to give directions to the conductor of each train to go ahead, stop, or turn off at a siding ahead, as may insure the track being clear for the train which has the right of the road and prevent danger of collision.

Under another system employed on some double-track roads, each operator is required to telegraph to his neighbor on the passage of a train, who, on its approach, if the track be clear ahead, displays a safety-signal; or, if not, a danger-signal, when the train is stopped. This arrangement provides against danger of collision by trains proceeding in the same direction; but the number of operators required and the expense of maintenance have led to the trial of automatic electro-magnetic devices by which these station-signals may be operated.

In 1867, Mr. Thomas S. Hall patented an electric signal, so arranged that the displacement of a rail at a switch or drawbridge would exhibit a signal at the distance of half a mile or more in each direction, at the same time causing a bell to ring until the source of disturbance was removed. This was, however, effected by closing the circuit, so that in case of accident to the apparatus itself, the signal would not be made, nor would its failure to operate be detected without an inspection.

Mr Wm. Robinson, in 1870, invented a continuous circuit arrangement in which the danger-signal was kept constantly exhibited, except when the circuit was broken by the wheels of an approaching train striking a lever at the side of the track. If a rail were displaced, or the apparatus was out of order, the engineer, seeing the danger signal, would be governed accordingly; but, on the contrary, if the safety-signal appeared when the train reached the proper point, it showed that both the track and the electric apparatus were in order.

Another device of the same inventor rang a bell at a railroad crossing when a train arrived within a certain distance.

A continuous line of signals at fixed intervals of a mile or so apart, upon the closed-circuit plan, has also been devised.

The wear and tear in the operating mechanism of signals of this kind, occasioned by the frequent passage of heavy trains at high rates of speed, being very great, it has been proposed to use the rails themselves as a telegraph line for this purpose, the circuits being made by the iron wheels as they pass over the intervals separating the ends of the rails at the joints Mr F. L. Pope says that he has tried an arrangement of this kind on the Boston, Lowell, and Nashua Railroad, and that it was almost absolutely certain in its results during an experience of five months.

Rail′way-slide. (*Railway Engineering.*) A device for shifting a car from one line of rails to another. It consists of a platform running on wheels transversely across the tracks. The car is run up an inclined plane on to the platform; the latter is then moved transversely, and the car descends the incline on to the other track.

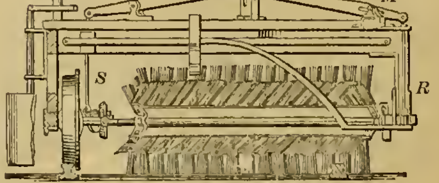
Rail′way Speed-meas′ur-er. An instrument for determining the speed of railway-trains. Whishaw's, termed by him a *centimetral chronometer* or *velocentimeter*, is provided with clock-work, a dial, and index-hand, by which the rate is determined between stations at known distances apart, as ¼ mile.

Redier's *horograph* affords a means of determining whether or no a prescribed rate of speed, measured by the number of revolutions of the driving-wheel, has been maintained.

Another French invention records on a sheet of paper, once a minute and at the end of every kilometer, the speed and the distance traveled, and also the time of arrival and duration of stoppage at each station.

Rail′way-sweep′er. (*Street-Railway Engineer-*

Fig. 4141.

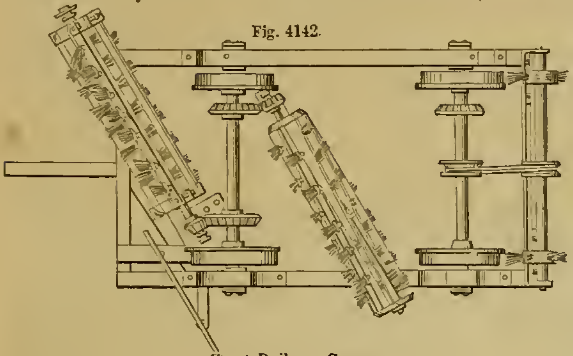


Street-Railway Sweeper.

ing.) Stationary splint-brooms at the fore part of the engine are commonly used for clearing small obstructions from the track. Rotary brushes are also used. Fig. 4141 is of this kind. It is fixed on a diagonal shaft and rotated by gear connection with the axle. By means of the screw *Q*, levers *L M*, and connecting-rods *R S*, it may be lifted out of gear and clear of the track when desired.

Fig. 4142 is a plan view, which shows the relation of the brush-cylinders to the bed and the wheels.

Fig. 4142.

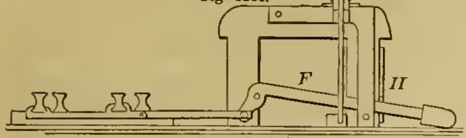


Street-Railway Sweeper.

The brushes are revolved by gearing on their shafts and on the wheel-axles, or by belt and pulleys; are adjustable vertically; may be preceded by oblique and vertically adjustable scrapers; set obliquely to clear the horse-track, or revolve in line with the rail to clear the wheel-track.

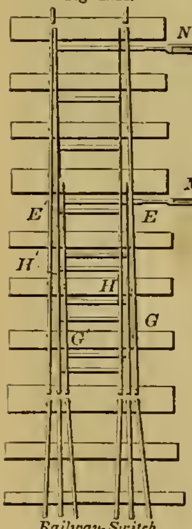
Rail'way-switch. (*Railway Engineering.*) A device for shifting cars from one track to another. It consists essentially of a pair of movable rails united by iron straps, and pivoted at one end in continuity with a track and connected by a rod to a lever by which the other end of the pair is brought into line with either one of two or more tracks on which a train may be approaching or is intended to proceed.

Fig 4143.



Railway-Switch.

Fig 4144.



Railway-Switch.

Various arrangements have been proposed or adopted to lessen or avoid the danger of running off the track in case the switch is not in proper position.

In Fig. 4143, the weighted bell-crank lever *F* keeps the switch-rails in line with those of the main track, and is held firmly down by a swing-catch *H* while they are in this position; the switch-rails are shifted to correspond with those of the side track by lifting the lever *F*, the catch being swung out of the way, and the lever is then held up until the train has passed. The weight on the lever causes it to automatically replace the movable rails should the switchman neglect to do so.

In Fig. 4144, the exterior rails' *E E*, which connect the main line and branch tracks, are fixed. The interior long rails *H H'* are coupled, as are also the short rails *G G'*, and each pair independently connected by the rods *M N* to their respective switch-levers. In case these are misplaced, the flanges of the wheels entering the wedge-shaped openings formed by the tapering ends of the movable rails throw them into their proper positions, while the fixed outer rails prevent the cars from leaving the track. See SWITCH.

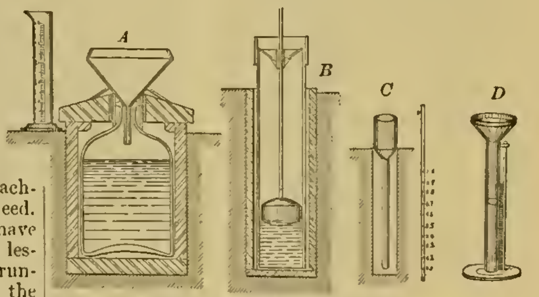
Rain. (*Pyrotechny.*) Gold-rain is composed of small, equally sized stars, about ½ inch in diameter: they appear of a golden color when burning, produced by lampblack and flowers of zinc; and as they burn slowly, their effect in falling, particularly in large numbers from a considerable hight, is very beautiful.

Rain-cham'ber. (*Metallurgy.*) In the extraction of copper, a compartment into which spray is injected, and through which the smoke is compelled to pass, to remove poisonous vapors. Proposed by Sir Humphry Davy. See also Whelpley and Storer's patent, 1864.

Rain-gage. An instrument for measuring the amount of rain that falls on a given surface. Also called an *Ombrometer*, *Udometer*, *Pluviameter*. In Fig. 4145, *A* is a simple device for this purpose. It comprises merely a copper funnel 5 to 7 inches in diameter, inserted in the neck of a bottle placed on a stand and protected from the sun's rays, to prevent evaporation. The rain collected in the bottle is measured in a glass jar having $\frac{1}{10}$ the area of the funnel, and graduated so that a rainfall of $\frac{1}{10}$ inch collected by the funnel is measured by 1 inch on the side of the vessel. The stand should be placed at a sufficient distance from any buildings, etc., to prevent their affecting the amount falling into the funnel.

B consists of a copper cylinder, 5 to 7 inches in diameter and 2½ feet long, in which is a float of nearly the same area as the cylinder, but rising and falling freely therein. It carries a graduated rod, which rises upward as rain accumulates in the cylinder, indicating the fall in inches and decimals. Snow and hail are melted, to ascertain the amount of water which they form, the first being pressed down in the gage-funnel as it fills, if necessary.

Fig. 4145.



Rain-Gages.

The Smithsonian rain-gage *C* is of brass, and has a wooden cylinder, which is inserted permanently in the ground for the protection and ready adjustment of the instrument. It has a graduated scale, which reads to 10ths and 100ths of an inch.

The scale may be dipped into it, or may be made to float, so as to be raised as the water accumulates, exposing the graduations on the rising rod.

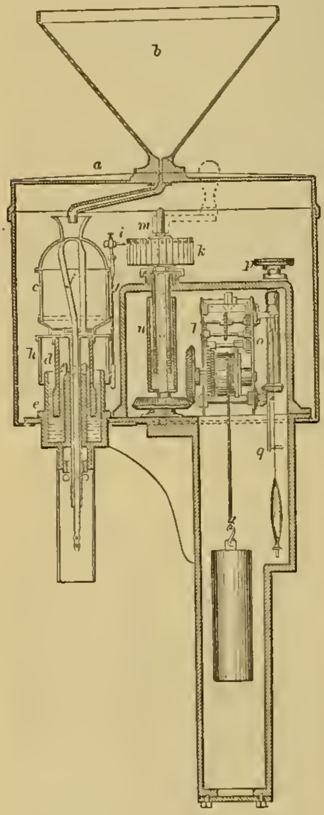
Still another gage *D* consists of a large and a smaller tube connected at bottom, the smaller tube having $\frac{1}{10}$ of the sectional area of the mouth of the larger one.

The smaller tube is graduated, and 1 inch of rise is equal to $\frac{1}{10}$ of an inch fall of rain.

The tube should be 6 inches long and 2 inches in diameter, connected with a tube ½ inch in diameter, and with a funnel on the larger, to give it the proportions stated.

The self-recording rain-gage (Fig. 4146), a very delicate and accurate instrument, was invented by Mr. Robert Beckley, of the Kew Observatory.

Fig 4146.



Beckley's Self-Recording Rain-Gage.

a is a thin cast-iron box, about one foot square, and having a hinged top to which the funnel *b* is attached; the upper surface of this has an area of just 100 square inches. A pipe, having a strainer at its lower orifice, leads from the funnel to a copper receiver *c* supported by a hollow cylinder *d* floating in mercury contained in the annular cistern *e*. As water enters the receiver, the float *d* descends in the mercury, its area relatively to that of the cylinder being so proportioned that it descends uniformly with the admission of equal quantities of water into the receiver *c*. When the level of the water rises as high as the top of the siphon *f*, this begins to operate, rapidly emptying the receiver, which then rises and assumes its original position. As the receiver contains just 25 cubic inches, this occurs whenever ¼ inch of rain has fallen.

The siphon *f* is contracted and flattened at its upper portion, so that the water continues to rise in its shorter leg until a sufficient head of water has accumulated above it to overcome the capillary attraction, when the flow down the longer leg commences and continues until all the water in the reservoir is discharged. Several small irregular apertures at the lower part of the siphon admit air and prevent any water being retained by capillary attraction. The long leg of the siphon, after issuing from the receiver, passes through a brass tube guided by rollers through the central part of the mercury cistern, so as to keep float and receiver perfectly vertical and central. A thin layer of fluid glycerine over the surface of the mercury prevents oxidation, and also acts as a lubricant.

A spring *g* attached to the cover *h* of the float receives at its upper extremity a pencil *i* which presses against a cylinder *k* of white glazed earthenware, rotated by clock-work mechanism, shown at *l*. The cylinder fits easily on the spindle *m*, so as to be removable and adjustable, and its circumference is divided by vertical lines into twenty-four spaces. When the record of the day is complete, it is replaced by another, and the pencil-marks made on its surface as the reservoir descends are washed off. The clock *l* is contained in a hermetically closed case, having mercurial stuffing-boxes at *n*, in which the vertical spindle revolves, by a reversal of whose movement the winding is effected, and at *o*, through which the pendulum is set in motion This movement is effected by turning the milled head *p* rotating two bevel-wheels imparting motion to a small arm *q*, which, pressing against the pendulum-rod, forces it out of a vertical position. When pressure is removed from the milled head, the arm falls back to its original position, permitting the pendulum to oscillate freely. The clock-work mechanism employed may of course be adapted to run any number of days desired.

Crossley's rain-gage is an adaptation of his liquid meter, the parts being inclosed in a box and having a vibrating bucket whose pulsations are recorded by a train of gearing and an index-finger on a dial.

The rain-gage of the late Professor Coffin was an inverted cone, having a horizontal surface of 172.8 square inches; the rain falling into it passed down, through an orifice so small that no appreciable evaporation could occur, into a close-fitting can. One inch of rain in depth would, therefore, make $\frac{1}{10}$ of a cubic foot when collected, the weight of which is 100 ounces. Each ounce that the can contained after a storm, consequently, represented $\frac{1}{100}$ of an inch in perpendicular fall. The amount necessary to merely moisten the funnel without precipitation into the can was easily determined as a constant.

Ronalds's rain and evaporation gage has a float in a central covered vessel, which, by means of a silken cord passing over a pulley, turns an index indicating the amount of rain received in an exterior uncovered vessel communicating with the first, and having an area of one square foot, in case any has fallen between two observations, diminished by the amount which has evaporated; if no rain has fallen, the amount of evaporation only is indicated, the index turning in the opposite direction.

The amount of rain falling annually is very unequally distributed over the earth's surface, depending on many conditions. The direction of the wind, its permanence, temperature, the condition and elevation of the surface over which it passes, all exert an important influence.

High mountain-ranges intercept a large proportion, in some cases nearly all, of the aqueous vapor with which the atmosphere becomes charged during its passage over the sea, the source whence the great supply of moisture is derived, and cause it to be deposited on their windward sides, while those to leeward receive little or none.

Thus the trade-wind districts of the west coast of South America are rainless, the moisture brought from the Atlantic by these winds being in part discharged upon the eastern plains of that continent before reaching the Andes, which intercept the remainder. Proximity to the sea, when the prevailing winds are from that direction, also greatly increases the mean rainfall. In Ireland and the West of England a larger quantity falls than in Central and Eastern England; the amount at Liverpool exceeding that of London by about one half, while at Seathwaite, Borrowdale, in Cumberland, the annual fall reaches the, for that latitude, extraordinary amount of 141.54 inches: this is, however, principally due to the high ranges of hills eastward of this place.

At Sitka, Alaska, and Bergen, Norway, where both these conditions of proximity to the ocean and the vicinity of high mountains to leeward are fulfilled, the annual fall is respectively 87.9 and 88.6 inches, while at Stockholm it is 20.4, and at St. Petersburg 17 3 inches.

The whole western seacoast of America, north of latitude 41°, is from this cause characterized by an annual fall exceeding 60 inches, diminishing to ½ of that amount and less eastward of the mountains

Intensely heated plains, by elevating the temperature of the winds passing over them, even though saturated with vapor on their arrival, tend to prevent precipitation. Thus the desert of Sahara, Egypt, Arabia, Southern Persia, and the great desert of Gobi in Central Asia, constitute a rainless tract embracing a considerable portion of the earth's circumference. The table-lands of Thibet and Mexico, parts of California, and the great North American desert are also either entirely or comparatively rainless.

Local causes frequently determine the amount of rain which may fall in a short time at a given spot This not unfrequently amounts to a large fraction of the annual precipitation. At London, on the 27th of November, 1845, 6¼ inches, more than ¼ of the total annual amount, fell within 24 hours.

At Joyeuse, in the department of the Ardeche, France, 31 173 inches have been known to fall in 22 hours; at Genoa, 30 inches in 24 hours; and at Gibraltar, 33 inches in 26 hours, — the latter equaling the total yearly fall in England and in the Northern United States.

At San Diego, California, but 5 inches fall in the course of the year. Grass Valley, in the same State, has an annual fall of 60 inches.

The tropics, as being the great source for supplying the atmosphere with aqueous vapor by evaporation, naturally constitute the great area of precipitation, though, owing to other causes modifying the normal distribution of rain, the average tropical fall may occasionally be largely exceeded in some extra-tropical places. For instance, on the Pacific coast of Patagonia, latitude 50° 55″ S., 144 inches have been known to fall in 40 days.

At Sierra Leone, 314 inches fell in four months of 1838; 20 inches of which fell in two days.

The average annual rainfall of Bengal is 200 inches; on the Bhore Ghaut, above Bombay, 220 inches frequently fall in four months.

The greatest known rainfall in the world occurs in some parts of India.

At Mahubalechoar, on the western slope of the Ghauts, 4,461 feet above the sea, the average yearly fall during a period of forty years was 275 inches.

At Cherrapoonje, at the same elevation, on the Garrow Mountains to the south of the valley of the Brahmaputra, the annual rainfall is 550 inches, which is about equal to the rainfall of a century at Alexandria, Egypt. This was even exceeded in the experience of the naturalist Hooker, who observed in some of the valleys of the Himalaya a fall of 470 inches in seven months, and 30 inches on one occasion in four hours, equal to the average annual rainfall in France. This was at Khasia, where, according to Mr. Yule, in the month of August, 1841, there fell 264 inches, or 22 feet; 30 inches falling daily during five successive days. This is attributable to the abruptness of the mountains which face the Bay of Bengal, from which they are separated by 200 miles of Jheels and Sunderbunds.

This fall is very local: at Silhet, not thirty miles farther south, it is under 100 inches; at Gowahatty, north of the Khasia, in Assam, it is about 80; and even on the hills, twenty miles inland from Churra itself, the fall is reduced to 200.

During the rainy season, from April to November, as much as 10 or 12 inches of rain falls in a day in Burmah and Siam.

The enormous rainfall of Khasia would, however, seem to be equaled in Cayenne, where Admiral Roussin reports 12 feet 6 96 inches having fallen between the 1st and 24th of February, 1820. At Cumana, in Venezuela, on the same coast, the annual amount is but 8 inches.

Latitude exerts a great effect on rainfall, the amount of vapor suspended in the atmosphere decreasing rapidly as we approach the poles, though, owing to its being discharged more equally throughout the year, the number of rainy days is generally greater than in lower latitudes.

There are six maximum points of rainfall in Europe, estimated in rainy days, not quantity, — Norway, Scotland, S. W. Ireland and England, Portugal, N. E. Spain, Lombardy.

In Ireland it rains 208 days in the year.

In England it rains 150 days in the year.

In Kazan it rains 90 days in the year.

In Siberia it rains 60 days in the year.

On the Dofrefelds of Norway it rains and mists nearly continually an aggregate of 82 inches per annum; about equal to Bombay, Havana, Sierra Leone.

Humboldt estimates the average rainfall at the equator, 96 inches; at latitude 19°, 80 inches; at latitude 45°, 29 inches; at latitude 60°, 17 inches.

According to Professor Thomson, the average number of days on which rain falls is, between latitudes 12° and 43° north, 78; between latitudes 43° and 50° north, 103, between latitudes 50° and 60° north, 161. Local circumstances, however, largely interfere with this; at Rome, for instance, there are but 64 days of rain in the year, and at Padua 120.

London has 220 dry days in the year, and Dublin but 150. The number of days of heavy rain is nearly the same at both places, — from 16 to 32 annually.

Dr. Heberden found that on top of Westminster Abbey, from July, 1766, to July, 1767, but 12.099 inches of rain fell; on top of a lower building near by, 18.139 inches; and at the ground, 22.608 inches.

At York, as determined by Phillips in 1834 - 35, the amount at an elevation of 213 feet was 14.963 inches; 44 feet, 19.852 inches; at the ground, 25.706 inches.

At the Paris Observatory the relative amounts falling three meters from the surface of the earth, and a station twenty-seven meters above this, were as 1.116 to 1.

The effect produced on the annual rainfall of a country by clearing it of its forests is a subject which of late years has received, as it deserves, a great share of attention. Sir John Herschel, Lyell, and the most eminent authorities in meteorology generally concur in the opinion that the tendency of cutting down the woods is to cause an absolute diminution of the rainfall. The plains of Babylonia, once so fertile, now an arid desert; the elevated plateaus of Central Spain, which in the time of the Romans yielded abundant harvests, and now afford but a scanty subsistence to sheep, — appear to owe their present sterility to this cause; while it is stated that, in Central America, lakes situated in tracts formerly cleared by the Spaniards, which had diminished in volume, have again become full on account of the increased rainfall due to encroachment of vegetable forms on this cleared land.

It is also stated that the amount of arable land in Egypt has been increased in recent times by planting palms and other trees in desert and unfertile places. The origin of some of the oases in the great Sahara desert is attributed to the same cause.

However the absolute yearly rainfall may be affected in this way, — our data do not extend over a space of time extending back sufficiently far to positively determine if there has been an important diminution in its amount since the settlement of this country, — there can be no question but the deprivation of its woody covering tends to promote evaporation from the soil, rendering it arid and sterile and causing the falling rain, which would otherwise slowly percolate through it, to run quickly off, carrying with it the lighter and more fertilizing particles to the water-courses by which they are ultimately conveyed to the sea.

This also tends to impair the permanency of flow of streams, as the water which would accumulate and be gradually discharged by means of springs, tending to moderate the extremes of high and low water, flows off at once, causing floods, immediately succeeded by intervals of extreme low water.

Some observers insist that this result has already been developed in many tributaries of the Ohio; those down which in the memory of man heavily laden arks or flat-boats were floated to a market being now entirely unnavigable

The transitory character of the floods in the western tributaries of the Missouri, notably the Platte River, afford confirmation of the fact that inland navigation, as well as agriculture, depends largely on a sufficient growth of timber, which can alone maintain those conditions of evaporation and discharge of moisture which are most favorable to the support of man.

The following table gives the average annual rainfall, in inches, for a number of places on the globe. The figures for the United States are derived from the tables prepared for the Smithsonian Institution by C. A. Schott, Esq : —

Brunswick, Me	44.68	Milwaukee, Wis	30.40
Hanover, N. H	40 32	Fort Snelling. Minn	25.11
Burlington, Vt	34 15	Muscatine, Iowa	42 88
New Bedford, Mass	41.42	St Louis, Mo	42.18
Providence, R. I	41.54	Fort Gibson, Ind Ter	36.37
Fort Columbus, N. Y. Harbor	43.24	Fort Towson, Ind. Ter	51.08
Penn Yan, N. Y	28.42	Fort Leavenworth, Kan	31.74
Buffalo, N. Y	33.84	Fort Kearney, Neb	25.25
Newark, N J	44.85	Fort Randall, Dak	16.51
Philadelphia, Pa	44 05	Fort Laramie, Wyoming	15.16
Pittsburgh, Pa	37 09	Fort Massachusetts, Col	17.06
Washington, D. C	37.52	Fort Garland, Col	6.11
Baltimore, Md. (Fort McHenry)	41 10	Fort Craig, New Mexico	11.67
Fortress Monroe, Va	47.04	Fort Marcy, New Mexico	16.65
White Sulphur Springs, Va	37 54	Fort Defiance, Arizona	14 21
Gaston, N. C	43.40	Salt Lake, Utah	23.85
Charleston, S. C	43.63	Fort Bridger, Utah	6 12
Savannah, Ga	48.32	Sacramento, Cal	19.56
Key West, Fla	36 23	San Francisco, Cal	21.69
Fort Myers, Fla	56.55	San Diego, Cal	9.16
Mt. Vernon Arsenal, Ala	66.14	Meadow Valley, Cal	57.03
Huntsville, Ala	54.88	Dalles, Oregon	21 74
Natchez, Miss	53.55	Fort Hoskins, Oregon	66.71
New Orleans, La	51.05	Fort Vancouver, Washington Territory	38.84
Baton Rouge, La	60.16	Fort Colville, Wash Ter	9.83
Fort Brown, Texas	33.44	Neah Bay, Wash. Ter	123.35
Fort Bliss, Texas	9.56	Sitka, Alaska	83 39
Fort Smith, Ark	40 36	Vera Cruz, Mexico	183.20
Washington, Ark	54.50	Cordova, Mexico	112.08
Springdale, Ky	48 58	Bermuda	55.34
Marietta, Ohio	42.70	San Domingo	107 6
Cleveland, Ohio	37.61	Havana, Cuba	91.2
Detroit, Mich	30.05	Rio Janeiro, Brazil	59 2
Mackinac, Mich	23.96	Maranham	277 00
Richmond, Ind	43.32	Cayenne	116 00
Peoria, Ill	41.25	Toronto, Canada	35 17
		St Johns, Newfoundland	58.30
		St. John, N. B	51.12

To these may be added the following figures of foreign rainfall: —

London, England	24.4	Stockholm	20.4
Liverpool, England	34 5	Copenhagen	18 35
Manchester, England	36.2	Berlin	23.56
Bath, England	30.0	Mannheim	22.47
Truro, England	44.0	Prague	14.1
Cambridge, England	24.9	Cracow	13 3
York, England	23	Brussels	28.06
Borrowdale, England	141.54	Paris	22 64
Dublin, Ireland	29 1	Geneva	31 07
Cork, Ireland	40.2	Milan	38.01
Limerick, Ireland	35	Rome	30 86
Armagh, Ireland	35.12	Naples	29.64
Aberdeen, Scotland	28 87	Marseilles	23.4
Glasgow, Scotland	21 33	Lisbon	27.1
Bergen, Norway	88.61	Coimbra Port	118.8

Bordeaux	34 00	Pekin, China	26.93
Algiers	36.99	Canton, China	69.30
St Petersburg	17 3	Singapore, Malacca	97
Simpaeropol, Crimea	14.83	Sierra Leone, Africa	86.2
Kutais (E shore of Black Sea)	59.44	Uttray Mullay, India	267.2
Bakou (S of Caspian)	13.38	Madras, India	44.6
Ekatherinburg, Ural Mts.	14.76	Calcutta, India	76.4
Barnaoul, Siberia	11.80	Cherrapoonjee, India	592
		Khasia, India	610

Raised Up-on'. (*Shipbuilding.*) Having the upper works hightened; the opposite of *razeed.*

Rais'er. (*Carpentry.*) The front of a step. The elevation of a step. A *riser.* The flat portion of a step is the *tread.*

Rais'ing. 1. (*Metal-working.*) The process of forming circular work or embossing in sheet-metal by striking up or raising from the interior surface.

In the case of circular works, as candlesticks, teapots, and other vessels and their covers, this is generally effected by *spinning* in the lathe.

In other cases hammering is resorted to, the metal being raised and the desired form imparted by successive blows while the plate is placed on an anvil or former, care being taken to preserve as nearly as possible a uniform thickness throughout.

Where large numbers of the same pattern are to be made, stamps and dies are usually employed. See EMBOSSING; SPINNING; STAMPING.

2. (*Printing.*) Placing scraps of paper on the tympan so as to increase the pressure at a particular point, to cause the ink to adhere more fully and give a dark impression at that point. Practiced with woodcuts. Also called *underlaying.*

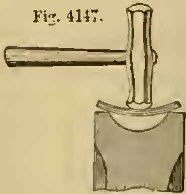
3. (*Leather-manufacture.*) The operation of swelling the pores of leather by steeping in dilute acid, in order to enable the tanning liquor to penetrate more easily.

Rais'ing-board. (*Leather-working.*) A corrugated board which is rubbed upon leather after it has been tanned, shaved, daubed, and dried, in order to *raise* the grain. A *crippler.*

Rais'ing-gig. (*Cloth-manufacture.*) A machine for raising a nap on cloth. A *gig-machine.*

Rais'ing-ham'mer. (*Metal-working.*) A long-headed hammer with a rounded face, used by silver and copper smiths to convert a sheet of metal into a bowl-shape.

Fig. 4147.



Raising-Hammer.

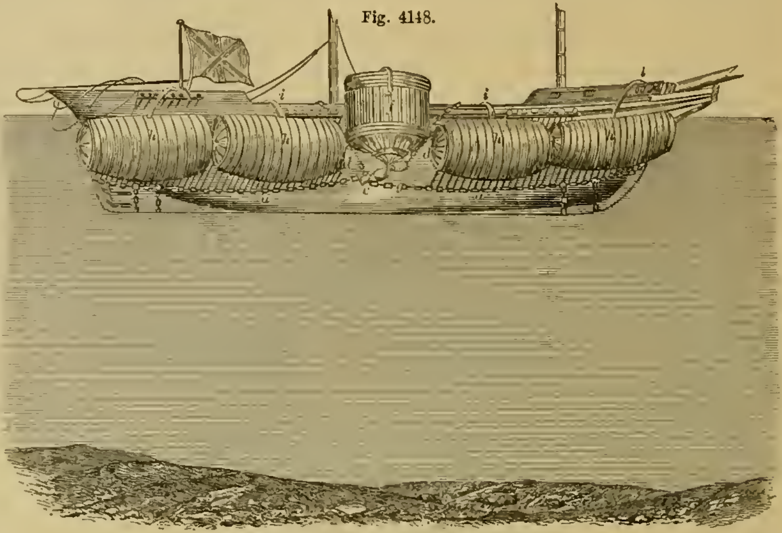
Rais'ing-knife. (*Coopering.*) A knife employed by coopers in setting up the staves in form for a cask.

Rais'ing-plate. (*Carpentry.*) That plate of a frame which rests on the vertical timbers and supports the heels of the rafters.

Rais'ing Sunk'en Ves'sels. (*Hydraulic Engineering.*) Among the various devices for this purpose may be cited: —

1. The *camel* or *caisson* submerged and chained to the vessel; the water in the caisson displaced by air, either by pumping out the water or forcing in the air; the flotative power of the caisson thus lightened lifting the vessel to the surface. The *camel* has long been used in Holland for floating vessels over the bars of rivers. The invention is credited to Bakker of Amsterdam, about 1688, the year that the great Prince of Orange came over to England and superseded the last of the Stuart kings. The *camel* consists of twin hollow vessels, so arranged that they can be applied on either side of the ship's hull. They are made water-tight, and on the deck of each windlasses are attached, by which ropes passed under the keel of the vessel are worked. Each half of the camel is allowed to fill with water, which sinks with the weight, and when the ropes are adjusted the water is pumped out, and the buoyancy of the hollow vessels lifts the ship out of its bed at the bottom of the stream.

Fig. 4148.



Austin's Plan for Raising Sunken Vessels.

The largest men-of-war were thus lifted over the shoals of the Zuyder-Zee. The camel has been used in many other places since.

A modified form consists of caissons or large barrels submerged and attached by slings to the vessel.

Captain Austin's plan differs from those described in having large inflatable canvas bags *h h h h*, rendered water and air proof by caoutchouc and strengthened by envelopes of netting. These are brought into position against the vessel by slinging the chains to which they are attached around the hull. Two tugs, taking the ends of a chain *a*, sweep the bottom where the vessel lies until the bight encounters the vessel. Buoys attached to the chain at intervals show by their position on the surface of the water the lay of the vessel. Another chain *a'* is now swept around the other end of the vessel, and rings *c* on the ends are passed over the ends of the chain *a.* A stopper *g* is sent down the chain *a* to prevent the ring slipping back. Another bag *f* is then sent down the chain *a,* the same being on each side of the vessel, and is secured by a stopper *d.* All being ready, the bags *h h h h f* are inflated by air driven in by pumps through the pipes *i i*, which reach to the surface, and the vessel floats, as seen in the figure. The bags are secured to the main chains by smaller ones.

Colonel Gowan tried this plan in 1851 in an attempt to raise the wreck of the United States steamer "Missouri," burned and sunk in the Bay of Gibraltar in 1845. He found it ineffectual ; the difficulty being, in this case, the bursting of the bags. He tried them again at Sevastopol with the same result. He removed the wreck at Gibraltar Roads by blowing it to pieces by the explosion of loaded cast-iron cylinders inserted beneath the vessel. The charges were ignited by electricity, and the portions of the wreck removed piecemeal.

2. Another mode is by slinging a vessel to lighters, which are raised by the tide, and the vessel transported to shoaler waters. The slings are shortened during the next tide, and the process repeated.

One of the earliest accounts of raising sunken vessels is that given of the raising of the "Mary Rose," by Edward Bedall of Boston, Colony of Massachusetts, 1642. She had been sunk in the previous year, and the diving-bell seems to have been used in adjusting the slings by which she was raised and transported to shoal water, where the hull, lading, and guns were recovered.

The steamer "Erie," burnt and sunk in Lake Erie in 1854, was raised by Colonel Gowan by means of chain falls working from two open-trussed frames supported upon hulks on either side.

This gentleman, under a contract with the Russian government afterward, between 1857 and 1862, raised the hulls of the vessels sunk in the harbor of Sevastopol during the siege of that place by the Allies. These were more than 100 in number.

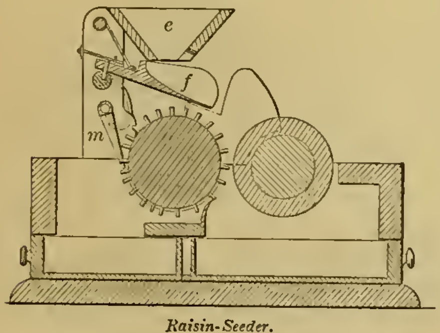
The attempt was first made to lift them entirely by means of floating caissons or docks on either side, connected by chains to the hull of the vessel. It was found, however, that, as the vessel rose, the docks, though firmly anchored, were drawn together with such force that they could not be separated even when steam-tugs and gunboats aggregating 1,000 horse-power were brought into requisition for this purpose.

A pump capable of raising nearly 1,000 tons of water per minute was then employed. This removed the water from the interior of the hull much faster than it could enter from without, the ports and other openings having been previously closed as far as possible, and by this, in conjunction with the floating caissons and a chain 1,000 feet in length, having links of some 350 pounds' weight, the work was successfully accomplished.

3. A third plan is to raise the wreck by direct hoisting power. An instance of this is Bishop's floating-derrick, shown at Fig. 1617, page 688.

4. Vafea's plan for raising sunken ships consists in first closing hermetically the hatches, port-holes, and all other openings in the deck or upper or side parts of the sunken ship, and then pumping down air to the bottom of the ship through tubes inserted either through the bottom of the ship's hull, or through the deck, each tube being passed down close to the bottom of the ship. The air thus introduced rises by itself toward the under side of the deck, and, not being able to escape, presses the water contained in the ship down and out through the hole made by accident or through holes made for the purpose. The vessel will thus be rendered buoyant, and will rise to the surface.

Fig 4149.



Raisin-Seeder.

Rais'in-seed'er. (*Household.*) A machine for taking the seeds from raisins. The example shows the usual form. The raisins falling from the hopper *e* down the spout *f* are impaled upon closely set wires on the cylinder by revolution against a rubber drum ; a scraper removes the seeds from the surface, and the pulp is subsequently drawn off the wires and collected. The wires are set so closely as to force outward the seeds ; these, when removed by the scraper, fall into one drawer, while the pulp removed from the wires by the rake *m* falls into the left-hand drawer.

Rake. (*Agriculture.*) An implement having a head provided with teeth and a long handle projecting from the head in a direction transverse to that of the teeth and nearly perpendicular to the head. A grain-rake works better when the teeth and handle are at an angle of about 75°. The head is put on a "little *hooking*," as it is called.

Rakes are *hand* and *horse*. Specific names indicate purpose or construction ; as, hay, stubble, barley, manure, horse, tilting, drag, etc.

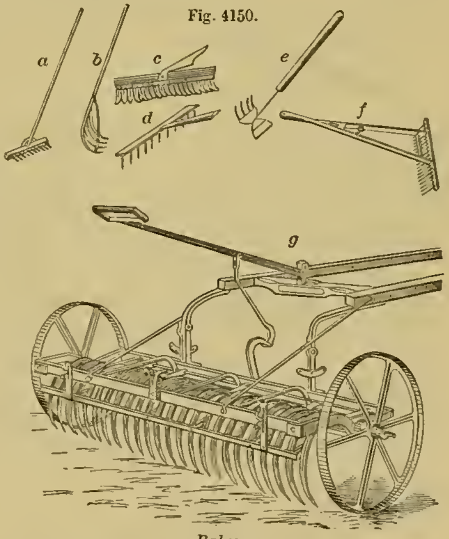
Hand-rakes are of wood for hay or grain, and of metal for garden use.

The rake is not represented in the sculptures or paintings of ancient Egypt. So says Wilkinson. The seed was covered by the plow, hoe, or by tramping of goats ; probably, also, by dragging bushes over it.

The Roman hoe (*raster*, a scraper), when its blade was divided to form teeth, was known as *raster-bidens* or *quadridens*, etc., according to the number of prongs. It was the ordinary tool for stirring the ground when deep digging by the spade (*pala*) was not required.

The hay or grain hand-rake (*a*) in the United States is made of wood, and the same rake answers for either. The material will vary with the place, but the general statement may be made that the handle and head should be of a material strong in proportion to its weight, say red-elm or sassafras ; and the teeth of the strongest wood procurable, say hickory. In England, willow is used for the handle and head, ash for the teeth. The handle is mortised

Fig. 4150.



Rakes.

into the head and stayed by a round rod passing through the handle and into the head, where the ends are split and wedged, or secured by pins.

b is the Japanese rake.

Grain-rakes in Britain are made of large size for raking and gleaning the stubbles: the head is 4 feet long; the teeth of iron, 4 inches long and 1½ inches apart.

One variety has wheels at the end 9 inches in diameter; the rake of the teeth is adjustable. It is used for grain or hay, and was the precursor of our more ambitious *horse-rakes*.

In Scotland, a rake is used with a jointed head 15 feet long. The handle has a cross-bar, and the implement is drawn by two men.

The garden-rake varies in size and somewhat in the kind of material. See *d f*.

Cheap rakes are cast and made malleable. Others have wrought-iron heads and wrought pins riveted thereinto. Some are light and effective, being made of steel.

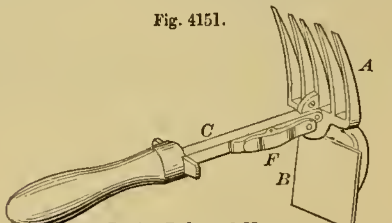
A small hand-tool (*e*) for working among flowers is made to combine a hoe-blade and a rake on respective sides of the insertion of the handle.

A rake (*c*) to take off the heads of flowers in pastures or on lawns consists of blades instead of teeth. The sharp edges cut off the flowers, which fall over the head of the rake as it is dragged along. Daisies are considered a great eyesore on English lawns, and dandelions by the neat gardeners of our own country.

This rake is in principle like the clover-headers of the nineteenth century and the wheat-harvester of Gaul, which gathered the crops of that fertile land in the first to the fifth centuries A. D.

Fig. 4151 has a rake *A* and hoe *B* pivoted on the shank *C*; either of these may be turned down on the shank, when the other can be used as a fork or a spade. A latch *F* serves for locking in either of the above positions.

Fig. 4151.



Garden Rake and Hoe.

Horse-rakes are of several kinds, and have come into extensive use of late years. The mower, horse-rake, and horse hay-fork are a most effective trio in the business of cutting and saving hay.

Horse-rakes are wheeled or wheelless. Some rake-heads revolve, as in the old *flop-over* rake; in others, the rake-head is formed by or attached to the axle or trails behind it, and the teeth are only lifted to deliver the hay. In some the teeth are independent, so as to yield to obstacles without affecting the operation of other teeth. The rake-head is in some cases turned by hand at the proper moment, but is more commonly arranged to receive motion from the power of the animal when a holding device is released by the driver.

Howard's horse-rake (English), *g*, Fig. 4150, is thus described by the makers: —

> "It is intended for raking hay, corn, stubble, or twitch-grass. The shaft-irons are furnished with a joint and quadrant, by which the teeth may be readily altered, so as to rake upon their points, or set more or less off the ground. This method is to prevent the rake collecting the soil and rubbish with grain, an objection frequently raised against the use of horse-rakes; the teeth, being curved or sickle-formed, are much stronger than when angular, and the hay and grain work round them much more freely; the bar running under the teeth, and by which they are raised, is so arranged that the teeth do not, as in other rakes, rest upon it, but allows them to drop into any hollows of the land The frame and teeth are made entirely of wrought-iron; the teeth work independently of one another, so as to adapt themselves to irregularities of the surface. It is mounted on high wheels, which are capped to prevent the hay working round the axles.
>
> "By means of a pull-down lever, which requires only the strength of a boy to manage, the rake can be emptied of its load without stopping the horse; the frame, being made of iron instead of wood, allows the wheels to be brought about a foot nearer together, which is an advantage in narrow lanes and gateways."

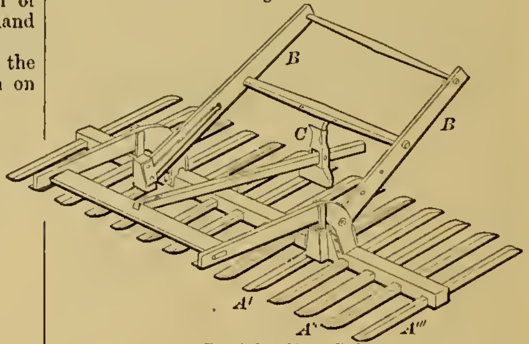
This rake is recommended for dragging-in clover-seed in the spring, and for covering other grass-seeds; also as a stubble-rake.

Horse-rakes are classified as follows: —

Rakes……
- Horse-rakes.
  - Revolving.
  - Lifting.
    - By operator.
    - By draft.
- Hay-drags.
- Hay-cockers.

Fig. 4152 is an illustration of the revolving-rake, operated by a person walking in the rear and holding the upper round connecting the bars *B*. The teeth *A′ A″ A‴* and the others in the series rest nearly level upon the ground, the block *C* preventing the rake from tilting as long as pressure is kept on the bars *B B*. When a sufficient quantity of hay has accumulated on the forward part of the rake, the bars are lifted, tilting the rake and allowing the forward ends of the teeth to catch in the ground, at the same time withdrawing the block *C*, which acted as a detainer. The rake revolving discharges its load, and the other row of teeth comes into action.

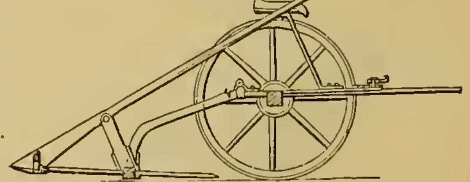
Fig. 4152.



Revolving Horse-Rake.

Fig. 4153 is another form of the revolving-rake, in which the operator rides and manages the rake by means of a lever, by which the rake is kept to its work, or is tilted as occasion requires.

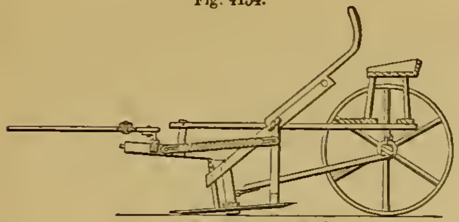
Fig. 4153.



Sulky-Rake (Rear Work).

Fig. 4154 is another view of a sulky-rake, on the revolving principle, in which the working portions are in front of the driver. By the operation of the lever the stop is lifted from the rear ends of the

Fig. 4154.

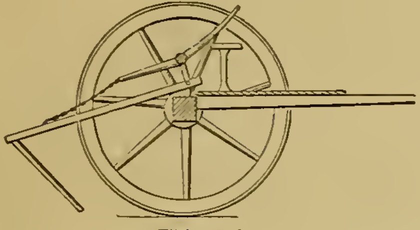


Sulky-Rake (Forward Work).

teeth and the front end tilted down, so as to catch in the ground and revolve the rake.

Fig. 4155 is a rake of the tilting order, the rake-bars trailing behind the axle and being raised as occasion requires to drop a load of collected hay. The rakes fall by gravity, and are raised by lever and chain.

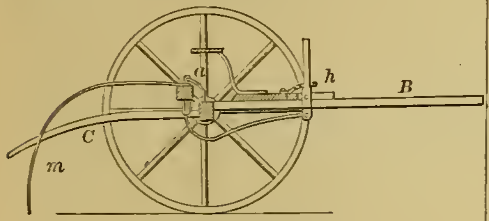
Fig. 4155.



Tilting-Rake.

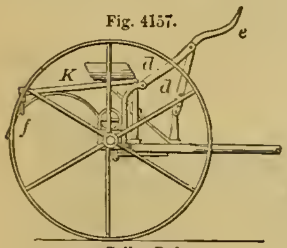
Fig. 4156 is a spring-tooth rake. The rake-axle is connected by a bent arm with the lever *h*, pivoted to the thill *B*, and held by a notch in a segment-rack. When the lever is released therefrom, the draft causes the axle to turn on its hinge-joint *a*, raising the teeth *m* from the ground, and discharging the hay by its own weight and the action of clearers *C*.

Fig. 4156.



Spring-Tooth Horse-Rake.

Fig. 4157.

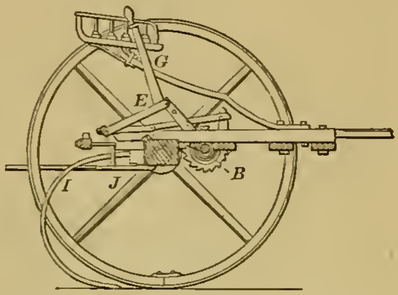


Sulky-Rake.

In Fig. 4157, the rake-head is partially revolved to deposit a windrow by pushing forward the lever *c* and turning the lever back; the toggle-levers *d d* turn the rake down for gathering, and lock it fast. The teeth are cleared by a series of bars *K*, having pins *f* which pass between them.

In Fig. 4158, the teeth *I* are held in raking position when the lever *G* is thrown backward, as shown. On being pushed forward, it, through the medium of a series of connected levers *E*, lifts the teeth, which are then thrown quickly upward by the action of a spring *B* on the end of one of the series. The spring surrounds the axis of a ratchet-wheel, by which its tension may be adjusted. Horizontal bars *J* passing between the teeth free the hay therefrom.

Fig. 4158.



Horse-Rake.

Another form is that of a wheeled rake with oscillating teeth elevated by a spring at the will of the operator, the spring being wound or set by the motion of the wheels, while the teeth are held in working position by an automatic spring-catch. This is tripped by the driver's foot, and the springs then operate to instantaneously elevate the teeth and support them while dropping a bunch of hay, or going to and from the field. By actuating a hand-lever, the springs are released, and the teeth then drop by gravity.

2. (*Nautical.*) *a.* The backward slope of a mast.

b. The forward pitch of the stem.

c. The backward slope of the stern, by so much as it overhangs the keel. The *rake* of a rudder is that of the stern-post.

Rak'er. (*Bricklaying.*) A piece of iron having two points bent at right angles, used for picking out decayed mortar from the joints of old walls preparatory to replacing it by new mortar. Technically termed *pointing.* See Fig. 4109.

Rak'ing-mold'ing. (*Building.*) A molding in an inclined position, as on the under side of a stairs baluster, etc.

Rak'ing-pie'ces. (*Bridge.*) Pieces laid upon sills supported by the *footings* or *impost* of a pier. Above them are the *striking-plates*, which support the ribs of a bridge *centering*, and which are driven in to allow the centering to drop clear of the completed arch. See Centering.

Ram. 1. The heavy weight of a pile-driving machine. Otherwise called the *monkey.*

2. The piston of the large cylinder of a hydraulic press.

3. A water-raising device in which the concussion produced by arresting a descending body of water is made to force a smaller quantity of water to a hight greater than the fall. See Hydraulic Ram.

4. A steam-hammer used in connection with the *squeezer* in *setting up* the *bloom* as it is lengthened by the action of the squeezer.

5. A warlike implement, formerly used, consisting of a spar with a heavy metallic head (*aries*) swung from a frame and used to batter down walls or mash gates.

6. (*Shipbuilding.*) A spar, hooped at the end, and used for moving timbers on end by a jolting blow.

7. (*Nautical.*) A projecting device at the bow of a war-vessel, designed to crush in the sides of an adversary by running against her "end on."

It formed a very important means of offense in ancient naval warfare, the prows of galleys in former times having been, as may be seen by the examination of old coins and sculptures, generally furnished with rams.

At the battle of Salamis, 480 B. C., Queen Artemisia, an Asiatic Greek herself, though allied with the Persians, effected her escape by running down a Persian ship, causing the Greeks to mistake her galley for one belonging to their own fleet.

The term *ram* is also applied to a ship provided with such an appendage.

The great ship of Ptolemy Philopator had two heads, two sterns, and seven beaks, one of which was longer than the others.

With the introduction of armor-plating the use of the ram has been revived in modern warfare The first effective use made of it was by the Confederate "Virginia," the captured "Merrimac," sinking the United States ships "Cumberland" and "Saratoga," in Hampton Roads, March 9, 1862.

In the naval engagement at Lissa, in July, 1862, the Austrian admiral's ship "Archduke Ferdinand Maximilian" sank the Italian iron-clad "Re d'Italia" by a well-delivered thrust of her ram.

One of the rams built on the Clyde, in Scotland, for the Confederate States, but afterward purchased by the British government, is thus described by the "Liverpool Courier": "The iron hull has a coating of 10 inches of teak, and armor plates 4½ inches thick, nearly the whole length of the side, but tapering in thickness at bow and stern. The topgallant rail of the bulwarks is of wood, and removable, the bulwarks proper being of iron, hinged on the deck level, and falling outwardly against the ship's side, thus literally 'clearing for action,' and giving the guns in the turrets an uninterrupted sweep, except directly fore and aft. The muzzles of the guns are only a little above the deck level, and the tops of the cupolas are but 5 feet high, so that they do not present a very conspicuous mark. The turrets extend some depth below, and have thus the protection of the ship's sides. What is exposed above the deck has 5½-inch plating, doubled near the muzzles of the guns, and 14-inch teak backing. The turrets are 18-sided in the surface presented to shot.

"There are two turrets, each to carry two 12-ton guns, ranged side by side, and throwing a 156-pound spherical shot, or a 300-pound bolt, if the weapons are rifled. The tower rests on a turn-table, running on wheels, the motion being obtained by four crab-winches, acting on a toothed rim fixed to the keelson that supports the tower. The tower is prevented from shifting by a wrought-iron central spindle, bolted into the framework and bed of the vessel. Outside, the towers are 24 feet in diameter; inside, 19 feet. The charge and projectile will be handed up to the gun by means of tackle, these turret guns being positively easier to work than ordinary broadside guns, while the men are all under cover of the armor-plating Aim is taken from the outside of the turret. For this purpose there are three little holes in the roof for the gunner to put his head through, filled with iron bonnets to glance off rifle bullets The gunner, in fact, brings the port-holes of his turret to bear upon the object.

"The dimensions of the 'Scorpion' (and 'Wyvern') are: Length on water line, 224 feet; beam, 42 feet 6 inches; depth, 20 feet; measurement, about 1,830 tons. Their great beam gives these vessels wonderful stability as floating batteries. The screw-propeller is 14 feet in diameter, and has three blades"

The Confederate ram "Tennessee," in the extraordinary fight with nearly half our entire fleet, which took place inside the harbor of Mobile, proved herself one of the most formidable crafts for harbor defense which has ever been constructed. Her hull was originally intended for a man-of-war, and was put together in a most stanch and substantial manner. Her length was about 180 feet. In form she was a modification of the old "Merrimac." Her armor consisted of 2½-inch iron in bars 8 inches wide crossing one another and bolted down with 1¼-inch bolts, making five inches of solid iron. This again was backed by 2 feet of solid oak through the entire portion of the boat above the water-line, and extending some feet even below that. From her forward casemates forward, including her pilot-house, an additional inch of iron was given her, making 6 inches of plating, and an additional foot of wooden backing, making 3 feet at this part of the boat.

Her gun-room, if that be the proper term to use, occupied about two thirds of her length, and was constructed with a flat top composed of 2½ by 8 inch iron bars, crossed and bolted together, forming a close lattice-work above her gunners, and affording ventilation while in action. The sides were inclined like those of the old "Merrimac," and through them, in the fight with our fleet, no ball succeeded in penetrating. Her ports, of which there were two on either side, and one fore and aft, were closed by means of iron shutters, which revolved upon a pivot in the center of one side, and were worked by means of a cog-wheel on the inside They were liable, however, to derangement, and in the engagement with our fleet two were actually so deranged as to prevent their being opened, while a third, the after one was shot away entirely, the pivot on which it revolved being broken off, and it was through this that the fragment of shell entered which wounded Admiral Buchanan, as he was standing near, directing a gunner to clear away some splinters with which it had become filled. Ten shots struck in close contiguity to this port, which it was early discovered it was impossible for her crew to close, and this really became the heel of Achilles to the fated "Tennessee." Somewhere between forty and fifty shots struck her during the fight in nearly every part of the boat, but not one penetrated her impervious armor. One 15-inch shell from the monitor "Manhattan," as is supposed, made a deep indentation which must have caused her to stagger, but bounded off from her ribs of steel. The impact of the blow, however, stove through her two feet of wooden blocking, and produced inside all the evidences of the missile's having come through The splinters flew promiscuously in all directions in the neighborhood inside The ram was armed with two 7 and one 8 inch rifled guns of the Brooke pattern, fore and aft, and with four of the same 6-inch guns in her broadsides.

The attack by Lieutenant W. B Cushing upon the Confederate ram "Albemarle," in the Roanoke River, was made October 28, 1864. With a tug rigged with a torpedo spar, he ran the gantlet of the batteries and destroyed the ram, his own vessel being sunk in the encounter. The gallant commander and one seaman escaped. Lieutenant Cushing died December 24, 1874, aged 32.

Ram-block. (*Nautical.*) A block without sheaves for the lanyards of the shrouds. See DEAD-EYE.

Rămed. (*Shipbuilding.*) Said of a ship on the stocks when the frames, stem, and stern-post are up and adjusted.

Ram-head. (*Nautical.*) An old name for a halyard-block.

Ram-line. (*Nautical.*) A line used in striking a straight middle line on a spar, being secured at one end and hauled taut at the other.

Ram'mer. 1. (*Fire-arms.*) *a.* The rod by which the charge is forced home. See RAMROD.

b. A staff having a cylindrical or conoidal head attached, used in cannon for the same purpose. The rammer-head is made of beech, maple, or other hard wood not easily split, and is bored for about two thirds of its length to receive a tenon on the staff. For rifled guns or for hollow projectiles, its face is countersunk.

Rammers for large guns are technically termed *rammers* and *staves*. For field artillery, a *sponge* is attached to the other end of the staff, and the combined implement is called a *sponge and rammer*.

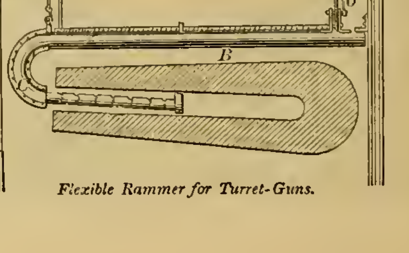
The sponge is made of coarse, well-twisted woolen yarn, woven into a warp of strong hemp or flax thread, after the manner of Brussels carpet.

They are woven in threads with selvages between them, which, being cut, the sponges are sewed to fit formers of the same diameter as the sponge-heads.

Hair sponges, frequently called brush-wipers, are sometimes employed, and are very useful, for cleaning the grooves of rifled guns.

Fig. 4159 is a flexible rammer for turret-guns. It is attached to the monitor turret by a hinge, so as to be lowered into ser-

Fig. 4159

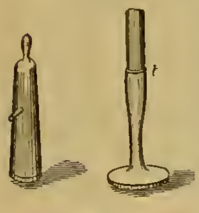


Flexible Rammer for Turret-Guns.

viceable position when required. It is composed of a tube *B* surrounding a series of jointed plates *C*, which can be flexed in one direction, and are caused to protrude from the tube and follow the bore of the gun by means of a screw operated by a hand crank and gear *n o*, or other suitable mechanism.

2. The pavior's rammer (Fig. 4160) is used in settling paving-stones firmly into their beds. The rammer is used by a motion in direction of its length, as in the annexed illustration, in the ramrod of the fowling-piece, the gun-rammer, or even, in the largest sense in which the word is used, the ram of a steam-vessel brought into action by the motion of the vessel end on upon the enemy's ship. See Ram.

Fig. 4160.



Rammers.

3. (*Founding.*) A tool for ramming the sand into the flasks. They are of two kinds; square and round. The former is thin and calculated to affect the bottom of the soft sand, compressing and driving it into the interstices of the pattern. The round or flat rammer (*b*, Fig. 4160) hardens the upper surface only; it is always used last. Rammers are sometimes entirely of iron; they are best made with ash or hickory handles, about four feet long, shod with a cast-iron end of suitable size and weight. Bench-rammers have short handles.

Ra-mo-neur′. A chimney-sweeping device.

Ramp. 1. (*Fortification.*) An inclined road in a fortification leading from one level of the enciente to another. See Bastion.

2. (*Carpentry.*) A concavity on the upper side of a hand-rail formed over risers, or over a half or quarter space, by a sudden rise of the steps above.

Ram′pant Arch. One whose abutments spring from an inclined plane.

Ram′part. (*Fortification.*) An embankment around a fortified place. In the more perfect condition the wall of the rampart forms a scarp and is crowned by the parapet. See Intrenchment; Bastion.

The term *bulwark* is sometimes applied to a rampart, and sometimes to an outwork for the defense of the main work.

Ram′rod. A rod of wood or metal, used for forcing the charge to the bottom of a gun-barrel, and also with a *wiper* or *ball-screw* attached, for cleansing the interior of the barrel and for withdrawing a charge. It is held to the gun by thimbles or by grooves in the band and a corresponding groove in the stock.

Wooden ones are now only used for sporting arms. The iron ramrod did not supersede the wooden one until 1742. It was introduced into the Prussian army by Prince Leopold, of Anhalt-Dessau.

The United States service ramrod, used prior to the introduction of breechloaders, is made of steel. Its parts are: —

The stem.
The head.
The cup.
The thread.
The cap.

It generally is made with a swell, to keep it in place; but in some patterns a spring in the stock serves this purpose, and the swell is dispensed with.

Ramrods, in the large gun-factories, are made by machinery. In the case of wooden ones, the blanks are driven through tubular cutters, which bring them to a cylindrical form. The iron ones are cut from a round rod. For polishing, they are placed upright in a frame which holds ten at a time, and are subjected to the action of hard-wood rubbers supplied with oil and polishing-powder. The grooved ends of the rubbers are pressed against the ramrods by springs, and the rubbers receive a rapid motion while the ramrods are slowly revolved.

Rams′den's Eye-piece. The *positive* eye-piece, principally used in micrometers, and invented by Ramsden, a celebrated instrument-maker in England (1735 – 1800).

His name is associated with science as the maker of the celebrated dividing-engine, and he is known by a number of his instruments, of great accuracy, in several European observatories, — sextants, telescopes, and mural circles.

The *Ramsden eye-piece* has two plano-convex glasses, each of which presents its concave side to the object-glass. See Positive Eye-piece.

Ran. 1. (*Rope-making.*) A reel of 20 yarns.

2. (*Nautical.*) Yarns coiled on a spun-yarn winch.

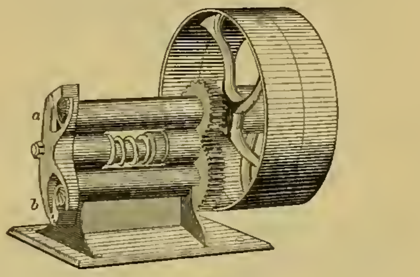
Rand. (*Shoemaking.*) One of the slips beneath the heel of a sole, to bring the rounding-surface to a level ready to receive the *lifts* of the heel.

Ran-dan′. (*Nautical.*) A mode of rowing with alternate long and short oars.

Rand-form′ing Ma-chine′. A machine which operates upon a skived rand-strip, to bend it into the circular (horseshoe) form suitable for its place in the heel of a shoe.

In Fig. 4161, the rand-strip is passed in at the orifice *a* shown at the upper left-hand corner of the engraving, and seized between two steel formers, one of which is held up against it by the central shaft, around which it is bent as its thin edge is crimped by the formers. The strip is kept in a curved path by a guide, and released by a stripper at the lower opening *b*, properly crimped and curved for application to the heel.

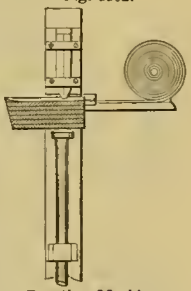
Fig. 4161.



Rand-Forming Machine.

Rand′ing-ma-chine′. (*Shoemaking.*) One for fitting rands on heel-blanks, to give the cup shape to the upper part of the blank. In the example, the machine consists of a heel-supporting post, a feeding and nailing mechanism, an edge-guide, and a rand-guide, by which the rand-coil or ribbon is directed and placed in position to be nailed upon the heel.

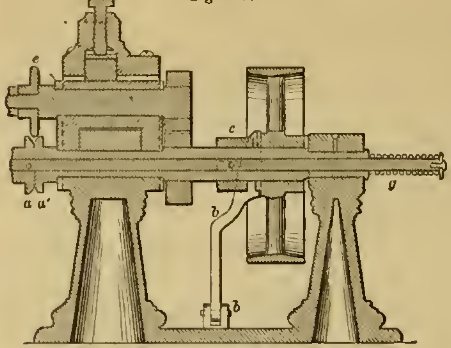
Fig. 4162.



Randing-Machine.

In Fig 4163, the forming cams *a a′* are made of shape to fit the bevel of the heel, and their inner sides are beveled to fit the bevel of the rand, which is passed upward between them, and rests against *a′*. The operator then depresses a treadle *h*, which swings back the starting-lever *b*, releasing the clutch ring *c*, when the spring *g* throws the center-rod to the right, closing the cam *a* against the rand and engaging the clutch-ring *c* with the end of the pulley *d*, and causing the shafts to rotate. The cam *e* runs on top of the rand, forcing it between the cams *a a′*, which press it into the desired form. When the shaft has made one revolution, a lug on the ring runs on to the beveled end of the lever *b*, whereby the ring and center-rod are carried

Fig. 4163.



Randing-Machine.

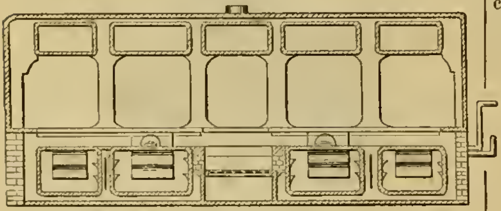
far enough to the left to disengage the clutch-teeth and separate the cams, so that the rand may be disengaged therefrom.

Rand'ing-tool. (*Shoemaking.*) One for cutting out slips of leather to form *rands*. The slip is cut into lengths, which are crimped into a horseshoe shape.

Range. A fireplace cooking-stove, usually bricked in at the sides, but sometimes portable.

Fig. 4164 has a middle fire-chamber and two ovens at each side. By means of dampers the heat is directed to as many as may be necessary. Elevated ovens are encircled by the flues above.

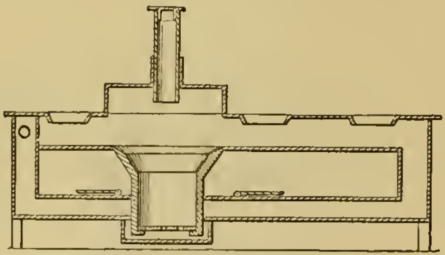
Fig. 4164.



Cooking-Range.

In Fig. 4165, the base-burning grate is fed from a cylindrical covered tube which slides in a suitable vertical tube fixed at the back part of the top plate.

Fig. 4165.



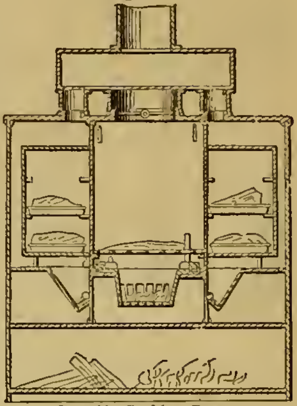
Base-Burning Range.

The radiating heat from the fire may be used by a reflector oven attached before it.

Fig. 4166 is a portable range having a central broiling-chamber, side ovens which can be utilized by means of dampers, and a hot-closet above.

Fig. 4167 gives a sectional elevation and a horizontal section of a range, showing the various parts. The grate has a water-back *D* and a horizontal flue *H* extending backward beneath the lower oven to the upright flue, which has forward projections between the ovens and a warming-shelf. Hot-air spaces occupy room on each side of the ovens.

Fig. 4166.



Portable Cooking Range.

2. (*Ordnance, etc.*) The horizontal distance to which a projectile is thrown.

Strictly, the distance from the muzzle of the gun to the second intersection of the trajectory with the line of sight.

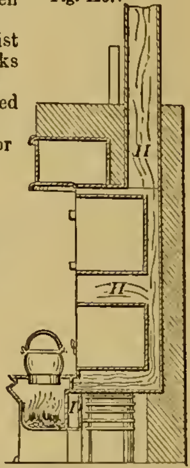
3. A ladder step.

4. (*Nautical.*) *a.* A length of cable a little in excess of the depth of water, roused up out of the *tier* and ranged on deck ready to run out of the hawse-hole when the anchor is cast.

b. A large cleat in the waist for belaying the sheets and tacks of the courses.

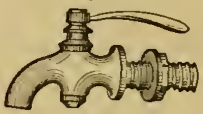
Horned ranges; two-pronged cleats or kevels.

Fig. 4167.



Range-cock. A faucet for the hot-water reservoir of a cooking-range.

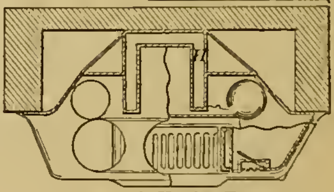
Fig. 4168.



Range-Cock.

Range-heads. (*Nautical.*) The bitts of the windlass.

Range-stove. A stove made in the form of a range, that is, with lateral extension, ovens, and boilers, as the case may be, on each side of a central fire-chamber.



Range and Air-Heating Furnace.

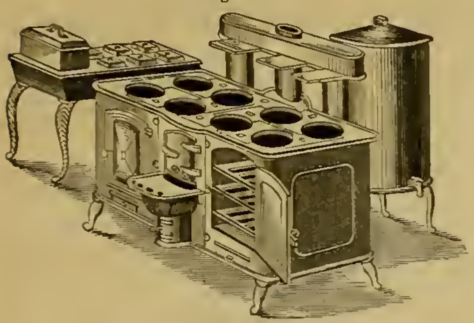
The example (Fig. 4169) is a *portable range*, or *range-stove*, adapted to be set out upon the floor of a kitchen, instead of being built into a recess in the wall, beneath the chimney.

Rap. A lay or skein, containing 120 yards of yarn. See Lay; Yarn; Hank; Reel.

Rape. A filter used in a vinegar manufactory to separate the mucilaginous matter from the vinegar. It derives its name from being charged with *rapes*, the stalks and skins of grapes from which the *must* has been expressed.

Raph'i-an-kis'tron. (*Surgical.*) An instrument used in the formation of an artificial pupil for the eye. See Iridectome, page 1195. See Pupil, Artificial.

Fig. 4169.



Range-Stove.

Ra'pi-er. (*Arms.*) A sharp-pointed sword, designed for thrusting. The blade has a lozenge-shaped section.

Ras'ing-i'ron. (*Nautical.*) An iron to clean old oakum out of the seams previous to recalking. A *reeming-iron* is for opening the seams to receive oakum. A *rave-hook.*

Rasp. An abrading tool of the nature of a file, but having, instead of chisel-cut teeth, its surface dotted with separate protruding teeth, formed by the indentations of a pointed punch.

It is used almost exclusively upon comparatively soft substances, as wood, horn, and the softer metals.

This, like many other mechanical devices, is found in the animal kingdom. Some mollusks have rasp-like tongues, by which they penetrate the shells of others for the purpose of feeding upon them.

The wasp carries a rasp, and with it abrades dry wood to obtain fiber, which becomes mixed with glutinous saliva, and forms the pulp of which so "skillfully she builds her cell." This dries into *paper*, and has a very considerable tenacity. Hornets' nests pendent from trees, varying in size from an orange to a half-barrel, are familiar objects, and are the most beautiful structure to which we can point as being formed of *raspings*. These insects also remove fibers of weather-beaten wood with their feet.

The rasp of the Tahitians, when visited by Captain Cook, was a piece of coral, — no mean substitute for one of metal. The teeth of the rasps used by cabinet-makers and farriers are cut in lines sloping from left to right; those for last-makers and some others, in the reverse direction; and for gun-stockers and saddle-tree makers they are disposed in curved or crescent-shaped lines. These distinctions are unnecessary, the only requisite being that each tooth should be intermediate between the two in front of it, so as not to form furrows in the work.

The rasp-cutting machine resembles the file-cutting machine (which see) in the striking and feeding parts, differing mainly in the several devices by which it is adapted to the cutting of rasps instead of files. To this end, the chisel-stock is pivoted to the rock-shaft so that the chisel may be vibrated, not only in a vertical plane, as usual, but also in a horizontal plane, thus cutting the teeth in curved lines across the blank. The forward feed motion is intermittent, taking place only after the completion of one row of teeth and before the commencement of another.

Rasp'a-to'ri-um. (*Surgical.*) A rasp used in rasping bones for surgical or anatomical purposes.

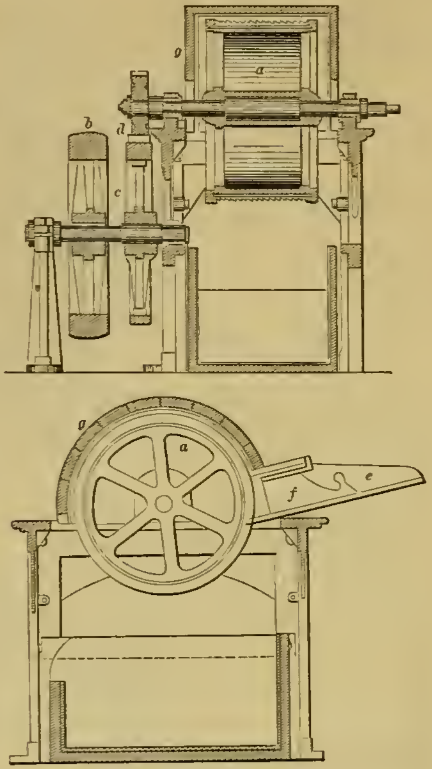
Rasp'a-to-ry. (*Surgical.*) An instrument for rasping bones. A *scalprum.*

Rasp'er. (*Baking.*) A file for rasping the burnt surface from loaves of bread.

Rasp'ing-ma-chine'. 1. A machine for rasping wood and bark for making dyes, tinctures, etc. See also Bark-cutting Machine, etc., Figs. 561, 564, 565, 566, 567.

2. A machine for grating beet-root for sugar. It consists of a drum *a* having its periphery set with saw-blades, and to which revolution is imparted by the pulley *b* through the gears *c d*. The cast-iron feed-plate *e* is divided by a ridge into two parts; the beets are placed on it and pushed up against the revolving rasp by wooden blocks *f*; a semicylinder of wood *g* lined with sheet-iron covers the upper part of the rasp; the pulp is received in a trough beneath.

Fig. 4170.



Mechanical Rasp for reducing Beet-Root to Pulp.

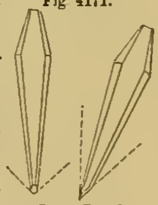
Rasp'ing-mill. A saw-mill for reducing dye-woods to dust.

Rasp-punch. A tool for cutting the teeth of rasps; it is held in the left hand of the workman at a suitable angle to the face of the blank, and struck with a mallet.

Ratch. A rack-bar with inclined angular teeth between which a pawl drops.

A circular *ratch* is a *ratchet-wheel.*

Fig 4171.



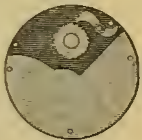
Rasp-Punch.

Ratch'et. The detent which falls into the interdental spaces of a ratchet-wheel, rising, as the wheel revolves, in one direction and preventing the backward motion of the wheel. (See Ratchet-wheel.) A pawl. A click.

If employed to *move* the wheel, it is a *pallet.*

The applications of the ratchet are very numerous. It is used in connection with *pawls* in hoisting

Fig 4172.



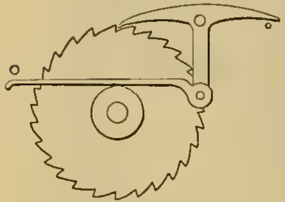
Ratchet and Click.

mechanism, capstans, windlasses, and winches; with *clicks*, in the winding mechanism of most machines which are actuated by springs; in machines where a rotary motion is obtained by impulses derived from an intermittent reciprocator, as in many feed motions; in most escapements in connection with *pallets* on the axis of the balance or on the anchor.

The terms *pawl*, *click*, *pallet*, have therefore special significations, indicating relation or function.

Fig. 4173 is a device of this kind, designed to prevent reverse motion of the shaft in sewing and other machines. It is so arranged that, while the wheel to which the pawl is connected revolves in the proper direction, the pawl does not interfere with its motion; but the instant the wheel commences to turn in a contrary direction, the pawl is made to engage with its ratchet, and the reverse motion is prevented.

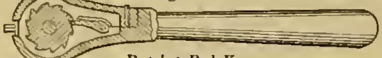
Fig. 4173.



Ratchet and Pawl.

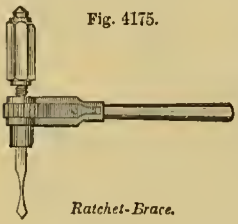
Ratch'et Bed-key. A wrench which has a ratchet on the socket or square, which engages the head of a bolt. As the handle is vibrated in one direction the spring-pawl turns the ratchet and spindle, and in the reverse motion the pawl snaps back over the teeth of the ratchet.

Fig. 4174.



Ratchet Bed-Key.

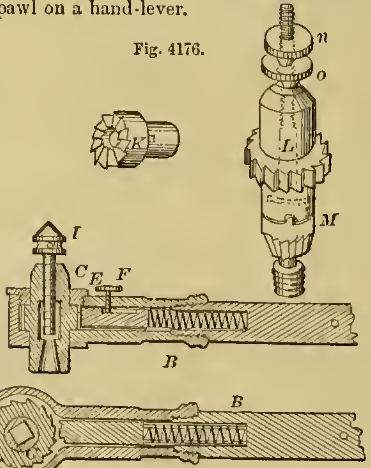
Fig. 4175.



Ratchet-Brace.

Ratch'et-brace. A boring-brace in which the spindle carrying the bit is rotated by means of a ratchet-wheel and a spring-pawl on a hand-lever.

Fig. 4176.



Ratchet-Brace.

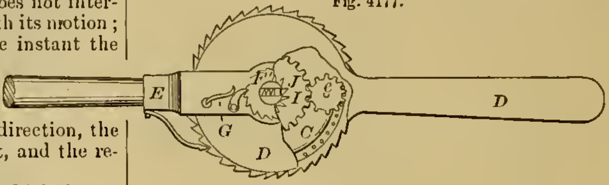
Fig. 4176 has two interchangeable shafts *C L* for drills and countersinks *M K*, fed respectively by thumbscrews *I o n*. Either is secured in place by the screw-cap *E*. The pawl is caused to engage the ratchet by pressure of a spring in the handle *B*, being prevented from falling out while one shaft is substituted for the other by a screw *F* entering a slot in the pawl.

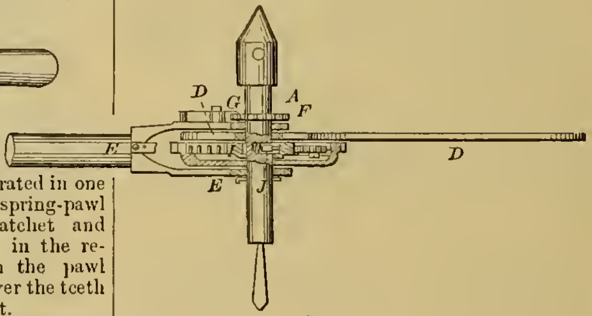
Ratch'et-drill. A drill whose rotatory movement is derived from a ratchet and pawl actuated by a lever.

The movement is usually intermittent, the pawl engaging the teeth only when the lever is pushed in one direction, and slipping over them when drawn backward. In some, however, a continuous rotary motion is imparted to the drill.

Sinclair's (Fig. 4177) is of this kind. The spindle *A* has a ratcheted shoulder *F* which holds the forked handle *E E* and disk handle *D D* in place, and in which the pawl *G* engages when this handle is worked in one direction. When the movement is reversed a second spring-pawl on the handle *E* engages the teeth of the wheel *C*, which are inclined in a direction opposite to those on the disk *F*. Pins on this wheel engage the pinion *c*, which rotates the wheel *I*; during this movement a spring-bolt *J* in the drill-spindle enters between two teeth of the wheel *I*, slipping over them when the handle *E* is again pushed forward, so that the pawl *G* again engages with *F*. By this means a continuous movement in one direction is communicated to the drill-spindle.

Fig. 4177.



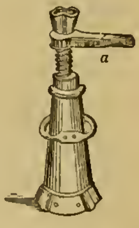


Ratchet-Drill.

The handle *D* serves to hold the device firm. See also RATCHET-BRACE.

Ratch'et-jack. A form of screw-jack. The rotatable lever-socket *a* has a collar encircling the head of the screw, and a pawl which drops into the notches of a ratchet fixed thereto, so that the operator may work the jack without moving from his place. See SCREW-JACK.

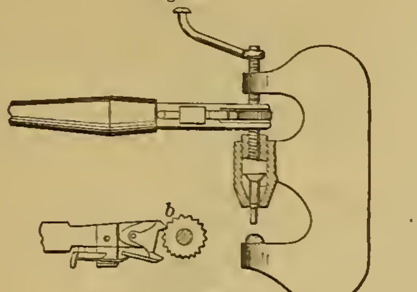
Fig. 4178.



Ratchet-Jack.

Ratch'et-punch. A punch operated by a screw, which is rotated by a lever having a pawl connection to a ratchet *b* on the shank of the screw. The crank on the upper end of the screw-shank is for a quick motion, to bring the punch down to its work or to raise it after the hole is made.

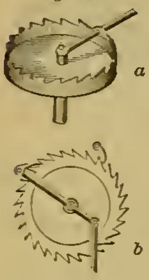
Fig. 4179.



Ratchet-Punch.

Ratch'et-wheel. A wheel having inclined teeth for receiving a ratchet or detent, by which motion is imparted or arrested.

Fig. 4180.



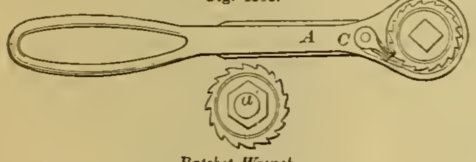
Ratchet-Wheel.

The teeth are of such shape as to revolve and pass the detent in one direction only. The detent may be a pallet, as at *a*, or a pawl, as at *b*. The former receives an intermittent rotation by a reciprocating circular movement of the arbor and its cam. The wheel in the second figure is intermittingly rotated by the motion of one pawl, while the other one acts as a detent in the intervals between the forward motions of the former.

Ratch'et-wrench. A wrench operated by a ratchet and pawl, so that it may be turned continuously without removal from the bolt or nut to which it is applied, by a backward and forward movement of the handle.

In Fig. 4181, the wrench-holder, turning in a cavity in the handle *A*, is removable, and its upper part has ratchet teeth, over which projects a lip on the pawl *C*. The nut fits into a cavity *a*, while the upwardly projecting portion of the bolt passes through the central aperture.

Fig. 4181.



Ratchet-Wrench.

Rate. 1. (*Nautical.*) In the old classification of men-of-war in the British navy, ships were *rated* according to the number of guns which they carried. This has been much disturbed by the introduction of armored vessels, heavy ordnance, rams, etc.

Formerly the first rate was from 100 guns upward; the second rate was from 90 to 100 guns; the third rate was from 80 to 84 guns; the fourth rate was from 60 to 74 guns; the fifth rate was from 32 to 40 guns; the sixth rate included the smallest armaments.

In the United States navy vessels are rated according to their tonnage. Thus, ships of 3,000 tons and upward are first rates; 2,000 to 3,000 tons are second rates; 800 to 2,000, or iron-clads from 1,200 to 2,000, are third rates; under 800 tons, or iron-clads under 1,200, are fourth rates. These are farther subdivided into classes, according to their armament and tonnage.

2. (*Horology.*) The daily gain or loss of a chronometer or other timepiece in seconds and fractions of a second.

Răt'ing. The *retting* or *rotting* of flax, to loosen the fiber from the woody portion and gum; the *hare* from the *shives*. See Retting.

Rat'line. (*Nautical.*) One of the ropes (from 1 inch to 1½ inch in circumference) forming the steps of the shrouds, whereby they are ascended.

Rat's-tail. 1. (*Nautical.*) The pointed or tapered end of a rope.

2. A tapered, round file.

Rat-tail File. A small, tapering file, circular in its transverse section.

Rat-tan'. (Malay, *rotan.*) The stem of a cane of the genus *Calamus*, especially used for making splints for chair seats and backs.

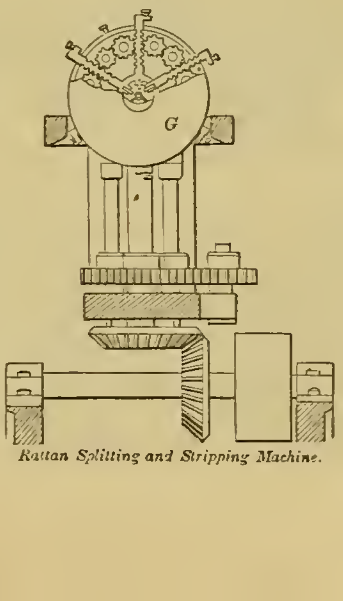
It abounds in Southern Asia in moist situations, and the various species are used for hanks for sails; cables, sometimes as much as 42 inches round; cords, withes, and walking-sticks; also for making splints for baskets and brooms, fish-weirs, hurdles, hoops, carriage-seats, and many other purposes. The larger varieties grow to a size of 3 inches diameter, and to a hight of nearly 100 feet. It is cylindrical, jointed, and destitute of branches.

Rat'tan-as. A coarse sacking made at the Mauritius.

Rat-tan'-ma-chin'er-y. The rattan used in this country is imported from Singapore, packed in bundles in lengths of 8 to 16 feet. It is sorted, preliminary to being prepared for its various uses, into 12 sizes, according to diameter, and washed in revolving boxes. The joints being scraped smooth by machinery, the hard outer surface is removed in strips, which are used for the bottoms of cane-seat chairs and similar latticed work, and the rounded pith portion, known as *reed*, is woven into baskets, tables, and chairs. The shavings are made into matting, the *rub* into mattresses.

After washing and scraping, the rattans are presented to the action of machines comprising a set of drawing or feeding rollers, and knives which make longitudinal incisions in the hard outer coating, dividing it into strips which are then separated from the inner porous or pithy portion by means of a tubular cutter, through which this part is drawn while the strips are thrown off by the conical exterior of the mouth of the cutter. Another machine then reduces the strips to an even thickness and width.

Fig. 4182.



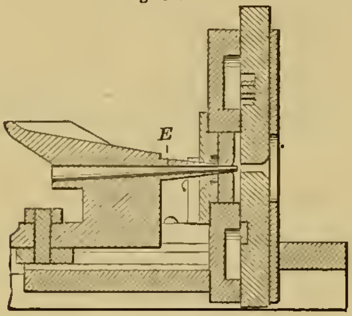
Rattan Splitting and Stripping Machine.

In the preparation of rattan for use, it gives occasion for the use of machines for straightening, washing, scraping the joints, slitting, stripping, dressing, or reducing, which is a planing and trimming operation, and polishing.

In one combined slitting and stripping machine a series of rotary cutters are pivoted in the end of rack-bars placed radially in the stock *G* and caused to simultaneously approach or recede from its center, so as to operate on the rattans as they are drawn through it by the feed-wheels. They are held to their work by springs, and accommodate themselves to the varying thickness of the rattan, which is then fed to a tubular cutter. Fig. 4182.

In Fig. 4183, the rattan, after being operated on by radial cutters, is presented to the tube or quill *E*, which may be adjusted at a variable distance from the cutters.

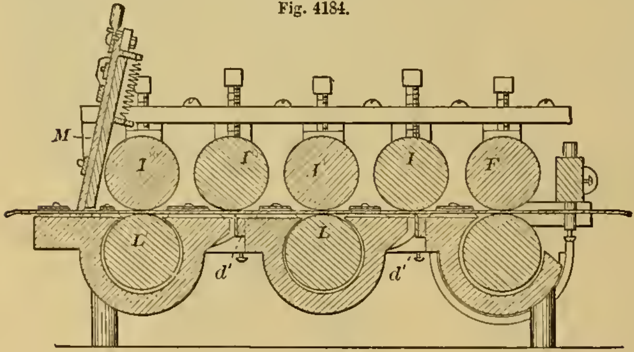
Fig. 4183.



Rattan-Stripper.

Machines for shaving off the joints and evening the strips are also used. In Fig. 4184, the first of these objects is effected by inclined knives *M*, and as the strip is drawn forward by the rolls *I‴ I″ I′ I L L′*, the pithy under-surface is removed by knives or scrapers *d d*, after which circular cutting-flanges on the roller *F* and its fellow trim the edges to an even width.

Fig. 4184.



Rattan-Shaving Machine.

Sawyer employs a tubular cutter, having an opening of hexagonal or other polygonal section, surrounded by radial ribs or fins, by which the outer coat is split, and at the same time separated from the interior, which is drawn through the tube.

Advantages are claimed for the hexagonally sectional form of the pith as peculiarly adapting it for its destined purposes.

Watkins has patented a method of uniting the ends of the separated strips by scarfing, removing the smooth, glossy part from the ends of strips, and joining them by cement, so that they may be formed into continuous lengths.

Also a process of saturating the pith when cut into strips, with a solution of shellac or other preparation, in order to harden it and render it adapted to purposes for which the outer surface only is usually employed.

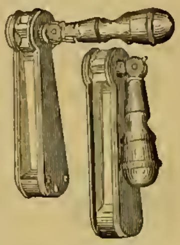
After being split off, the exterior rind is bleached, constituting chair *cane*, and put up in bundles of 1,000 feet. One hundred of these bundles make a bale.

Rat-teen′. (*Fabric.*) A kind of woolen stuff.

Rat′tle. *a.* An instrument consisting of a vibrating tongue and a rotating ratchet-wheel by which a sharp, *rattling* sound is produced to make an alarm. Watchmen were formerly furnished with them to sound a rallying signal, and they were kept in private houses to enable the occupant to call the watch or sound a fire-alarm. See WATCHMAN'S ALARM.

b. A child's toy made in a similar way, or consisting of a case of wicker-work or other material and inclosing small pebbles or other objects which produce a rattling sound.

Fig. 4185.



Policeman's Rattle.

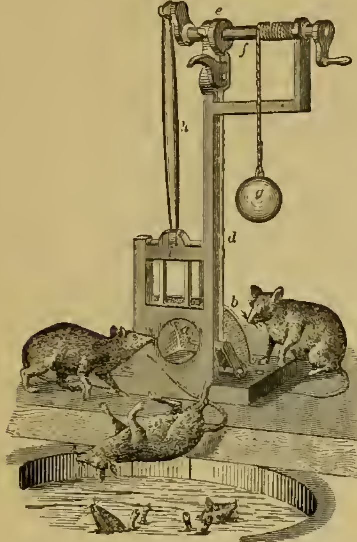
Rat′tler. (*Cutlery.*) A term applied by cutlers to a form of razor whose blade is ground very thin by laying it longitudinally on a stone and reducing the angle of the sides to about 15°. When the nick extends only a part of the way back, it is called a *half-rattler.*

Rat-trap. A device for catching or killing rats and similar vermin.

The older were generally of two well-known forms, — a wire cage, having funnel-shaped entrances with pointed wires at the inner extremity, through which the animal, attracted by the bait, could enter, but which opposed an invincible obstacle to his egress; and a pair of spring-jaws, which were forcibly closed when he attempted to remove the bait placed on a hook between them. Of late years the inventive faculty has been considerably exercised upon devices of this class. Among these are embraced, — revolving spikes, actuated by a weight; a portcullis, which impales the animal; doors which fall and inclose him; contrivances which knock him into the trap, or give him a killing blow (the sockdologer); double doors, of which the outer one closes when the rat enters, and is caused to open again when he passes through the inner, where he is imprisoned; traps with swinging doors, closed by the passage of the animal through them; traps which are automatically reset after he is secured or killed; peculiarly arranged dead-falls; tilting-boards and traps, through which he falls, and which then resume their usual position; and others.

In Fig. 4186, the bait is placed on a hook within the aperture *a*; it is protected on the other three sides by a wire-guard *b*, and, when disturbed, the hook partially rotates the rock-shaft *c*, releasing a lug at top of the rod *d* from contact with the tooth of the snail *e*, permitting the shaft *f* to rotate under the influence of the weight *g*, and through the medium of the pitman *h* causing the descent of the cross-head *i*, to whose under side are affixed two pins, which impale the animal when he meddles with the bait. The pins are disengaged from the animal's body and the trap reset by the onward movement of the shaft *f*, which continues its revolution until the snail *e* again engages the stop.

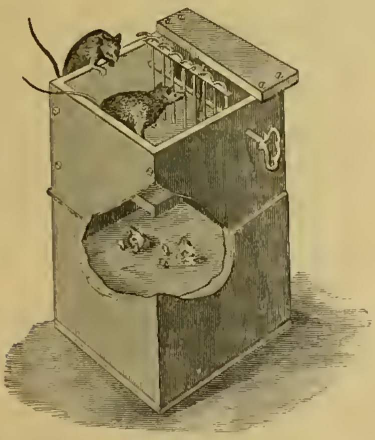
Fig. 4186.



Rat-Trap.

Fig. 4187 consists of a box having a hinged open top and a cistern below. The bait is protected by a wire guard having an opening in the middle large enough to admit the animal's muzzle. On seizing the bait a catch is released, allowing the pivoted platform to partially rotate by the animal's weight and drop him in the cistern below, when the depressed end again rises and the catching device is re-engaged, holding the platform in position until displaced by another nibble. See also ANIMAL-TRAP.

Fig. 4187.



Rat-Trap.

Rave. (*Vehicle.*) One of the side pieces of a wagon-body frame or of a sleigh.

Rave-hook. (*Nautical.*) A hooked iron for clearing old oakum out of the seams.

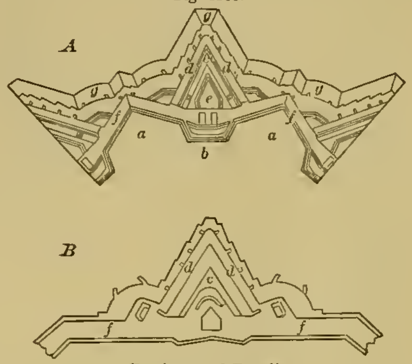
Rav'el. (*Weaving.*) A comb-like instrument between whose teeth the yarn-threads are passed when being distributed upon the beam of the loom. The *ravel* has a length equal to the width of the web, and maintains the order which the threads acquire in the *warping-mill.* A *separator.*

The ravel is also used in winding yarns from balls or hanks on to a *balloon.*

Rav'e-lin. (*Fortification.*) A detached work having a parapet and ditch forming a salient angle in front of the *curtain.* It is erected upon the *counterscarp*, and receives flank defense from the body of the place.

Inside the *ravelin* may be a *redoubt* and ditch; the *gorge* is unprotected, and the *ravelin* may be considered a *redan* upon the *counterscarp.*

Fig 4188.



Bastions and Ravelin.

In the figure: —
a a are the bastions of the main work.
b, Curtain.
c, Ravelin.
d d, Ditch of ravelin.
e, Redoubt of ravelin.
f f, Main ditch.
g g g, Glacis.

Rav'el-ing-en'gine. (*Paper-making.*) A machine for tearing rags for making into pulp for paper. A *teazing-cylinder.* See RAG-ENGINE.

Ra'vens-duck. (*Fabric.*) A quality of sail-cloth.

Raw-hide. The untanned skin of animals, such as the cow and buffalo; usually prepared by liming and scraping off the hair.

The hide is cut into a continuous strip, several of which are afterward twisted or plaited together to form a rope, which is immersed in a solution that tends to preserve and render it more pliable. Ropes of this material are preferred to chain, hemp, or manilla for tiller ropes, being stronger than the two latter, and not liable to break suddenly like the first.

A mode of making small belting from raw-hide by cutting into a continuous strip, stretching, and afterward treating with a preservative solution, was patented by a firm in Leeds, England.

Raw-silk. Reeled silk wound from the cocoons, several fibers forming one thread.

The cocoons are immersed in warm water to soften the natural gum on the filaments, and the ends of a number being gathered are wound as a single thread upon the reel. When the skein is dry, it is made into a hank. See SILK-REEL.

Ra-za'go. (*Fabric.*) Coarse tow-cloth of Spain.

Ra-zee'. (*Nautical.*) A vessel cut down to a less number of decks, as from a two-decker to a frigate. The opposite of one *raised-up.*

Ra'zor. A keen-edged cutting instrument employed for removing the hair of the beard and head.

The edge and the back of the blade are more or less curved, and lines drawn from each side of the back and meeting at the edge include an angle of about 18°. If made in one piece, the sides are slightly hollowed in grinding. The cutting part is, however, sometimes made much thinner, and of uniform taper from back to front, and inserted in a backing piece.

The blade is formed with a tang, which is fastened in the handle by a rivet. The handle has no back.

From distant ages the custom of shaving has descended to modern times, though in different times and nations the practice has varied, the scalp or the face, in whole or in part, being subjected to the operation.

The ancient Egyptians shaved the head and face regularly. The priests shaved all over every three days. They also bathed twice a day and twice each night. The wool of any animal was an abomination in the temple, and therefore they were scrupulously dressed in linen. So also were the Hebrew priests (see Ex xxviii. 42; Lev. vi, 10). Cotton was not known in Egypt except as a curiosity from India.

Joseph shaved himself before being presented to Pharaoh, and from their long residence in Egypt the Israelites came to adopt certain practices of a religious or social character. Moses made regulations concerning shaving, and special observances are prescribed in the ceremonies in taking the vows of a Nazarite, and in relation to the cleansing of lepers. This was about 1490 B. C. Samson was an unshaven man until he fell into bad company and lost virtue, strength, and sight. The comparison (Isaiah vii. 20) of the king of Assyria to a hired razor seems to infer the completeness of the operation he would perform upon the subject, and the comparison of the king to a traveling barber may have inferred contempt for the agent.

The shaven crown and braided cue of the Chinese were originally marks of subjection imposed by the Manchoo Tartars so late as A. D. 1627.

Perhaps it was only the present peculiar mode that originated in this way, as the Japanese follow the same practice, adopting, however, a different style of tonsure.

The Homeric heroes were bearded. The custom of letting the beard grow prevailed until the time of Alexander, when, according to Plutarch, in Lysander, and Athenæus, the Greeks began to shave, and continued to do so until the time of Justinian.

" And this custom of shaving the beard originated in the age of Alexander, as Chrysippus tells us in the fourth book of his ' Treatise on the Beautiful and on Pleasure.' And Diogenes, when he saw some one once whose chin was smooth, said, ' I am afraid you think you have great ground to accuse nature for having made you a man and not a woman.' And at Rhodes there is a law against shaving, but no one minds it. And at Byzantium there is a law against barbers being possessed of razors, but they shave none the less. So says the admirable Chrysippus." — ATHENÆUS.

" Ctesippus, the fine son of Chabrias,
Has ceased to shave himself three times a day.
A great man among women, not with men "
TIMOCLES: quoted in the " Deipnosophists."

Ctesippus, the Brummel of his time, became a proverb: —

" And I, too, once was a young man, O woman,
Nor did I then five several times a day
Bathe, as I now do bathe; nor at that time
Had I a soft cloak, such as now I have,
Nor such perfumes as now; now, I will paint myself,
And pluck my hair, by Jove! Aye, I will be
Ctesippus; not a man; and in brief time
I too, like him, will eat up all the stones."
MENANDER.

Ctesippus had sold the stones of his father's tomb to obtain means for his luxury.

In 454 A. U. C., Paulus Ticinus Mænas imported barbers into Rome from Sicily. They were at first peripatetic, but afterward had shops, which became the lounges of the metropolis, as we find by the contemporary poets and satirists. Pliny says that Scipio Africanus was the first Roman who shaved daily.

As early as Hippocrates some surgical operations were regarded as beneath the attention of physicians, and were relinquished to the barbers. The Council of Tours, in 1163, prohibited the clergy from performing bloody operations, and the barbers became the possessors of their practice. Barbers were incorporated with the surgeons of London by act of Henry VIII., but were deprived of this association early in the eighteenth century. In Holland and Germany the mixed practice still continues.

After many hirsute centuries shaving again became common under Louis XIII. and XIV of France, each of whom ascended the throne in infancy, and thus made smooth chins fashionable.

During the reigns of Elizabeth of England, and Peter of Russia, laws were enacted to compel certain classes to shave. The people were disgusted.

In Spain and Portugal the whiskers became the great objects of attention, and the loss of honor was followed by the loss of whiskers. John de Castro, in the reign of Catharine, Queen of Portugal, pledged one of his whiskers to the merchants of Goa, as security for a loan of 1,000 piasters.

The whiskers belonging to the image of Confucius are supposed to be capable of imparting wisdom and manly beauty to any one who may wear them. Unfortunately, decapitation is the reward of any one who removes them from the image, so that their virtues are never tested.

Artificial hair was used by the Egyptians, Carthagenians, Greeks, and Romans. A splendid wig has been preserved in one of the Egyptian tombs, and is now in a European museum.

Wigs were again brought into use in France about 1629, and the practice spread throughout civilized Europe. Kings, courtiers, and the devotees of law, physic, and divinity were not full dressed without a wig. The absurd idea yet obtains. Horsehair and goat's hair yet protect or parch the legal and judicial brain in the " *tight little island.*" See HAIR, par. 6, page 1047.

Cortez found the Mexicans using razors of obsidian.

Pepys, in his Diary (May, 1662), recommends " trimming one's self with a pumice-stone, which I learnt of Mr. March, and I find it very easy, speedy, and pleasant."

Among the Knights of the Razor are to be found enrolled the great inventors Ctesibus, Arkwright, and the great English painter, Turner; the latter was a very humble member of this ancient and honorable fraternity, and was dropped from the rolls of the order at quite an early age, having shown a degree of genius for drawing which was perhaps deemed incompatible with his success in his hereditary profession.

The order of procedure in making the best razors is as follows: —

1 The blade is molded.
2. Forged.
3. Ground and *scorched* to take off the black scale.
4 Drilled for the joint, and stamped with the name.
5. Hardened and tempered.
6. Ground.
7. The shoulders are ground on a dry stone.
8. The blade is ground on a leaden *lap*, which gives the true curve to the surface.
9. The tang and back are glazed by a leather glazer.
10. Polished on a buff-wheel with crocus.
11. Handled.
12. Set.

Razor-blades are forged from cast-steel (except the cast-iron ones); the bars being tilted to ½ inch in breadth, and a thickness equal to the back of the razor.

The blades are heated in a coke or charcoal fire, and dipped into the water obliquely. In tempering, they are laid on their backs upon a clear fire, about half a dozen together, and they are removed, one at a time, when the edges, which are as yet thick, come down to a pale straw color. Should the backs accidentally become heated beyond a straw color, the blades are cooled in water, but not otherwise.

Holtzapffel agrees with Stodart, that the best cooling mixture is water at 40° Fah.

Shavings of leather, added to the fire, are said to prevent the cracking of the razor when plunged into water.

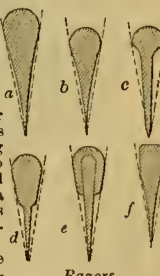
After tempering, they are ground on a stone of 5 or 6 inches diameter for the finer, or from 12 to 15 inches diameter for the coarser, kinds, and afterward on a lap charged with fine emery in oil; two *courses*, the last with finer emery than the first, being employed.

The final polishing is effected on a soft leather wheel charged with crocus, both the wheel and razor being heated

As the glazing and polishing wheels revolve away from the edge, a wire edge is left, which is *struck off* by tilting it up and sweeping it, edge foremost, over the face of a hone. Should the wire edge still remain, it is drawn perpendicularly over a strip of horn, and the sweeping operation repeated.

It is then honed, being laid flat on the side for this purpose. The manner of rubbing the edge against the stone varies among different operators, some preferring a long and sweeping and others a zigzag motion, while others again employ short circular or elliptic strokes; all, however, agree in working from heel to point. Should the wire edge arise during this process, it must be rubbed off on the horn as before. The work is then finished on the strop.

Fig. 4189.



Razors.

The keenness of its edge may be tested by drawing it obliquely across the thick skin of the palm of the hand, but the cutler also tries it upon the finger-nail, holding it at right angles to the nail and slightly drawing it, by which means a very slight notch or inequality may be detected.

When viewed with a magnifying power of 50 to 100, the edge of a razor exhibits a series of faint undulations, resembling ripple-marks These, however, offer no impediment to its cutting properties, and unless imperfections are visible when a power of 20 to 30 linear measurement is used, the razor will generally prove satisfactory.

The hollowed form is imparted to the side to reduce the quantity of metal required to be removed in sharpening. *a b* show the most ordinary forms; each is ground transversely, the former on a wheel of 12, and the latter on one of 4 inches diameter.

In some cases, as *c*, the blade is ground longitudinally, giving it a thinner edge; these are termed *rattlers* by the Sheffield cutlers in consequence of their tendency to vibrate when shaving a heavy beard. Others (*d*) are ground in both ways. These are called *half-rattlers*. *e* is formed by setting the blade in a backing *f* has a brass frame or guard to prevent persons whose hands are tremulous from accidentally cutting themselves. It is called a guard-razor.

Ra'zor-pa per. Smooth, unsized paper, one side of which is treated with a composition of crocus and flour-emery in powder. It is used to wipe the razor, and is intended as a substitute for the strop.

Ra'zor-strop. An implement for sharpening razors or other thin-edged tools. It usually has a handle and a case for receiving it when not in use. Some kinds have but two abrading surfaces, — that to which the razor is first applied, consisting of leather thinly coated with fine emery-powder; and the second, by which keenness of edge is finally imparted, of leather alone. Others have four sides, coated respectively with a hard composition and with leather of different degrees of fineness, to which the razor is successively applied.

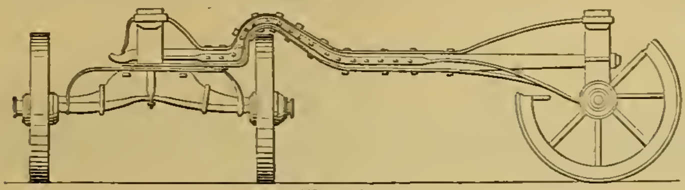
Barbers keep their razors in order after being once *set* by rubbing on a leathern strap suspended by one end, and held by the other.

Reach. 1. (*Vehicle.*) A pole connecting the rear axle to the *bolster* of a road-wagon. A *coupling-pole.*

Some modern carriages have none, the *bed* or body performing that duty.

A reach for a certain description of city wagon is shown in Fig. 4190. It is arched in front, so that the fore wheels may pass under it, enabling the vehicle to be turned in a shorter space. The circular sway-bar is extended, so as to support the reach when turned in any position.

Fig. 4190.

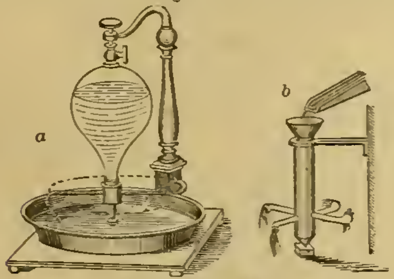


Wagon-Reach.

2. (*Hydraulic Engineering.*) That portion of a canal between two locks having a uniform level. Also called a *pond.* *Locks*, *lifts*, *inclines*, *slides*, or *sluices* connect *reaches* of different levels.

Re-ac'tion Wa'ter-wheel. A wheel to which a rotary motion is imparted by the action of streams of water issuing tangentially from its sides under the pressure of a head of water entering it from above. The principle, which is that of recoil, is embodied in *Barker's mill* and in the turbine. It differs in nothing from Hero's Æolipile, except that in the latter steam under pressure is the motor. Reaction water-wheels are made single or double, the latter having two on a single shaft. One form has radial buckets on which the water confined in a vertical chute impinges (see FLUTTER-WHEEL) and then escapes at the ends through wheels on the reaction principle. This form has a horizontal axis. See also TURBINE.

Fig 4191.



Reaction Water-Wheels.

The motive power exerted by liquids escaping horizontally is illustrated by a device called the hydraulic tourniquet (Fig. 4191), consisting of a vessel pivoted at its upper and lower extremities and having two pipes at bottom whose ends are bent in opposite directions. On filling the vessel with water, it escapes through these tubes, causing the vessel to revolve on its axis.

Perley and Pattee's saw-mill, at the Chandière Falls, Ottawa River, Canada, has 6 gang-saws, each driven by a Rowe reaction-wheel, 5 feet in diameter, 400 inches sectional area of discharge. The head is 14 feet, and the power of each is about 70 horses.

Read'ing-glass. A large magnifying lens, used to assist in reading, etc.

Read'y Reck'on-er. A table or an instrument for making simple calculations, as the amount of wages due a workman for a given time, etc.

Re'al Ra'di-us. (*Gearing.*) The radius of the circle touching the crests of the teeth of a cog-wheel. The radius of the *pitch-circle* is called the *geometrical radius.*

Ream. A quantity of paper of any size containing 20 quires or 480 sheets. A common practice is now to count 500 sheets to the ream.

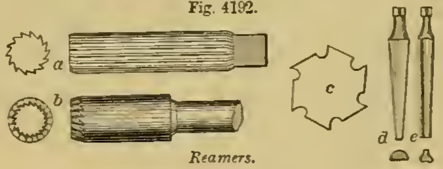
Ream'er. Sometimes, but incorrectly, written *rimmer.* A tool used to enlarge a hole and bring it to a shape the counterpart of the tool, whether cylindrical or tapering.

Broaches are *reamers*, being multiple-sided taper rods, whose angles cut the sides of the holes in which they are rotated. See BROACH.

The reamer is used in *truing* or rounding the holes made by a rock-drill.

As a machinist's tool (*a b*), it is fluted and slightly tapering; the blades being worked out of the solid metal by planing or milling on a machine. The flutes are then *backed off* like a *tap* to give a saliency to the cutting-edge.

Fig. 4192.

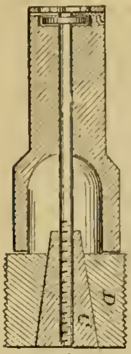


Reamers.

Instead of mere longitudinal fluting, the grooves in the tool may be made spiral, a right and a left hand, crossing obliquely so as to leave the surface in diamond-shaped portions. The flutings are then planed out and backed off, the result being a toothed reamer *c* of effective character.

The flat-sided reamers, such as *d e*, triangles, squares, and pentagons, are properly termed *broaches.*

Fig. 4193.



Expanding Tap and Reamer.

Tools to be driven through a hole are Drifts (which see).

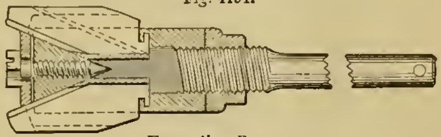
Half-round reamers are used in braces to enlarge holes in sheet-metal or small castings.

A revolving tool which cuts one size as it goes is a *drill.* A *reamer* is a cutting tool for enlarging a hole, and should enter the hole a piece before it begins to cut, so as to work steadily and straightly. This is not descriptive of the action of a drill, even though employed to enlarge an opening, as the *cored-out* hole in a casting.

In Fig. 4193, the cutters *D* are made in sections, having dovetail projections fitting grooves in the conical plug *C*, which is drawn upwardly so as to expand the tool radially to cut a dovetailed or undercut recess.

In Fig. 4194, the cutters are moved longitudinally by connection with a nut on the shank, and are driven outward in their guide-slots by the conical end of the shank.

Fig. 4194.



Expanding Reamer.

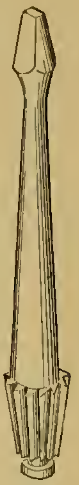
Ream'ing-bit. A broach of hardened steel having a taper form and angular cutting-edges. See Bit.

Fig. 4195 has a guide at the end of the reamer to fit the hold to be enlarged and maintain the reamer in central position.

It is used for boring out truly or enlarging a hole commenced by a bit of ordinary construction. It has usually a shank about as large as the hole made by its cutting-face, to insure the straightness of the hole. Frequently, it has cutting-edges on its cylindrical portion, and acts to dress off irregularities and make a perfectly cylindrical opening.

Reaming-bits are used in drilling metal; also in dressing to roundness and enlarging the size of holes bored by rock-drills. See Reamer.

Fig. 4195.



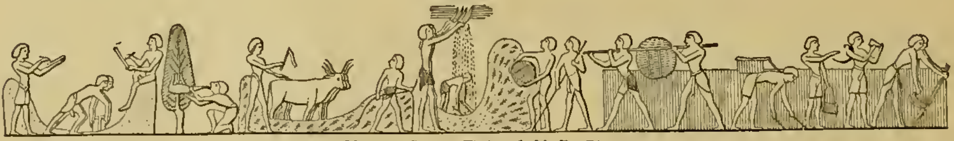
Reaming-Bit.

Ream'ing-i'ron. (*Calking.*) A blunt chisel used for opening the seams between the planking of a ship preparatory to calking them with oakum.

Reap'er. A machine for cutting grain in the field. Wheat and barley were commonly cultivated in ancient Egypt. The former was cut in five months after sowing, the latter in four. The wheat was bearded, and generally cut below the ear, as in the annexed figure. It was cut with a smooth-edged or a toothed sickle. Both are represented in the tombs, and illustrations are given in this work under the caption Sickle.

The whole series of harvesting and thrashing operations are shown in the accompanying illustration, which is from a tomb at Thebes of the probable date of 1490 B. C. The condition of the standing wheat shows that it was cut below the ear. Two men are working together, and, according to the then usual mode of representing such things, the motions of the parties are exactly simultaneous. The next man is taking a drink, sickle over his shoulder, in a manner quite customary among us, at this distance of thirty-three centuries. The man behind him is probably a gleaner, and urges him to hurry, as he too wants a drink. Next is shown a gleaner with his basket slung upon his back. He picks up the scattering ears and jerks them into his basket, like the chiffonier of Paris with his rags. We next see two men with a rope basket, carrying the ears from the field to the heap where they are tramped by cattle; a man tending with a whip and another throwing in the ears with a three-pronged fork. Then comes the winnowing; men with scoops lift the grain and chaff, throwing them up in the air, that the wind may blow away the chaff. By this time all parties are dry, and here is a kid-skin bottle hanging in the tree and a dusty Copt taking a pull at it. The next scene is at the grain-heap, where two scribes keep tally, — one, of the amount brought from the winnowing-floor, and the other of the amount sent to the granary.

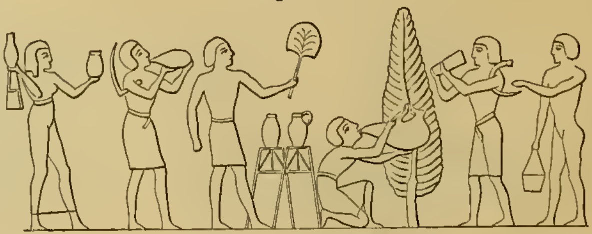
Fig. 4196.



Harvest Scene (*Thebes*, 1490 *B. C.*).

Another harvest scene from the tombs is worth noticing in this connection, though the part selected is more specific in the refreshment line than in the work performed. In Egypt, as with us, the cool drink at the end of the row was not the least pleasant part of the day's experiences, but they could not rest in the shady fence-corner for lack of the trees and the fences. In the drawing, one tree lends its welcome shade, and to a limb is hung the kid-skin bottle at which the "fellah" is sucking. On the stand are two jars waited on by another "fellah" with a flabella, — call it a fly-brush. A thirsty man is devoting himself to a bottle, and a female comes up with a fresh supply. Another reaper, sickle on

Fig 4197.



Harvest Scene (*Time of Moses*).